The Impacts of Household Water Quality Testing and Information on Safe Water Behaviors: Evidence from Randomized Experiment in Ghana

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Abstract

Households in developing countries face an enormous set of health risks from using contaminated water sources. Using a randomized experiment, we investigate the impacts of household water quality testing and information on safe water behaviors. In southern Ghana, we offer households the opportunity to participate in water quality self-testing and receipts of water quality improvement messages (information). The treatment group was separated into two groups, (1) school children intervention group and (2) adult household members intervention group to identify the most effective channel in the delivery of water quality information. The comparison group neither participated in the water quality self-testing nor received information. Participation rate, which is used as a proxy for uptake, is high among school children intervention group in comparison to adult household members intervention group. The household water quality testing and information experiment increase the choice of improved water sources and other safe water behaviors. We do find limited evidence based on gender of participants, especially in terms of improved water source choices. School children intervention group compared to the adult household members intervention group is the most effective channel in the delivery of water quality information, thereby making a strong case of using school children as "agents of change" in improving safe water behaviors. The study implies that household water quality testing and information could be used as "social marketing" strategy in achieving safe water behaviors. The study has also implications on the Sustainable Development Goals, especially on microbial water testing and safe water behaviors.

Keywords: Information; Agents of Change; Water Quality; Health Behavior; Randomized Evaluation; Water Storage; Water Transport; Water Treatment; Africa; Ghana

JEL classification: C93; D83; I12; O10; O12; Q25; Q50; Q53; Q56

1. Introduction

Worldwide, inadequate access to improved drinking water sources affects about 663 million people, with sub-Saharan Africa accounting for about 50 percent of the population without access to safe water sources (UNICEF and WHO, 2015). According to Bain *et al*. (2014), drinking water sources for about 1.8 billion people worldwide suffer from fecal matter contamination, rendering the water unsafe for human consumption. Furthermore, several water sources considered to be "improved" (based on WHO/UNICEF criteria) are not good enough for consumption.

In many developing countries, provision of water is mainly regarded as public good whilst many water resources are usually considered as common property resources (Kremer *et al.* 2011), thereby shifting the burden of water quality testing and information to providers (or state actors) rather than consumers (or private individuals and households). But a major challenge to the provision of improved water sources to householders is the potential of recontamination during water collection, transportation and handling from point of source (POS) to point of use (POU). This therefore, requires additional efforts from water users (both individuals and households) in ensuring the safety of water for both drinking and general purposes through behavioral changes.

In 2012, global diarrhoea deaths associated to poor quality of drinking water was 502,000 (Prüss-Ustün *et al*. 2014). Therefore, several lives could be saved through provision of quality drinking water sources to the populace in developing countries. Ghana, like many other countries in sub-Saharan Africa, is prone to several forms of water, sanitation and hygiene (WASH) related diseases. For instance, cholera outbreak which started in June 2014 claimed about 243 lives nationwide as at January 2015, with total reported cases of 28,922. The cholera epidemic affected about 60 percent of all the administrative districts of Ghana. Greater Accra region (the study location) was the hardest hit in terms of the cholera outbreak. Between 28 December 2014 to 4 January 2015, there was a nationwide reported cholera cases of 102 with Greater Accra region alone accounting for 98 percent (i.e. 100 cases) of those cases (Ghana Health Service (GHS), 2015). Several factors accounted for the cholera epidemic including poor waste disposal, inadequate drinking water, inadequate personal hygiene and poor sanitation.

In many developing countries including Ghana, "formal" household water quality testing is virtually non-existent with many households relying on the physical properties (or traditional approaches) including color or odor of the water as indicators for the quality of drinking and general purpose water whilst others also use visual (or ocular) method to determine the quality of drinking and general purpose water. These approaches are not only insufficient but they are not reliable ways of identifying polluted or contaminated water, because these contaminants are mostly not visible with the eyes, which require some form of "formal" water quality testing to identify the type of contaminants present or absent in water.

This study relates to several other works. First, the study uses data from three rounds (waves) of household surveys (through in-depth structured interviews) to assess the potential effects of household water quality testing and information on a variety of household safe water behavior changes. The analysis techniques introduce robustness and sensitivity checks to obtain valid estimates. Furthermore, the study becomes more important based on household use of multiple drinking and general purpose water sources, which is among the least researched areas in terms of both water quantity and quality issues.

Second, the study is related to growing literature on water quality improvement and its effects on household health outcomes and WASH behavior changes. Devoto *et al*., (2012) shows that "information and facilitation drive" on household private tap water connection leads to improvement in wellbeing/welfare, even though there may be no health and income improvements. In Günther and Schipper (2013), the provision of safe water storage and transport containers leads to improvement in water quality and health outcomes (decrease in diarrheal diseases). Kremer *et al*., (2011) studied the impact of spring protection on water quality and health outcomes. They show that spring protection leads to reduction in diarrheal diseases and improvement in water quality. Water quality information to households is known to improve WASH behaviors (Madajewicz *et al*., 2007; Hamoudi *et al*., 2012; Jalan and Somanthan, 2008). But a systematic review by Lucas *et al.*, (2011) suggested that despite several studies on water quality testing and dissemination of drinking water contamination data to households, rigorous impact evaluation studies are needed. This study fills this gap in literature.

Third, this study makes contribution to the growing literature of water quality testing and information and its effects on household and individual health outcomes and WASH behavior changes. We provide what to the best of our knowledge the first study to apply multiarm randomized evaluation to study the heterogeneous impacts of household water quality testing and information on safe water behavior changes. Being the first (based on our knowledge) to apply multiarm randomized evaluation of household water quality testing and information, we are able to compare the impacts based on gender (male versus female) of participants and type of household member (children versus adults). None of the previous studies analyzes the channels for the delivery of water quality information. In addition, the study used on-field water testing kits (Acquagenx's Compartment Bag Test (CBT)) which quantifies the level of fecal contamination of a given water sample. This is an improvement on previous studies (e.g. Brown *et* al., 2014; Madajewicz *et al*., 2007; Hamoudi *et al*., 2012; Jalan and Somanthan, 2008) that used presence or absence test kits. The study design is based on self- water quality testing and recording of results at the household level. This is an addition to literature since previous studies were based on water quality testing and dissemination of information by field assistants.

Finally, we contribute to current literature and discussions on the need for microbial monitoring of water quality as indicated by the United Nations Post-2015 Sustainable Development Goals (SDGs), providing evidence on the practical ways (or learning experiences) of achieving such monitoring framework in poor resource settings.

The study is organized as follows. Section 2 describes the water quality testing and information experiment, and data. Section 3 presents the impacts of the intervention on safe water behaviors. The section also presents the estimation strategy in analyzing the water quality testing and information experiment impacts. Section 4 draws conclusions.

2. Water Quality Testing and Information Experiment, and Data

This section describes the water quality testing and information experiment, allocation into treatment and comparison groups, data collection and attrition.

2.1 Water Quality Testing and Information Experiment

AG-WATSAN Nexus Project

The AG-WATSAN Nexus project, Ghana is a subset of a broader project implemented by Center for Development Research (ZEF) of the University of Bonn in collaboration with project partners in four countries (Ethiopia, Bangladesh, India and Ghana). The Ghana project was implemented in conjunction with Institute of Statistical, Social and Economic Research (ISSER) of the University of Ghana. The Ghana project fits into the main thematic area of the project which is investigating the linkages and synergies between agriculture, and water, sanitation and hygiene. The Ghana component was mainly an experimental study involving school children and adult household members on how water quality self-testing and information could improve household WASH behaviors and water quality. The study also looked at the potential benefits in terms of health outcomes as measured in diarrhea rates reduction and impact on children health (through anthropometric measurements). The AG-WATSAN Nexus Project, Ghana allowed participants to undertake water quality self-testing and use their experiences in household water management. The project performed key activities such as encouraging households to get involved in water quality testing and using the information in managing household water, providing training on water quality testing including water sample collection, delivery of portable water testing toolkits (Acquagenx's CBT) and water testing results diary/score sheets. Water quality improvement messages in the form of handouts were distributed to participants. Finally the project also provided platform to discuss water quality information after water quality testing training programs.

Water Quality Testing and Information Experiment Design

List of eligible participants was compiled from the household listing/tracking data obtained in March 2014 and baseline household data completed in April-May 2014. Participants in the water quality testing and information treatment arms were first of all informed of their selection and explanations were provided about the water quality testing intervention using the Acquagenx's CBT through the school teacher in charge of the project at the public basic school level. The project was explained to the understanding of the participants as a joint study between ZEF and ISSER to help households improve their WASH environment, and also understand WASH issues in rural and urban areas in Greater Accra region. Four main design decisions were made in regard to the water quality testing and information experiment: type of water test kits, the number of test kits per participant, training approach and timing, and personnel to be hired. The type of water test kits was Acquagenx's CBT. This test kit fits the study since it allowed us to quantify the level of *E. coli* in a given water sample. We decided against using the present and absent test kits due to potential of false predictions/results.

For the number of test kits per participant, it was decided that the number will be fixed at two per participant. This was done to allow participants to perform the water quality self-testing using different water sources available to the households. Furthermore, households rely on multiple water sources for drinking and general purposes, and also factoring in cost of the test kits we decided that two test kits per participant would be enough for the self-water quality testing. In relation to training approach and timing, we decided to use a group based training procedure for the experiment which was deemed to be more cost-effective than individualize (door-to-door) delivery. Association with other participants (for instance participation together with other community members) could serve as catalyst for active involvement in the study. The group based approach presents practical lessons since provision of the experiment free of charge will not automatically mean that everyone will take it. Individualize delivery approach assumes that providing the intervention to the households free of charge means everyone will automatically take the intervention. Distance and time constraints could serve as an additional barrier to participation in the water quality testing and information and this is largely ignored by individualize delivery approach.

Due to logistical and administrative challenges, the first round experiment (period one experiment) had to be made in two phases. The first phase was the training on the use of water testing kits, and the second phase involved water quality self-testing by the participants using their own water sources. The training workshops/sessions were organized at a selected date and time (in consultation with the public basic school authorities) during the first to third week of July 2014. The timing was done in consultation with school authorities since the schools played two important roles: (1) use of school children as one of the treatment arms and also in order not to disrupt academic exercises, (2) schools served as venue for the training workshops.

The training workshops employed a variety of teaching and learning methods which included presentations, plenary discussions, and group work, among others. The training workshops therefore applied experiential learning approaches with limited formal training. This improved the knowledge and understanding of participants on the activities of water quality testing and information intervention. The training workshops were based on demonstration (practical sessions) with the distribution of water test kits for group-based practical sessions. The training workshops also included water sample collection. The training workshops were undertaken in the various local languages, under the close supervision by the ZEF/ISSER survey team. Each intervention group met twice for about one hour to one and half hours for the training workshops. The first meeting was for the initial water quality testing, with second meeting used for recording of results and discussions on the steps to improve water quality at the household level.

The second phase of the period one experiment involved the delivery of water test kits and households performing self-water quality testing. The water test kits were delivered in the second week of October 2014 (three months after the training workshop). Water quality improvement messages (information) in the form of hand-outs (available upon request) were also distributed to the participating households. Each household was given two copies of the hand-outs for reference and also discussions with other household members. The hand-outs containing the water quality improvement messages were designed using messages from previous studies such as Brown *et al,* (2014) and Hamoudi *et al,* (2012). The water quality self-testing was done at the convenience of the participants and recording of results made on a sheet/diary provided by the study team. Participants in the adult household members intervention group were notified to submit results, through the contact person (selected pupil) to the school teacher in charge of the project at the public basic school, whilst participants in the school children intervention group submitted the results directly to the school teacher. Following Karlan *et al*., (2014) the study did not impose strict compliance on when to test water and also to submit results, since we could not control participant's behavior. Participants were given flexible time frame (for example one week period) for completion of water testing and also submission of test results. This was made flexible as possible, by extending the submission date for some of the treatment arms.

Finally, we decided to use health officers (specifically community health nurses) for the training workshops. The community health nurses were chosen because of their experience in performing community outreach programs on health behaviors. Two days' training session using a well-designed training protocol (available upon request) was held for community health nurses in order to familiarize themselves with the water quality testing and information experiment. Here three female community health nurses (based on availability) were hired to undertake this task. To avoid ethical issues, community health nurses on annual leave were employed for the task. The community health nurses were supported by one project staff to undertake the training exercise. Two teams (made of two persons each) were formed for the training workshops (one team for each of the two study districts). Monitoring and supervision was undertaken periodically to ascertain the performance of the hired community health nurses.

The second round of the intervention (period two experiment) was undertaken in the second week of March 2015, after the completion of third round of household survey. Hired field assistants delivered water quality improvement messages (information) to the participants of the first phase of the intervention. The water quality improvement messages were the same ones used during the first round (period one experiment) of the water quality testing and information experiment. For the adult household members intervention group, we employed individualize delivery (which was more practical) by visiting the participating households. In the case of school children intervention group, we used the group based approach where the students were assembled in their respective public basic schools for the exercise. Each participant were then given two copies of the hand-out containing the nine water quality improvement messages for reference and also discussions with other household members.

Due to costs and time constraints, we could not randomize the water quality testing and information experiment to test the effect on using different options on type of test kits, number of test kits per participant, training approaches and timing, and also type of personnel hired for the training exercise. These are some of the areas for future research. For instance, what are the tradeoffs between using individualize delivery versus group-based approach, and also imposing strict compliance of training schedules and delivery of test results versus voluntary attendance of training schedules and flexible compliance on delivery of test results.

2.2 Sample Frame and Randomization of Water Quality Testing and Information Experiment

In order to obtain a representative sample frame for the water quality testing and information experiment, we applied a variety of sampling techniques. The sample design takes into consideration the inclusion criteria in choosing the study setting such as use of unimproved water systems and sanitation services, and being located in multipurpose water system. This was to achieve the overall aim of the AG-WATSAN Nexus project of understanding the linkages between agriculture, and water, sanitation and hygiene. In order to obtain the required preliminary data on households, an institutional survey (data collection exercise using designed questionnaires) was conducted in public basic schools, and water and sanitation (WATSAN) committees in the two selected districts (Shai-Osudoku district and Ga South Municipal) in the Greater Accra region of Ghana. This was done to understand the existing WASH situations in the localities and also to identify communities located in multipurpose water system. The WATSAN committee survey which was basically a community survey together with public basic schools data therefore represent the initial sample frame.

The initial stage of the data collection exercise (institutional survey) yielded interviews with 35 WATSAN committees and 48 public basic schools. The public basic schools and WATSAN committees data collection exercise was conducted during the second week of December 2013 by Center for Development Research (ZEF) of University of Bonn, Germany in collaboration with Institute of Statistical, Social and Economic Research (ISSER) of University of Ghana, Legon. During the public basic school survey, we obtained the school register for pupils from grade five to eight. This represents a student population of 4651 from the 48 public basic schools interviewed. Eligibility criteria for the participating public basic schools required that there is both primary and junior high school located on the same compound. Further the study targeted school children in the upper primary (grade 5-6) and junior high (grade 7-8). Grade 1-4 students might be too young to undertake water quality testing. This was the main reason for their exclusion from the study. Grade 9 school children were dropped from the study due to potential "loss" of participants after completion of basic education certificate examination (BECE). Upon basic school completion, some might migrate to other communities which might be difficult to track during survey periods.

The household baseline survey was based on cluster random sample (preferably multistage cluster random sample), with random selection of students to represent the households based on sampled public basic schools. From the institutional data (initial sample frame), communities and public basic schools were selected from the study sites based on existence of multipurpose water system, and dependent on unimproved water and sanitation services, and then within each public basic school, we selected pupils (who represented the households). The sampling procedure using STATA software takes into consideration the grade and also gender of the student.

Upon completion of sampling, a household tracking/listing exercise was undertaken in March 2014 to identify all the selected students and their respective households. Selected siblings from the same households were replaced with students from different households from the same school, grade and gender. During the household baseline data collection, within each selected household, the household head or individuals (for instance, spouse) who are knowledgeable in WASH practices were interviewed. Other criteria for individuals interviewed included those who usually make decisions on household WASH. In addition, selected pupils were also interviewed on WASH knowledge and practices at individual and household levels (only limited to school children intervention arm during period one experiment). In all, the sample design yielded a total household sample of 512 (i.e. 32 students per 16 selected public basic schools). This represents the sample frame for the household baseline data collection used for the water quality testing and information experiment.

The study involves water quality testing and information delivered to the two treatment arms; (1) school children intervention group and (2) adult household members intervention group.

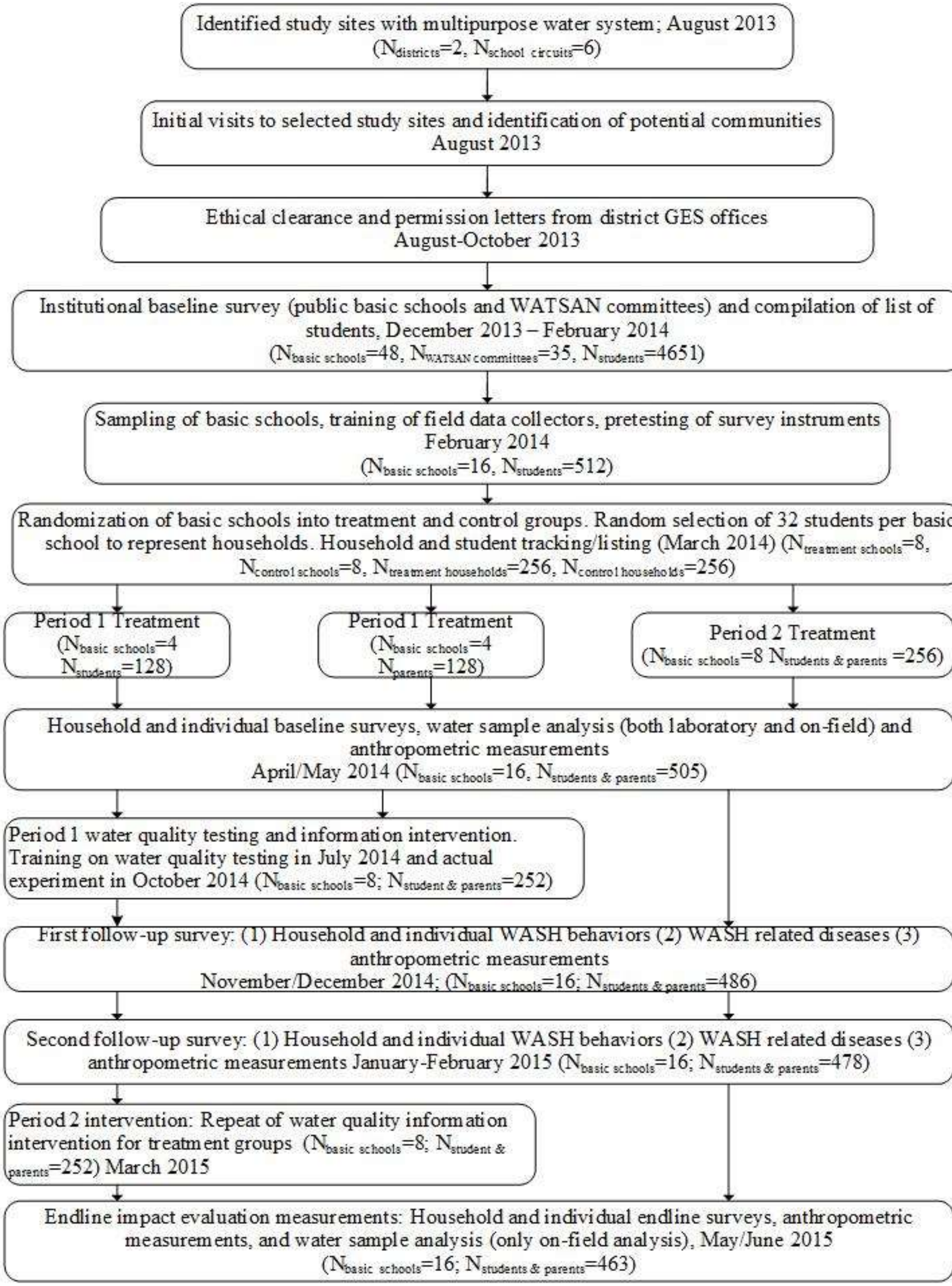
The 512 households were randomly allocated into one of the two experimental blocks by equal proportions (to achieve balance design): 256 water quality testing and information and 256 to comparison group (no water testing and no information). In the case of 256 participants for the water quality testing and information experiment, the total number of participants was separated into equal proportions of males and females, and also adult household members and students. This is to identify the most effective channel for WASH information delivery. Here there were 128 adult household members and 128 students. This was further apportioned as 64 boys and 64 girls for the students, and 64 males and 64 females for the adult household members. In order to achieve balance in the gender of participants for the adult household members, selected males students were to be represented by their fathers or male guardians whilst the female students were to be represented by their mothers or female guardians. Since not all selected parents/guardians would be available for the experiment, we allowed the selected households to delegate. The delegate was to be of the same gender of the selected students. This makes the reference to this intervention as adult household members intervention group instead of parents/guardians intervention group (refer to Appendix Table A1, and Figure 1 for the sample frame, randomization design and timelines for the experiment).

There are mainly two types of randomization for impact evaluation of WASH-related interventions involving schools and school children. These are: (1) within-school randomization designs and (2) across-school randomization designs. These two approaches differ in scope, objectives of study and its application. Within-school randomization design is essential in identifying "peer effects" but its major weakness is that it could limit the "true" size of the effects/impacts of the interventions due to contamination. According to Miguel and Kremer (2004), within school randomization designs on worms prevention affects the possibility of objectively analyzing spillover effects. Miguel and Kremer (2004) further highlighted that "across pupils within schools" randomization is essential in using experimental procedures in analyzing the main effects of intervention schools into both "direct effect and within-school externality effect". One way of dealing with contamination is through blinding of the respondents or interventions. Whilst across school randomization design is helpful in limiting the potential sources of contamination of the control groups, other factors such school and household characteristics cannot be controlled, especially in smaller sample studies.

The study applies cluster-randomized evaluation design. Due to within-school interactions between school children and teachers, the study's unit of randomization is the public basic school whilst the unit of analysis is at the individual and household level. Therefore households stratified by community and public basic school (unit of randomization) were assigned to the treatment arms. Randomization was conducted anonymously and it was undertaken by a third party (the so-called third party randomization) with no interest or whatsoever in the study. Furthermore, the baseline household data obtained was used to verify the randomization process by performing the mean orthogonality tests based on observable attributes/covariates across the treatment arms. Participants were “blinded” as much as possible in terms of details of intervention to avoid them knowing what other groups were doing. Furthermore, selected public basic schools were far apart (at least 3 kilometers apart) to limit interaction between the treatment and comparison groups. This means conscious effort was made not to leak too much information concerning the study locations and treatment arms. The experiment was presented to the participants as a research study between ZEF and ISSER, and also community and school WASH awareness program.

Summary (descriptive) statistics based on comparison of means of each treatment block to the control group (for instance, use of t-test or *p-value*) and also F-test for regressions based on the covariates in the treatment blocks was undertaken. The regression of the covariates on the various treatment blocks was undertaken to ascertain the randomization process and imbalances by identifying statistically significant variables across the allocation of treatment arms (see Karlan *et al*., 2014; Devoto *et* al., 2012 and Kremer *et* al., 2011 for more information).

Figure 1: AG-WATSAN Nexus Project Timeline, 2013-2015



2.3 Data Collection

The study (including consent and assent form) has ethical approval from Ethics Committee of Center for Development Research as well as the Noguchi Memorial Institute for Medical Research (NMIMR), Ghana. At NMIMR the study is registered as NMIMR-IRB CPN 017/13-14 and Federalwide Assurance FWA 00001824. The study also had written permission letters from the two district Ghana Education Service (GES) offices.

The study relies mainly on one data source: (1) household survey data. The household survey data have been collected on a wide range of variables on the households and their respective members through structured interviews and in case of children under seven years, anthropometric measurements. The household survey data was conducted on four different time periods (survey waves) making it possible to estimate both short-run and medium term impacts of the water quality testing and information experiment. The survey waves have quarterly timeframe. It should be noted that the timeframe was not strictly quarterly due to logistical and administrative constraints. The baseline household survey yielded 505 household interviews, a success rate of 98.6 percent.

The second round of household data collection (i.e. first follow-up survey) in November/December 2014 yielded 486 household interviews (with attrition rate been 3.76 percent). The third round of household data collection (i.e. second follow-up survey) in January/February 2015 resulted to interviews with 478 households (an attrition rate of 5.35 percent). The second phase of the experiment was undertaken in second week of March 2015. This was a repeat of the water quality improvement messages used for the period one experiment. The fourth round of data collection (i.e. third follow-up survey/endline) was undertaken in May-June 2015. We completed 463 out of 505 surveys for fourth round survey for overall success rate of 91.68 percent. The data analysis for this study relies on households with baseline data and at least one follow-up data. Due to delay in completion of fourth round survey (third follow-up survey), we include only first and second follow-up surveys in the analysis.

Table 1: Observational Counts and Attrition

Surveys	**Household Baseline**	**First Follow-up**	**Second Follow-up**	**Third Follow-up/Endline**
Targeted	512	505	505	505
Completed	505	486	478	463
Variation	7	19	27	42
Percent of variation (Attrition)	**1.37**	**3.76**	**5.35**	**8.32**

2.4 Baseline Summary Statistics and Orthogonality Tests

Table 2 presents baseline descriptive statistics and mean orthogonality tests for household safe water behaviors and socioeconomic characteristics. The baseline summary statistics and mean orthogonality tests draw heavily on approach by Karlan *et* al., (2014). For complete analysis, we perform the analyses for all households having baseline information irrespective of whether the households completed the subsequent follow-up surveys. In Table 2, we present the comparison of means between each of the treatment arm to the comparison group, an *F-test* from separate regression of each outcome variable on the two treatment arms (column 5), and an *F-test* from a regression of all the covariates on each of the study arm (last but one row of each table). The *F-test* presents a test for the overall difference in study arms as a whole for each outcome variable. The *F-test* shows whether or not large differences exist in the covariates between the study arms. The weakness of the *F-test* is if statistically significant difference is detected in covariates (i.e. P-value<10 percent) across the treatment arms, we cannot determine which study arm is different from another. In order to address this weakness in *F-tests*, we perform separate analysis (available upon request) based on pairwise comparisons of each outcome variable for the treatment and control groups. Furthermore, in the baseline analysis and also subsequent analysis, we combine the two control groups (i.e. school children and adult household members control groups) as comparison group. This is essential in comparing the means of the study arms. In the baseline analysis, we analyze the *F-tests* (column 5) with regressions excluding the comparison group. Obviously STATA software will drop one of the study arms in the *F-tests* and we deliberately selected the comparison group, to serve as the basis of comparison for the intervention arms. The standard errors are adjusted by clustering at the public basic school level. By not clustering the standard errors at the public basic school level, we find that some of the covariates are statistically significant different from zero. We address this bias by running separate regressions for all outcome variables including baseline household covariates (results with even number columns under the impacts sub-section). This is expected to deal with any bias (both observed and unobserved) during data collection and randomization.

The mean tests show no statistically significant difference between the study arms under baseline household composition and socioeconomic characteristics (Table 2, panel A). Most baseline household head characteristics and multipurpose water characteristics are similar across the treatment and comparison groups (Table 2, panels B and C). The *F-test* shows largely statistically insignificant differences between these outcomes across the treatment and comparison groups. The same results are found under the safe water behaviors sub-sections. Treatment and comparison groups have homogenous sources of drinking water as well as water transport, handling and storage practices, and water consumption and security issues (Table 2, Panels E-H).

Average household size is about six. Approximately two female children under age 15 reside in the average household. Majority of the households have electricity through the national grid (about 76 percent). The household heads are relatively old with an average age of 49 years. Literacy of the household heads is moderately high with about 41 percent reporting of being able to read and write in English. Most of the households reside in locality with multi-purpose water systems. About 45 percent of the households reside in localities with irrigated fields. About 25 percent of the households participate in irrigated agriculture whilst about 16 percent of the households participate in fishing. Access to improved water supply is fairly high compared to many rural areas in Ghana as about 73 percent of the households rely on improved main drinking water sources based on WHO's joint monitoring program (JMP) classification. Water sources are far from the households as households spend on average 12.35 minutes travelling to and from main drinking water source. The mean of household water treatment by any means is about 12 percent. Water storage behavior is fairly high as 91.5 percent of the households have stored water in covered containers. In general, the households in the intervention and comparison groups are similar along many of the covariates. Out of total of 86 *F-tests* performed, 14 were statistically significant different from zero at the various confidence levels. This was largely influenced by the variations in water quality, treatment and health risk indicators at the household level (Table 2, Panel D) which represent about 50 percent of those variables indicating statistically significant difference from zero.

Table 2: Baseline Descriptive Statistics and Orthogonality Tests, Mean (April-May, 2014 Survey)

	(1) All	(2) Child treatment	(3) Adult treatment	(4) Comparison group	(5) F-test (p-value) from regression of variable on child treatment and adult treatment
Panel A: Household composition and socio-economic status					
Household size	6.083	6.056	5.976	6.150	**0.156**
	(0.113)	(0.225)	(0.246)	(0.153)	**(0.857)**
Number of female members 15 years or older	1.848	1.824	1.843	1.862	**0.048**
	(0.050)	(0.096)	(0.105)	(0.071)	**(0.953)**
Number of female children under 15 years	1.210	1.344	1.189	1.154	**0.916**
	(0.048)	(0.098)	(0.093)	(0.068)	**(0.421)**
Household has electricity	0.764	0.832	0.776	0.724	**2.169**
	(0.019)	(0.034)	(0.037)	(0.028)	**(0.149)**
Household resides in Ga South Municipal (1=Urban district, 0=Shai-Osudoku)	0.499	0.496	0.496	0.502	**0.000**
	(0.022)	(0.045)	(0.045)	(0.032)	**(1.000)**
Value of household annual expenditure (GHS)	6,503	5,926	6,133	6,974	**0.876**
	(206.200)	(308.000)	(405.700)	(321.800)	**(0.437)**
Value of household assets (GHS)	30,917	27,726	28,173	33,870	**0.192**
	(3,109)	(5,436)	(4,848)	(5,044)	**(0.827)**
F-test (p-value) from regression of each study arm on all above covariates		**0.778**	**0.847**	**2.116**	
		(0.615)	**(0.567)**	**(0.106)**	
Observations (N)	**505**	**125**	**127**	**253**	

Notes. Clustered standard errors are presented in parenthesis. The total sample for the columns (1)-(5) may vary based on missing data for each outcome variable. Additional tests (not reported here) are performed for pairwise comparison of the covariates for the treatment and comparison groups. *T*-tests of any treatment vs. control groups (1 test), each individual study arm vs. another arm (3 tests), making a total of 4 tests per covariate, and then 28 tests in total for household composition and socioeconomic characteristics.

Table 2: Baseline Descriptive Statistics and Orthogonality Tests, Mean (April-May, 2014 Survey) (continued)

	(1) All	(2) Child treatment	(3) Adult treatment	(4) Comparison group	(5) F-test (p-value) from regression of variable on child treatment and adult treatment
Panel B: Head of the household					
Head is a male	0.743	0.696	0.803	0.735	**3.626***
	(0.020)	(0.041)	(0.035)	(0.028)	**(0.0519)**
Head's age (Years)	48.81	47.82	48.31	49.56	**0.815**
	(0.556)	(1.088)	(1.119)	(0.791)	**(0.461)**
Head is married	0.688	0.720	0.764	0.635	**1.970**
	(0.021)	(0.040)	(0.038)	(0.030)	**(0.174)**
Head can read and write in English	0.408	0.407	0.432	0.396	**0.139**
	(0.0220)	(0.0445)	(0.0445)	(0.031)	**(0.871)**
Farming is current primary occupation of the household head	0.501	0.472	0.551	0.490	**0.179**
	(0.022)	(0.045)	(0.044)	(0.032)	**(0.838)**
Head's Christian	0.778	0.760	0.738	0.806	**0.339**
	(0.019)	(0.039)	(0.039)	(0.025)	**(0.718)**
Head is Ga/Adangbe ethnic group	0.445	0.488	0.344	0.474	**0.543**
	(0.022)	(0.045)	(0.043)	(0.032)	**(0.592)**
F-test (p-value) from regression of each treatment assignment on all above covariates		**1.133**	**0.897**	**2.528***	
		(0.394)	**(0.533)**	**(0.062)**	
Observations (N)	**505**	**125**	**127**	**253**	

Notes. Standard errors are presented in parenthesis. The standard errors are adjusted by clustering at the public basic school level. The total sample for the columns (1)-(5) may vary based on missing data for each outcome variable. Additional tests (not reported here) are performed for pairwise comparison of the covariates for the treatment and comparison groups. *T*-tests of any treatment vs. control groups (1 test), each individual study arm vs. another arm (3 tests), making a total of 4 tests per covariate, and then 28 tests in total for household head characteristics.

Table 2: Baseline Descriptive Statistics and Orthogonality Tests, Mean (April-May, 2014 Survey)

	(1) **All**	**(2)** **Child treatment**	**(3)** **Adult treatment**	**(4)** **Comparison group**	**(5)** **F-test (p-value) from regression of variable on child treatment and adult treatment**
Panel C: Multipurpose water systems, irrigated agriculture and fishing characteristics					
Presence of irrigated fields in the community	0.452 (0.022)	0.400 (0.045)	0.535 (0.044)	0.434 (0.031)	**0.387** **(0.686)**
Household participates in irrigated agriculture	0.253 (0.019)	0.136 (0.031)	0.402 (0.044)	0.237 (0.027)	**2.427** **(0.122)**
Presence of fishing waters in the community	0.730 (0.020)	0.774 (0.038)	0.774 (0.038)	0.685 (0.030)	**0.318** **(0.733)**
Household has access to fishing waters	0.626 (0.022)	0.645 (0.043)	0.642 (0.043)	0.607 (0.031)	**0.043** **(0.958)**
Household engage in fishing	0.159 (0.016)	0.112 (0.028)	0.216 (0.037)	0.154 (0.023)	**0.795** **(0.470)**
F-test (p-value) from regression of each treatment assignment on all above covariates		**1.100** **(0.401)**	**1.964** **(0.143)**	**0.896** **(0.509)**	
Observations (N)	**505**	**125**	**127**	**253**	

Notes. Clustered standard errors are presented in parenthesis. The total sample for the columns (1)-(5) may vary based on missing data for each outcome variable of interest. Additional tests (not reported here) are performed for pairwise comparison of the covariates for the treatment and comparison groups. *T*-tests of any treatment vs. control groups (1 test), each individual study arm vs. another arm (3 tests), making a total of 4 tests per covariate, and then 20 tests in total for multipurpose water systems characteristics.

Table 2: Baseline Descriptive Statistics and Orthogonality Tests, Mean (April-May, 2014 Survey) (continued)

	(1) All	(2) Child treatment	(3) Adult treatment	(4) Comparison group	(5) F-test (p-value) from regression of variable on child treatment and adult treatment
Panel D: Water quality, treatment and health risk					
Water from source is clear	0.746	0.910	0.624	0.728	**21.53*****
	(0.012)	(0.026)	(0.044)	(0.028)	**(3.90e-05)**
Water from source was of good taste	0.535	0.656	0.333	0.577	**4.053****
	(0.023)	(0.043)	(0.043)	(0.031)	**(0.039)**
No problem with main drinking water source	0.531	0.653	0.429	0.522	**2.975***
	(0.022)	(0.043)	(0.044)	(0.032)	**(0.082)**
Main drinking water source is dirty	0.127	0.065	0.159	0.142	**7.671*****
	(0.015)	(0.022)	(0.033)	(0.022)	**(0.005)**
No problem with main general purpose water source	0.456	0.556	0.373	0.448	**1.422**
	(0.022)	(0.045)	(0.043)	(0.031)	**(0.272)**
Main general purpose water source is dirty	0.207	0.121	0.206	0.250	**3.056***
	(0.018)	(0.029)	(0.036)	(0.027)	**(0.077)**
Satisfied with water quality	0.648	0.758	0.452	0.692	**6.956*****
	(0.021)	(0.039)	(0.045)	(0.029)	**(0.007)**
Household treat water to make it safer to drink	0.120	0.0820	0.146	0.127	**0.730**
	(0.015)	(0.025)	(0.032)	(0.021)	**(0.498)**
F-test (p-value) from regression of each treatment assignment on all above covariates		**1.012**	**1.163**	**0.951**	
		(0.467)	**(0.381)**	**(0.506)**	
Observations (N)	**505**	**125**	**127**	**253**	

Notes. *** p<0.01, ** p<0.05, and * p<0.1. Standard errors are presented in parenthesis. The standard errors are adjusted by clustering at the public basic school level. The total sample for the columns (1)-(5) may vary based on missing data for each outcome variable of interest. Additional tests (not reported here) are performed for pairwise comparison of the covariates for the treatment and comparison groups. *T*-tests of any treatment vs. control groups (1 test), each individual study arm vs. another arm (3 tests), making a total of 4 tests per covariate, and then 32 tests in total for water quality, treatment and health risk indicators.

Table 2: Baseline Descriptive Statistics and Orthogonality Tests, Mean (April-May, 2014 Survey) (continued)

	(1) All	(2) Child treatment	(3) Adult treatment	(4) Comparison group	(5) F-test (p-value) from regression of variable on child treatment and adult treatment
Panel E: Water source choices					
Improved main drinking water source (based on JMP classification)	0.731 (0.02)	0.696 (0.041)	0.669 (0.042)	0.779 (0.026)	**0.993** **(0.393)**
Other improved (based on JMP drinking water ladder)	0.659 (0.02)	0.608 (0.044)	0.669 (0.042)	0.680 (0.029)	**0.075** **(0.928)**
Unimproved sources (based on drinking water ladder)	0.109 (0.01)	0.208 (0.036)	0.110 (0.028)	0.059 (0.015)	**0.487** **(0.624)**
Surface water (based on drinking water ladder)	0.160 (0.02)	0.096 (0.027)	0.220 (0.037)	0.162 (0.023)	**1.551** **(0.244)**
Multisource user_**drinking water**	0.392 (0.02)	0.408 (0.044)	0.307 (0.041)	0.427 (0.031)	**1.735** **(0.210)**
Multisource user_**general purpose water**	0.420 (0.02)	0.480 (0.045)	0.291 (0.041)	0.455 (0.031)	**5.785**** **(0.014)**
Improved **secondary** drinking water source	0.677 (0.033)	0.745 (0.062)	0.590 (0.080)	0.676 (0.045)	**0.755** **(0.487)**
Improved **main** general purpose water source (JMP classification)	0.586 (0.022)	0.552 (0.045)	0.591 (0.044)	0.601 (0.031)	**0.048** **(0.953)**
Main drinking water is sachet/bottle	0.147 (0.016)	0.192 (0.035)	0.126 (0.030)	0.134 (0.022)	**0.150** **(0.862)**
F-test (p-value) from regression of each treatment assignment on all above covariates		**1.302** **(0.314)**	**1.266** **(0.330)**	**1.501** **(0.240)**	
Observations (N)	**505**	**125**	**127**	**253**	

Notes. *** p<0.01, ** p<0.05, and * p<0.1. Standard errors are presented in parenthesis. The standard errors are adjusted by clustering at the public basic school level. The total sample for the columns (1)-(5) may vary based on missing data for each outcome variable of interest. Additional tests (reported at appendix) are performed for pairwise comparison of the covariates for the treatment and comparison groups. Additional tests (not reported here) are performed for pairwise comparison of the covariates for the treatment and comparison groups. *T*-tests of any treatment vs. control groups (1 test), each individual study arm vs. another arm (3 tests), making a total of 4 tests per covariate, and then 36 tests in total for water source choices. Note that improved secondary drinking water source is dropped from the analysis in the last but one column, since not all households have secondary drinking water source.

Table 2: Baseline Descriptive Statistics and Orthogonality Tests, Mean (April-May, 2014 Survey) (continued)

	(1) All	(2) Child treatment	(3) Adult treatment	(4) Comparison group	(5) F-test (p-value) from regression of variable on child treatment and adult treatment
Panel F: Water transport, collection and handling techniques					
Distance to main drinking water (one way, in meters)	197.9	138.9	262.4	195.2	**4.725****
	(13.69)	(21.11)	(32.28)	(19.13)	**(0.026)**
Distance to main general purpose water (one way, in meters)	225.6	165.3	240.4	248.3	**3.572***
	(14.35)	(24.67)	(27.22)	(21.91)	**(0.0538)**
Time to main drinking water source (round trip, in minutes)	12.35	9.811	15.56	11.99	**3.805****
	(0.539)	(0.774)	(1.435)	(0.682)	**(0.046)**
Time to main general purpose water source (round trip, in minutes)	12.88	11.09	13.18	13.60	**0.809**
	(0.491)	(0.876)	(0.899)	(0.751)	**(0.464)**
Total number of water trips in the past 7 days	38.31	39.59	38.54	37.59	**0.073**
	(1.480)	(2.927)	(3.080)	(2.064)	**(0.930)**
Children 5-17 years fetch water	0.907	0.866	0.894	0.932	**1.605**
	(0.013)	(0.031)	(0.028)	(0.016)	**(0.233)**
Children under 12 years fetch water	0.418	0.411	0.409	0.425	**0.078**
	(0.023)	(0.047)	(0.046)	(0.032)	**(0.926)**
Total number of water trips in the past 3 days	15.16	15.49	15.52	14.82	**0.036**
	(0.576)	(1.106)	(1.272)	(0.785)	**(0.965)**
F-test (p-value) from regression of each treatment assignment on all above covariates		**0.725**	**2.255***	**0.695**	
		(0.636)	**(0.094)**	**(0.658)**	
Observations (N)	**505**	**125**	**127**	**253**	

Notes. *** p<0.01, ** p<0.05, and * p<0.1. Clustered standard errors are presented in parenthesis. The total sample for the columns (1)-(5) may vary based on missing data for each outcome variable of interest. Additional tests (reported at appendix) are performed for pairwise comparison of the covariates for the treatment and comparison groups. Additional tests (not reported here) are performed for pairwise comparison of the covariates for the treatment and comparison groups. *T*-tests of any treatment vs. control groups (1 test), each individual study arm vs. another arm (3 tests), making a total of 4 tests per covariate, and then 32 tests in total for water transport, collection and handling techniques. Note that two variables (Children 5-17 years fetch water and Children under 12 years fetch) were dropped for the F-test of all covariates on each treatment assignment due to limited observation.

Table 2: Baseline Descriptive Statistics and Orthogonality Tests, Mean (April-May, 2014 Survey) (continued)

	(1) All	(2) Child treatment	(3) Adult treatment	(4) Comparison group	(5) F-test (p-value) from regression of variable on child treatment and adult treatment
Panel G: Water quantity, consumption/usage and security					
Volume (liters) of drinking water consumed (past 2 days)	81.75	81.27	75.25	85.20	**0.329**
	(3.437)	(6.833)	(5.025)	(5.403)	**(0.724)**
Volume (liters) of general purpose water consumed (past 2 days)	247.3	244.4	240.3	252.2	**0.410**
	(6.380)	(13.00)	(13.11)	(8.839)	**(0.671)**
Household have enough water for drinking, cook, etc in the past 30 days	0.890	0.882	0.849	0.915	**0.599**
	(0.014)	(0.030)	(0.032)	(0.018)	**(0.562)**
Satisfied with time spent getting water	0.729	0.787	0.607	0.760	**1.856**
	(0.020)	(0.037)	(0.044)	(0.027)	**(0.191)**
No problem with access to water in the past 30 days	0.520	0.597	0.361	0.560	**1.961**
	(0.023)	(0.045)	(0.044)	(0.032)	**(0.175)**
F-test (p-value) from regression of each treatment assignment on all above covariates		**1.388**	**0.809**	**0.574**	
		(0.284)	**(0.561)**	**(0.719)**	
Observations (N)	**505**	**125**	**127**	**253**	

Notes. Standard errors are presented in parenthesis. The standard errors are adjusted by clustering at the public basic school level. The total sample for the columns (1)-(5) may vary based on missing data for each outcome variable of interest. Additional tests (reported at appendix) are performed for pairwise comparison of the covariates for the treatment and comparison groups. Additional tests (not reported here) are performed for pairwise comparison of the covariates for the treatment and comparison groups. *T*-tests of any treatment vs. control groups (1 test), each individual study arm vs. another arm (3 tests), making a total of 4 tests per covariate, and then 20 tests in total for water quantity, consumption/usage and security.

Table 2: Baseline Descriptive Statistics and Orthogonality Tests, Mean (April-May, 2014 Survey) (continued)

	(1) All	(2) Child treatment	(3) Adult treatment	(4) Comparison group	(5) F-test (p-value) from regression of variable on child treatment and adult treatment
Panel H: Water storage behaviors					
Usually stock drinking water in the house	0.853	0.852	0.863	0.848	**0.007**
	(0.016)	(0.032)	(0.031)	(0.023)	**(0.993)**
Type of container (=Clay pot)	0.378	0.350	0.306	0.429	**0.372**
	(0.024)	(0.047)	(0.045)	(0.034)	**(0.695)**
Type of container (=Other plastic container)	0.400	0.417	0.463	0.358	**0.207**
	(0.024)	(0.049)	(0.048)	(0.033)	**(0.816)**
Container is set on the ground	0.691	0.667	0.708	0.695	**0.065**
	(0.023)	(0.047)	(0.044)	(0.032)	**(0.938)**
Container closed by a lid or cork	0.912	0.942	0.917	0.896	**0.810**
	(0.014)	(0.023)	(0.027)	(0.021)	**(0.463)**
Used soap or detergent to wash container the last time	0.648	0.621	0.704	0.633	**0.493**
	(0.023)	(0.048)	(0.044)	(0.033)	**(0.620)**
Used only plain water in washing the container	0.337	0.350	0.287	0.357	**0.453**
	(0.023)	(0.047)	(0.044)	(0.033)	**(0.644)**
Drinking water storage container is covered	0.915	0.902	0.966	0.898	**0.862**
	(0.013)	(0.027)	(0.017)	(0.020)	**(0.442)**
Interior of drinking water storage container is clean	0.882	0.910	0.901	0.858	**0.471**
	(0.015)	(0.026)	(0.027)	(0.022)	**(0.633)**
Stored drinking water container is located on a platform	0.391	0.382	0.443	0.369	**0.262**
	(0.022)	(0.044)	(0.045)	(0.031)	**(0.773)**
Object used to fetch drinking water from storage container is clean	0.829	0.787	0.860	0.834	**0.307**
	(0.017)	(0.037)	(0.032)	(0.024)	**(0.740)**
Water for general purposes is stored in covered containers	0.699	0.736	0.717	0.672	**0.267**
	(0.020)	(0.040)	(0.040)	(0.030)	**(0.769)**
Stored general purpose water is located on a platform	0.261	0.232	0.307	0.253	**0.576**
	(0.020)	(0.038)	(0.041)	(0.027)	**(0.574)**
F-test (p-value) from regression of each treatment assignment on all above covariates		**1.224**	**0.732**	**4.750*****	
		(0.351)	**(0.703)**	**(0.003)**	
Observations (N)	**505**	**125**	**127**	**253**	

Notes. *** p<0.01, ** p<0.05, and * p<0.1. Standard errors are presented in parenthesis. The standard errors are adjusted by clustering at the public basic school level. The total sample for the columns (1)-(5) may vary based on missing data for each outcome variable of interest. Additional tests (reported at appendix) are performed for pairwise comparison of the covariates for the treatment and comparison groups. Additional tests (not reported here) are performed for pairwise comparison of the covariates for the treatment and comparison groups. *T*-tests of any treatment vs. control groups (1 test), each individual study arm vs. another arm (3 tests), making a total of 4 tests per covariate, and then 42 tests in total for water storage behaviors.

3. Water Quality Testing and Information Experiment Impacts on Safe Water Behaviors

This section discusses the demand (take-up), estimation strategy (including basic estimation equations), and the impacts of the household water quality testing and information experiment.

3.1 The Demand for Household Water Quality Testing and Information: Take-up of the Experiment

Using an administrative data compiled during the training workshop in July 2014, we analyze take-up of the water quality testing and information experiment. Table 3 presents descriptive statistics on the take-up of the water quality testing and information offer by the treatment groups and by gender of participants. If the dissemination of information to the treatment groups concerning the experiment was perfect, then we should expect full compliance (100 percent attendance) in the training workshops. Here attendance in the training workshops is mandatory or a prerequisite for the households to get the water testing kits and handouts on the water quality improvement messages. Recall that the training workshops were held for two days for each participating group (refer to experimental design section for more information on training schedules/approaches). At the end of the training workshop in July 2014, about 99 (79.2 percent) of the 125 school children on the average attended the training workshops. In contrast, about 64 out of 127 adult household members (50.4 percent) on the average participated in the training workshop. Based on the gender of participants, we find that on average more females (about 86 persons) attended the training workshop compared to that of male participants of about 77 persons. We also find that attendance in the training sessions was high for day one compared to day two. Also, male participants were more likely to miss the second day of the training session than their female counterparts. In day one of the training workshop 94 males participated, which reduced to 59 males for day two (a reduction rate of about 37.2 percent). In the case of female participants, during day one training session 92 persons attended and this reduced to 79 (a reduction rate of about 14.1 percent).

Comparing the results generated from the summary statistics to that obtained through first stage analysis was slightly different. Because the first stage analysis defines participation by an individual as one if even the participant attended only one day of the training session (i.e. either day one or day two) but under this section we apply simple arithmetic of adding-up the number of participants for each day during the training workshop. Of course, there are weaknesses in each approach such as having non-uniform attendance (i.e. a person not attending both day one and day two of the training sessions) which further complicates the analysis. Among households/participants in the treatment arms who did not attend the training workshops, the most commonly given explanations include busy with school/business activities, long distance between venue of training and dwelling, late invitation, among others. For brevity we do not econometrically estimate the factors affecting the demand for household water quality testing and information.

Table 3: Details on Take-up of Water Quality Testing and Information Experiment

Day	Total school children	Total adult household members	Total males	Total females
1	107	79	94	92
2	90	48	59	79
Total **	**197**	**127**	**153**	**171**
Average attendance for the two days of training	98.5	63.5	76.5	85.5
Total expected participants	**125**	**127**	---	---

**Double counting

3.2 Empirical Strategy: First Stage, Two Stage Least Squares (2SLS) and Reduced Form

We estimate the impacts of household water quality testing and information on a host of safe water behaviors: water source choices, perceptions of water quality, and water transport, storage and handling techniques. In the case of each outcome, we estimate four parameters of interest. First, the estimation of interest is the effect of households being assigned to treatment arm(s) and each outcome is examined with specification as:

(1) $Y_{it} = \propto_1 + \beta_1 Treatment_{it} + X'_{it}\gamma_1 + \varepsilon_{it1}$,

where Y_i is the outcome variable of interest (for example improved drinking water) for household *i* at time $t (t \in \{0,1,2\}$ for the three survey waves), $Treatment_{it}$ is a discrete variable equal 1 if household was assigned to household water quality testing and information, and X'_{it} is a vector of baseline household and community characteristics. Random assignment of households ($Treatment_{it}$) into either project or non-project ensures that $E(\varepsilon_{it1} \mid X_{it}, Treatment_{it}) = 0$, and therefore application of OLS will produce unbiased estimates of coefficients (β_1). Robust standard errors are reported. The reduced form parameter derived from Equation (1) estimates the causality of being assigned to household water quality testing and information. This answer an essential policy question of: what is the impact of offering interested households the option (voluntary participation) of water quality self-testing and information?

Second, we evaluate the average treatment effect of household's actual participation in water quality testing and information on each safe water behaviors. This is based on the premise that if even the water quality self-testing is provided free of charge not all households will be available for the exercise. Furthermore, actual participation may be hindered by inability to fully comply with procedures involving water quality testing and recording of the results. This is achieved with estimation analogous to this specification:

(2) $Y_{it} = \propto_2 + \beta_2 Participated_{it} + X'_{it}\gamma_2 + \varepsilon_{it2}$,

where $Participated_{it}$ is a dummy variable which is equal to 1 if the household had at least one participant in water quality testing and information experiment at time t ($t \in \{1,2\}$ for the two follow-up surveys), and is used as instrumental variable with $Treatment_{it}$ as follows:

(3) $Participated_{it} = a + bTreatment_{it} + V_{it}$,

We estimate Equation (2) by the two stage least squares (2SLS) with the first stage equation being Equation (3). The model is just identified, with the 2SLS estimate of β_2 represented by the ratio of the reduced form estimate and that of first stage coefficients (β_1/b). The estimate from the 2SLS is considered as the local average treatment effect (LATE) (Imbens and Angrist, 1994; Angrist *et al*., 1996 and Finkelstein *et al*., 2012). Alternatively, the 2SLS estimate of β_2 identifies causality of participation among the sub-groups of households who would participate in household water quality testing and information on being assigned to the experiment and would not participate in household water quality testing and information without being selected into the experiment. Baseline household characteristics are included as controls in some specifications (results with columns with even numbers) as sensitivity or robustness checks. The first and second columns of Table 4A present the estimation of the first stage equation. In the remaining tables, the estimation of Equation (1) is presented in Panel A whilst estimation of Equation (2) is shown in Panel B.

Third, we estimate reduced-form model (ITT estimation) for assignment into the treatment arms (school children versus adult household members) and also actual participation (IV or LATE estimation) by the two treatment arms on each safe water behaviors. This is based on the premise that the treatment arms may have differential impacts on safe water behaviors. For instance, water source choices may differ across the treatment arms. The estimates of the differential impacts as a function of treatment arms are achieved with regression analogues:

(4) $Y_{it} = \propto_3 + \beta_3 Child\ Treatment_{it} + \beta_4 Adult\ Treatment_{it} + X_{it}'\gamma_3 + \varepsilon_{it3}$,

where $Child\ Treatment_{it}$ is a dummy variable that household *i* was assigned to the school children intervention group in time t and $Adult\ Treatment_{it}$ is a dummy variable that household *i* was assigned to the adult household members intervention group in time *t*. X_{it}' is the vector of baseline household controls included in some of the specifications for robustness checks. Actual participation in the household water quality testing and information differs from the treatment assignment and also by the two treatment arms (refer to take-up of the experiment section for more information). This means participation by the treatment arms in the household water quality testing and information is endogenous to the treatment assignment. We quantify the effect of actual participation by the treatment arms in an IV (or LATE) estimation using random allocation of households into the treatment arms as instruments. The estimates for the first stage equation are shown in columns (1) and (2) of Table 4B. In the tables under the differential impacts, we present the ITT estimator using OLS in panel A, and estimates of the IV specification using 2SLS in panel B. For complete analysis we present results with and without baseline household covariates as controls, columns with even and odd numbers respectively.

Fourth, we are interested in analyzing the average treatment effects of the gender (male versus female) of those that participated in the household water quality testing and information experiment on each safe water behaviors. The estimation is done with specification analogues to this:

(5) $Y_{it} = \propto_4 + \beta_5 Male\_Participated_{it} + X'_{it}\gamma_4 + \varepsilon_{it4}$,

where $Male\_Participated_{it}$ is a dummy variable equal to 1 if the participant is a male, 0 female at time t. To avoid bulking the results of the gendered treatment effects together with impacts and differential impacts under one sub-section, the gendered treatment effects for all indicators on safe water behaviors are presented under a common theme as sub-section 3.8.

3.3.A Impacts on Water Source Choices

The results on the impacts of household water quality testing and information on water source choices are presented in Table 4A. For each outcome of interest, we estimate two regressions; (1) without baseline household covariates (columns with odd numbers) and (2) with household baseline covariates (columns with even numbers). The results presented include the intention-to-treat (ITT) estimation (Panel A) and instrumental variable (IV) estimation (Panel B). The ITT estimation presents the comparison in changes of water source choices between the treatment and comparison groups regardless of whether households had participants in the water quality testing and/or received the handouts containing water quality improvement messages (information). The ITT estimation avoids the potential of self-selection bias emanating from participation in the water quality testing and information experiment. The IV estimates take into consideration actual participation in the water quality testing and information. Panel A (ITT estimation) of the Tables for this section are estimated with econometric specification analogous to Equation (1) whilst estimates in Panel B are analyzed using analogous specification of Equation (2). In the IV estimation, the treatment variable is participation by any of the treatment groups (i.e. either school children intervention group or adult household members intervention group). The first stage shows high correlation between the treatment assignment indicator and the actual participation (columns 1 and 2). The treatment allocation to water quality testing and information experiment leads to actual participation or uptake by 72.8 percentage points (Panel A, column 1). The result is robust to specification including baseline household covariates (Panel A, column 2).

Based on ITT estimation (Panel A), we find that households offered the water quality testing and information used on average 6.6 percentage points (significant at 95 percent) more of improved main drinking water sources (using WHO's joint monitoring program (JMP) classification, Panel A, column 3). The result is robust when baseline household controls are included in the regression (Panel A, column 4). We also find less use of surface water as the main source of drinking water (based on WHO's JMP "drinking water ladder" classification). The result shows that use of surface water as the main source of drinking water decreased by 5.1 percentage points (significant at 95 percent, without baseline household controls). The result is similar for regressions including baseline household controls (Panel A, column 10). Furthermore, the use of improved water sources for general purposes such as cooking, bathing, washing, etc increased by 6.9 percentage points (Panel A, column 17).

We find an interesting result in relation to shift toward the choice of sachet water as the main drinking water source. The experiment included training of households on water quality testing and how to improve household water quality. From the training sessions, we tested different types of water supply (usually about four types of water sources). In almost all of the cases, sachet water was the safest in terms of number of *E. coli* per 100 mL. Sachet water is also the most expensive water source aside bottled water with one costing roughly GHS 0.20 (equivalent 5 cents) during the time of the intervention in July 2014, and also depending on the brand. Sachet water has a size of roughly half of a liter (500mL). Households were 4.8 percentage points (significant at 90 percent in regressions with baseline household controls not significant in regressions without baseline household controls; Panel A, column 20) more likely to use sachet water as the main drinking water source. We find no statistically significant additional effect of household water quality testing and information on other water source choice indicators such as use of other improved drinking water source (based on WHO's JMP "drinking water ladder" classification), use of unimproved main drinking water sources (based on WHO's JMP "drinking water ladder" classification), household choice and use of multiple water sources for both drinking and general purposes, and finally on the use of improved secondary drinking water source.

The IV estimation (Panel B) confirms the results obtained using the ITT estimation (Panel A). The signs and statistical significance for the coefficients are the same for all the outcome variables except slight changes in the magnitude of the coefficients. Using the IV estimation makes the estimates slightly higher compared to the ITT estimation.

Table 4A: Impacts on Water Source Choices

	First stage		Water source choices			
Dependent variable:	Participated		Improved main drinking water based on JMP		Other improved drinking water source based on JMP	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. ITT Estimation						
Treatment	0.728***	0.756***	0.066**	0.051*	0.049	0.025
	(0.020)	(0.020)	(0.030)	(0.031)	(0.031)	(0.032)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	960	901	960	901	960	901
R-squared	0.575	0.614	0.005	0.076	0.005	0.056
Mean (SD) of dependent variable in the comparison group	0	0	0.658	0.658	0.635	0.635
	(0)	(0)	(0.475)	(0.475)	(0.482)	(0.482)
Panel B. Instrumental variable estimation: "participated" instrumented with "treatment"						
Participated			0.091**	0.067*	0.067	0.033
			(0.041)	(0.040)	(0.042)	(0.042)
Household Controls			No	Yes	No	Yes
Observations			960	901	960	901
R-squared			0.001	0.073	-0.002	0.054
Mean (SD) dependent variable in the comparison group			0.658	0.658	0.635	0.635
			(0.475)	(0.475)	(0.482)	(0.482)

Table 4A: Impacts on Water Source Choices (continued)

	Water source choices							
Dependent variable:	Unimproved main drinking water sources based on JMP		Surface water as main drinking water source		Household reports of multiple drinking water sources		Household reports of multiple general purpose water sources	
	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Panel A. ITT Estimation								
Treatment	-0.016	-0.003	-0.051**	-0.048**	-0.045	-0.045	0.005	-0.020
	(0.022)	(0.022)	(0.024)	(0.024)	(0.030)	(0.032)	(0.032)	(0.034)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	960	901	960	901	964	905	964	905
R-squared	0.001	0.161	0.005	0.124	0.002	0.031	0.000	0.046
Mean (SD) of dependent variable in the comparison group	0.146 (0.354)	0.146 (0.354)	0.196 (0.397)	0.196 (0.397)	0.689 (0.463)	0.689 (0.463)	0.524 (0.500)	0.524 (0.500
Panel B. Instrumental variable estimation: "participated" instrumented with "treatment"								
Participated	-0.022	-0.004	-0.069**	-0.063**	-0.062	-0.060	0.007	-0.027
	(0.031)	(0.029)	(0.033)	(0.032)	(0.042)	(0.043)	(0.044)	(0.044)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	960	901	960	901	964	905	964	905
R-squared	-0.003	0.160	0.009	0.123	0.004	0.032	0.000	0.045
Mean (SD) dependent variable in the comparison group	0.146 (0.354)	0.146 (0.354)	0.196 (0.397)	0.196 (0.397)	0.689 (0.463)	0.689 (0.463	0.524 (0.500)	0.524 (0.500)

Table 4A: Impacts on Water Source Choices (continued)

Dependent variable:	Water source choices					
	Improved secondary drinking water source		Improved main general purpose water		Household use sachet water as the main drinking water	
	(15)	(16)	(17)	(18)	(19)	(20)
Panel A. ITT Estimation						
Treatment	0.041	0.030	0.069**	0.056*	0.023	0.048*
	(0.035)	(0.037)	(0.032)	(0.033)	(0.025)	(0.024)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	644	602	964	905	960	901
R-squared	0.002	0.060	0.005	0.087	0.001	0.154
Mean (SD) of dependent variable in the comparison group	0.701	0.701	0.479	0.479	0.169	0.169
	(0.458)	(0.458)	(0.500)	(0.500)	(0.375)	(0.375)
Panel B. Instrumental variable estimation: "participated" instrumented with "treatment"						
Participated	0.057	0.041	0.095**	0.074*	0.031	0.063**
	(0.050)	(0.050)	(0.044)	(0.043)	(0.034)	(0.032)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	644	602	964	905	960	901
R-squared	-0.004	0.055	0.003	0.083	0.005	0.157
Mean (SD) of dependent variable in the comparison group	0.701	0.701	0.479	0.479	0.169	0.169
	(0.458)	(0.458)	(0.500)	(0.500)	(0.375)	(0.375)

Notes: Robust standard errors in parentheses. Household and household head baseline controls include: household head is a male, head's age, head is married, head is literate (i.e. can read and write in English), head belongs to Ga/Adangbe ethnic group, head is a Christian, household is located in urban district (Ga South Municipal), household expenditure is high (i.e. 1 if percentile 50-100 of household annual expenditure), household undertakes fishing, household has electricity, and number of female members under 15 years of age.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Source: First and second follow-up surveys in November/December 2014 and January/February 2015.

3.3.B Differential Impacts on Water Source Choices

Table 4B presents differential treatment effects by the treatment arms (i.e. school children intervention group and adult household members intervention group) using two rounds of follow-up surveys in 2014 and 2015. The results are obtained using regression analogues to Equation (4) to analyze the differential impacts of water quality testing and information on water source choices. In the IV estimation, we instrument by using random assignment into the various treatment arms without any interactions. The first stage estimation is highly strong. The treatment allocation of households into water quality testing and information experiment increases school children's participation or take-up by 91.4 percentage points (s.e. 1.8 percentage points) whilst participation or take-up increases by 59.8 percentage points (s.e. 3.2 percentage points) for adult household members.

We find evidence of differential treatment effects based on the various treatment groups. As it was done under the previous section, we estimate two regressions for each outcome variable (1) without baseline household controls (columns with odd numbers) and (2) with baseline household controls (columns with even numbers). Panel A (Column (3)) presents the impacts on the choice of improved drinking water based on WHO's JMP classification. Choice of improved main drinking water sources is 11.9 percentage points higher for households in the school children intervention group (relative to average value of the comparison group of 65.8 percent). The result is robust to regression including baseline household controls (Panel A, column 4). There is no statistically significant additional effect for households in adult household members intervention group. Panel A, column 5 reports the choice of other improved water drinking water source based on WHO's JMP classification on "drinking water ladder" which comprise of use of public standpipe, rain water, borehole, and protected well. Choice of other improved main drinking water sources is 8.2 percentage points higher (significant at 95 percent, without baseline household controls but not significant with baseline household controls) for the households in the school children treatment group (relative to average value of 63.5 percent in the comparison group). There is no statistically significant additional effect for households in the adult household members intervention group.

Panel A, column 10 examines the use of surface water (which comprised of river, streams, canals, etc) as the main drinking water source. The choice of surface water as the main drinking water source is 11 percentage points lower for households in the school children group (relative to average value of 19.6 percent in the comparison group). The result is robust when baseline household controls are included in the regression (Panel A, column 11). There is no statistically significant reduction for households in the adult household members intervention group. Panel A, column 15 reports the impact on the use of improved secondary drinking water sources. Choice of improved secondary drinking water sources is 11.1 percentage points higher for households in the adult household members intervention group (relative to average value of 70.1 percent in the comparison group). The result is robust to specifications including baseline household controls (Panel A, column 16). There is no statistically significant additional effect for households in the school children intervention group. Panel A, column 17 presents the choice of improved general purpose water sources by households. The choice of improved main general purpose water sources is 16.5 percentage points higher for households in the school children intervention group (relative to average value of 47.9 percent in the comparison group). The result is robust to inclusion of baseline household controls (Panel A, column 18). For household main drinking water sources, we observe significant changes in making cash-intensive choices. Specifically, Panel A, column 19 indicates 16.9 percent of households in the comparison group use sachet water as the main drinking water source. This proportion is increased by 5.8 percentage points among households in the school children intervention group. The result is robust to regression including baseline household controls (Panel A, column 20). There is no statistically significant additional effect for households in the adult household members intervention group.

The results obtained using the IV estimation (Panel B) for the water source choices are similar to that of the ITT estimation (Panel A). We find slight improvement in the estimates using the IV estimation rather than the ITT estimation. This is highly expected since actual participation will lead to assimilation of the experiment. The level of statistical significance and signs of the estimates are similar to that of the ITT estimation. Lastly, we do not find statistically significant impacts on other water source choice outcomes such as use of multiple drinking and general purpose water sources, and use of unimproved main drinking water sources based on WHO's JMP classification on "drinking water ladder".

Table 4B: Differential Impacts on Water Source Choices

	First stage		Water source choices			
Dependent variable:	Child Participated	Adult participated	Improved main drinking water based on JMP		Other improved drinking water source based on JMP	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. ITT Estimation						
Child treatment	0.914***	-0.001	0.119***	0.088**	0.082**	0.038
	(0.018)	(0.006)	(0.035)	(0.035)	(0.037)	(0.038)
Adult treatment	0.003	0.598***	0.016	0.014	0.018	0.012
	(0.003)	(0.032)	(0.037)	(0.039)	(0.038)	(0.040)
Household Controls	Yes	Yes	No	Yes	No	Yes
Observations	901	901	960	901	960	901
R-squared	0.888	0.527	0.011	0.079	0.005	0.057
Mean (SD) of dependent variable in the comparison group	0 (0)	0 (0)	0.658 (0.475)	0.658 (0.475)	0.635 (0.482)	0.635 (0.482)
Panel B. Instrumental variable estimation: "child participated" and "adult participated" instrumented with "child treatment" and "adult treatment"						
Child participated			0.135***	0.096**	0.093**	0.042
			(0.040)	(0.038)	(0.042)	(0.041)
Adult participated			0.027	0.023	0.031	0.020
			(0.064)	(0.065)	(0.065)	(0.066)
Household Controls			No	Yes	N0	Yes
Observations			960	901	960	901
R-squared			0.004	0.076	-0.001	0.055
Mean (SD) dependent variable in the comparison group			0.658 (0.475)	0.658 (0.475)	0.635 (0.482)	0.635 (0.482)

Table 4B: Differential Impacts on Water Source Choices (continued)

Dependent variable:	Water source choices							
	Unimproved main drinking water sources based on JMP		Surface water as main drinking water source		Household reports of multiple drinking water sources		Household reports of multiple general purpose water sources	
	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Panel A. ITT Estimation								
Child treatment	-0.009	-0.009	-0.110***	-0.078***	-0.063	-0.063	0.009	-0.035
	(0.028)	(0.027)	(0.026)	(0.026)	(0.038)	(0.040)	(0.040)	(0.040)
Adult treatment	-0.022	0.004	0.007	-0.018	-0.028	-0.028	0.001	-0.006
	(0.027)	(0.027)	(0.032)	(0.032)	(0.037)	(0.040)	(0.039)	(0.042)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	960	901	960	901	964	905	964	905
R-squared	0.001	0.161	0.016	0.127	0.003	0.032	0.000	0.046
Mean (SD) of dependent variable in the comparison group	0.146 (0.354)	0.146 (0.354)	0.196 (0.397)	0.196 (0.397)	0.689 (0.463)	0.689 (0.463)	0.524 (0.500)	0.524 (0.500
Panel B. Instrumental variable estimation: “child participated” and “adult participated” instrumented with “child treatment” and “adult treatment”								
Child participated	-0.010	-0.010	-0.125***	- 0.086***	-0.071*	-0.069	0.010	-0.038
	(0.031)	(0.029)	(0.029)	(0.028)	(0.043)	(0.043)	(0.045)	(0.044)
Adult participated	-0.038	0.007	0.011	-0.029	-0.048	-0.046	0.002	-0.010
	(0.046)	(0.044)	(0.054)	(0.053)	(0.063)	(0.066)	(0.067)	(0.069)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	960	901	960	901	964	905	964	905
R-squared	-0.004	0.161	0.012	0.125	0.004	0.032	-0.000	0.046
Mean (SD) dependent variable in the comparison group	0.146 (0.354)	0.146 (0.354)	0.196 (0.397)	0.196 (0.397)	0.689 (0.463)	0.689 (0.463)	0.524 (0.500)	0.524 (0.500

Table 4B: Differential Impacts on Water Source Choices (continued)

Dependent variable:	Water source choices					
	Improved secondary drinking water source		Improved main general purpose water		Household use sachet water as the main drinking water	
	(15)	(16)	(17)	(18)	(19)	(20)
Panel A. ITT Estimation						
Child treatment	-0.037	-0.022	0.165***	0.138***	0.058*	0.079***
	(0.046)	(0.047)	(0.039)	(0.039)	(0.032)	(0.030)
Adult treatment	0.111***	0.082*	-0.024	-0.025	-0.012	0.017
	(0.040)	(0.043)	(0.039)	(0.041)	(0.029)	(0.030)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	644	602	964	905	960	901
R-squared	0.015	0.067	0.022	0.100	0.005	0.157
Mean (SD) of dependent variable in the comparison group	0.701 (0.458)	0.701 (0.458)	0.479 (0.500)	0.479 (0.500)	0.169 (0.375)	0.169 (0.375)
Panel B. Instrumental variable estimation: "child participated" and "adult participated" instrumented with "child treatment" and "adult treatment"						
Child participated	-0.042	-0.025	0.188***	0.151***	0.066*	0.086***
	(0.053)	(0.052)	(0.044)	(0.043)	(0.036)	(0.033)
Adult participated	0.198***	0.142*	-0.041	-0.042	-0.021	0.028
	(0.072)	(0.075)	(0.067)	(0.067)	(0.050)	(0.049)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	644	602	964	905	960	901
R-squared	-0.000	0.057	0.014	0.095	0.009	0.159
Mean (SD) dependent variable in the comparison group	0.701 (0.458)	0.701 (0.458)	0.479 (0.500)	0.479 (0.500)	0.169 (0.375)	0.169 (0.375)

Notes: Robust standard errors in parentheses. Household and household head baseline controls include: household head is a male, head's age, head is married, head is literate (i.e. can read and write in English), head belongs to Ga/Adangbe ethnic group, head is a Christian, household is located in urban district (Ga South Municipal), household expenditure is high (i.e. 1 if percentile 50-100 of household annual expenditure), household undertakes fishing, household has electricity, and number of female members under 15 years of age.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Source: First and second follow-up surveys in November/December 2014 and January/February 2015.

3.4.A Impacts on Water Quality, Treatment and Health Risk

Using a regression with specification analogues to Equations (1 and 2) we estimate the impacts of household water quality and information on perception of the households on water quality, water treatment and health risk (Table 5A). We include in some of the specifications baseline household characteristics as controls and also estimate separate regressions for differential treatment effects as a function of random allocation into the two treatment arms, and finally report robust standard errors. Recall that the experiment involved information component and practical aspects (including the training exercise) which allow us to analyze the perceptions of the households on water quality, treatment and health risk. We find that households in the treatment group are 11.7 percentage points less likely of reporting that water from source is of good taste the last time of fetching (Panel A, column 3; relative to average value of comparison group of 72.5 percent). The result is robust to regressions including baseline household controls (Panel A, column 4). Panel A, column 13 shows that households in the treatment group are 8.7 percentage points less likely to report of being satisfied with water quality. Other than these, we do not find statistically significant additional effect of household water quality testing and information on other perceptions on water quality, treatment and health risk variables such as water from source being clear, having no problem with main drinking water source, main drinking water source being dirty, household treating water to make it safer before drinking, among others.

Table 5A: Impacts on Water Quality, Treatment and Health Risk

	Water Quality, Treatment and Health Risk							
Dependent variable:	Water from source is clear		Water from source was of good taste		No problem with main drinking water source		Main drinking water source is dirty	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. ITT Estimation								
Treatment	-0.007	-0.009	-0.117***	-0.124***	0.010	0.024	-0.008	-0.012
	(0.026)	(0.026)	(0.030)	(0.031)	(0.032)	(0.034)	(0.023)	(0.024)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	963	904	961	902	951	893	951	893
R-squared	0.000	0.055	0.015	0.078	0.000	0.048	0.000	0.029
Mean (SD) of dependent variable in the comparison group	0.809	0.809	0.725	0.725	0.524	0.524	0.149	0.149
	(0.393)	(0.393)	(0.447)	(0.447)	(0.500)	(0.500)	(0.357)	(0.357)
Panel B. Instrumental variable estimation: "participated" instrumented with "treatment"								
Participated	-0.010	-0.012	-0.161***	-0.163***	0.014	0.032	-0.011	-0.016
	(0.035)	(0.035)	(0.042)	(0.040)	(0.045)	(0.045)	(0.031)	(0.031)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	963	904	961	902	951	893	951	893
R-squared	-0.001	0.054	-0.003	0.061	0.001	0.049	0.001	0.031
Mean (SD) dependent variable in the comparison group	0.809	0.809	0.725	0.725	0.524	0.524	0.149	0.149
	(0.393)	(0.393)	(0.447)	(0.447)	(0.500)	(0.500)	(0.357)	(0.357)

Table 5A: Impacts on Water Quality, Treatment and Health Risk (continued)

	Water Quality, Treatment and Health Risk							
Dependent variable:	No problem with main general purpose water source		Main general purpose water source is dirty		Satisfied with water quality		Household treat water to make it safer to drink	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Panel A. ITT Estimation								
Treatment	0.017	0.024	-0.022	-0.025	-0.087***	-0.085***	-0.042	-0.040
	(0.032)	(0.034)	(0.028)	(0.029)	(0.028)	(0.030)	(0.027)	(0.028)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	955	896	955	896	964	905	941	882
R-squared	0.000	0.030	0.001	0.032	0.010	0.052	0.003	0.048
Mean (SD) of dependent variable in the comparison group	0.476	0.476	0.247	0.247	0.779	0.779	0.243	0.243
	(0.500)	(0.500)	(0.432)	(0.432)	(0.415)	(0.415)	(0.429)	(0.429)
Panel B. Instrumental variable estimation: "participated" instrumented with "treatment"								
Participated	0.024	0.032	-0.030	-0.033	-0.119***	-0.113***	-0.058	-0.053
	(0.044)	(0.045)	(0.038)	(0.038)	(0.039)	(0.039)	(0.037)	(0.037)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	955	896	955	896	964	905	941	882
R-squared	0.001	0.031	0.004	0.035	-0.012	0.033	0.004	0.049
Mean (SD) dependent variable in the comparison group	0.476	0.476	0.247	0.247	0.779	0.779	0.243	0.243
	(0.500)	(0.500)	(0.432)	(0.432)	(0.415)	(0.415)	(0.429)	(0.429)

Notes: Refer to Table 4A

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

3.4.B Differential Impacts on Water Quality, Treatment and Health Risk

Table 5B estimates the differential impacts of the household water quality testing and information on the household perceptions on water quality, treatment and health risk. In general, we find that participation in the household water quality testing and information leads to substantial differential impacts for the two treatment groups. Panel A, column 1 shows that respondents reporting of having clear water from source are 6.2 percentage points higher (significant at 95 percent, without baseline households characteristics but not significant with baseline household characteristics) for households in the school children intervention group than households in the comparison group. Mean response of having clear water from source in the comparison group is 80.9 percent. Households in the adult household members intervention group reporting of having clear water from source are lower by 7.4 percentage points in relation to the comparison group. The result is robust to specifications including baseline household controls (Panel A, column 2). Panel A, column 3 reports of the differential impacts on water from source being of good taste during the last time of fetching. Reports of water from source being of good taste are 21.4 percentage points lower in households in adult household members intervention group (relative to average value of 72.5 percent in the comparison group). The result is robust to regressions including baseline household controls (Panel A, column 4). There is no statistically significant additional effect for households in school children intervention group.

Panel A, column 5, examines the households reporting of having no problem with main drinking water source. Respondents reporting of having no problem with main drinking water source are 10.8 percentage points higher for households in the school children intervention group (relative to average value of 52.4 percent in the comparison group). The result is robust to specifications with baseline household controls (Panel A, column 6). Households in the adult household members intervention group are 8.2 percentage points less likely of reporting no problem with main drinking water source (significant at 95 percent, without baseline household controls but not significant with baseline household controls) than the comparison group. In Panel A, column 7, households in the school children intervention group are on average 4.4 percentage points (significant at 90 percent, without baseline household controls but not significant with household baseline controls) less likely of reporting that the main drinking water source is dirty (relative to average value of 14.9 percent of the comparison group). We find no statistically significant additional effect for households in the adult household members intervention group.

Panel A, column 9 shows that households in school children intervention group are 10.6 percentage points more likely of reporting of having no problem with main general purpose water source (relative to average value of the comparison group of 47.6 percent). The result is robust to specifications including baseline household controls (Panel A, column 10). Households in the adult household members intervention group are 6.9 percentage points (significant at 90, without baseline household controls but not significant with baseline household controls) less likely of reporting of having no problem with main general purpose water source compared to the comparison group. The results in Panel A, column 11 shows that households in the school children intervention group are 11.8 percentage points less likely of reporting that their main general purpose water source is dirty (relative to average value of 24.7 percent in the comparison group). The result is robust to regressions including baseline household controls (Panel A, column 12). Households in the adult household members intervention group are 7.2 percentage points (significant at 95 percent, without baseline household controls but not significant with baseline household controls) more likely of reporting that the main general purpose water source is dirty compared to the comparison group.

Based on Panel A, column 13, satisfaction with water quality in households in the adult household members intervention group are 19.2 percentage points lower (relative to average value of 77.9 percent in the comparison group). There is no statistically significant additional effect for households in the school children intervention group. Panel A, column 15 presents impacts on household water treatment. Water treatment is 9.8 percentage points lower in households in school children intervention groups compared to the control group. The average value for the comparison group is 24.3 percent. The result is robust to regressions including baseline household controls (Panel A, column 16). We do not find statistically significant additional effect for households in adult household members intervention group.

Table 5B: Differential Impacts on Water Quality, Treatment and Health Risk

	Water Quality, Treatment and Health Risk							
Dependent variable:	Water from source is clear		Water from source was of good taste		No problem with main drinking water source		Main drinking water source is dirty	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. ITT Estimation								
Child treatment	0.062**	0.047	-0.017	-0.035	0.108***	0.103**	-0.044*	-0.038
	(0.028)	(0.030)	(0.036)	(0.037)	(0.039)	(0.041)	(0.026)	(0.027)
Adult treatment	-0.074**	-0.064*	-0.214***	-0.211***	-0.082**	-0.054	0.026	0.013
	(0.034)	(0.035)	(0.038)	-0.035	(0.039)	(0.042)	(0.029)	(0.031)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	963	904	961	902	951	893	951	893
R-squared	0.015	0.064	0.037	0.095	0.018	0.060	0.005	0.032
Mean (SD) of dependent variable in the comparison group	0.809 (0.393)	0.809 (0.393)	0.725 (0.447)	0.725 (0.447)	0.524 (0.500)	0.524 (0.500)	0.149 (0.357)	0.149 (0.357)
Panel B. Instrumental variable estimation: “child participated” and “adult participated” instrumented with “child treatment” and “adult treatment”								
Child participated	0.070**	0.051	-0.019	-0.039	0.123***	0.113**	-0.050*	-0.041
	(0.032)	(0.032)	(0.041)	(0.040)	(0.045)	(0.045)	(0.030)	(0.029)
Adult participated	-0.127**	-0.108*	-0.367***	- 0.352***	-0.141**	-0.091	0.044	0.022
	(0.058)	(0.058)	(0.068)	(0.067)	(0.068)	(0.070)	(0.051)	(0.051)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	963	904	961	902	951	893	951	893
R-squared	0.003	0.058	-0.003	0.060	-0.001	0.049	0.000	0.030
Mean (SD) dependent variable in the comparison group	0.809 (0.393)	0.809 (0.393)	0.725 (0.447)	0.725 (0.447)	0.524 (0.500)	0.524 (0.500)	0.149 (0.357)	0.149 (0.357)

Table 5B: Differential Impacts on Water Quality, Treatment and Health Risk (continued)

	Water Quality, Treatment and Health Risk							
Dependent variable:	No problem with main general purpose water source		Main general purpose water source is dirty		Satisfied with water quality		Household treat water to make it safer to drink	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Panel A. ITT Estimation								
Child treatment	0.106***	0.096**	-0.118***	-0.110***	0.023	0.014	-0.098***	-0.079**
	(0.040)	(0.042)	(0.030)	(0.031)	(0.032)	(0.034)	(0.031)	(0.032)
Adult treatment	-0.069*	-0.048	0.072**	0.061	-0.192***	-0.184***	0.013	-0.002
	(0.039)	(0.041)	(0.036)	(0.038)	(0.037)	(0.039)	(0.035)	(0.036)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	955	896	955	896	964	905	941	882
R-squared	0.015	0.040	0.025	0.052	0.039	0.076	0.011	0.052
Mean (SD) of dependent variable in the comparison group	0.476	0.476	0.247	0.247	0.779	0.779	0.243	0.243
	(0.500)	(0.500)	(0.432)	(0.432)	(0.415)	(0.415)	(0.429)	(0.429)
Panel B. Instrumental variable estimation: "child participated" and "adult participated" instrumented with "child treatment" and "adult treatment"								
Child participated	0.120***	0.105**	-0.134***	-0.120***	0.027	0.015	-0.112***	-0.086**
	(0.045)	(0.046)	(0.034)	(0.034)	(0.037)	(0.037)	(0.035)	(0.035)
Adult participated	-0.119*	-0.081	0.124**	0.103	-0.330***	-0.307***	0.022	-0.002
	(0.068)	(0.070)	(0.063)	(0.063)	(0.068)	(0.068)	(0.060)	(0.061)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	955	896	955	896	964	905	941	882
R-squared	0.001	0.031	0.012	0.041	-0.026	0.021	0.007	0.051
Mean (SD) dependent variable in the comparison group	0.476	0.476	0.247	0.247	0.779	0.779	0.243	0.243
	(0.500)	(0.500)	(0.432)	(0.432)	(0.415)	(0.415)	(0.429)	(0.429)

Notes: Refer to Table 4B

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

3.5.A Impacts on Water Transport, Collection and Handling Techniques

Next, in Table 6A, we explore the impacts of the household water quality testing and information experiment on water transport, collection and handling techniques. Recall that from the previous sub-section 3.3 there were gains in water source choices, particularly in terms of improved water sources and use of sachet water, among others. Therefore we examine whether these gains in choice of water sources translate to households making time gains or otherwise investing more time looking for safer water sources. We find evidence of households in the treatment group making substantial time gains in terms of minutes and distance saved from water collection trips.

Panel A, column 1, reports the impact on one-way distance to main drinking water source (in meters). Distance to main drinking water source is on average 23.22 meters less for households in the treatment group (relative to average value of 179.49 meters of the comparison group). The result is robust to regressions including baseline household characteristics (Panel A, column 2). Likewise, Panel A, column 3 shows that households in the treatment group travel on average 37.1 meters less (significant at 99 percent, with specifications without baseline household controls) in fetching main general purpose water (relative to the average value of 210.28 meters of the comparison group). In terms of time savings, households in the treatment group travel on average 1.72 minutes less (significant at 95 percent, with regressions without baseline household controls) to and from main general purpose water source (relative to average value of 12.95 minutes of the comparison group). There is no statistically significant reduction in time spent travelling to and from main drinking water source for households in the treatment group. The time and distance gains are substantial since households in the comparison group have on average 44.22 water fetching trips per week preceding the surveys.

Panel A, column 10 shows that households in the treatment group have on average 4.24 water fetching trips less (significant at 95 percent, without baseline household controls but not significant with baseline household controls) in the past seven days preceding the surveys (relative to average value of 44.22 water fetching trips in the past seven days preceding the survey for the comparison group). Likewise Panel A, column 16 shows that households in the treatment group have 1.78 less (significant at 95 percent, with baseline household controls but not significant without baseline household controls) water fetching trips in past three days preceding the survey (relative to 18.57 water fetching trips in the past three days preceding the surveys for the comparison group). Panel A, Columns (11)-(14) examine the households' use of children as labor for water fetching. In column 11 we find that use of children 5-17 years of age increase by 4.9 percentage points (significant at 95 percent) in the households of the treatment group (relative to average value of 85.6 percent in the comparison group). The result is robust to regressions including baseline household controls. This result could be misleading unless it is discussed in relation to results of Panel A, column 13. Column 13 shows that households in the treatment group are on the average 6 percentage points less (significant at 95 percent, with household baseline controls but not significant without baseline household controls) likely to use children less than 12 years of age in water collection (relative to average value of 39.6 percent in the comparison group). This means the results in columns 11 and 12 show that households in the treatment group rely on children above 12 years in performing water collection tasks. The result is interesting in the sense that on the average households in the treatment group rely on "older" children (i.e. those above 12 years of age in fetching water) compared to their counterparts in the comparison group. The IV estimation (Panel B) confirms the results obtained using the ITT estimation (Panel A). The signs and statistical significance are the same for all the outcome variables. Using the IV estimation makes the estimates slightly higher compared to the ITT estimation.

Table 6A: Impacts on Water Transport, Collection and Handling Techniques

	Water Transport, Collection and Handling Techniques							
Dependent variable:	Distance to main drinking water (in meters)		Distance to main general purpose water (in meters)		Time to main drinking water source (in minutes)		Time to main general purpose water source (in minutes)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. ITT Estimation								
Treatment		-	-	-			-	-
	-23.216*	31.954**	37.102***	38.235***	-1.150	-1.269	1.719**	1.754**
	(13.641)	(14.124)	(13.613)	(14.025)	(0.795)	(0.781)	(0.840)	(0.838)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	873	819	915	857	910	855	915	859
R-squared	0.003	0.069	0.008	0.055	0.002	0.061	0.005	0.039
Mean (SD) of dependent variable in the comparison group	179.493 (220.864)	179.493 (220.864)	210.279 (226.752)	210.279 (226.752)	10.919 (12.198)	10.919 (12.198)	12.954 (12.288)	12.954 (12.288)
Panel B. Instrumental variable estimation: "participated" instrumented with "treatment"								
Participated		-	-	-			-	-
	-31.817*	42.414**	50.626***	50.283***	-1.585	-1.691	2.352**	2.324**
	(18.586)	(18.536)	(18.389)	(18.170)	(1.092)	(1.029)	(1.142)	(1.097)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	873	819	915	857	910	855	915	859
R-squared	0.012	0.074	0.024	0.065	0.008	0.065	0.016	0.046
Mean (SD) dependent variable in the comparison group	179.493 (220.864)	179.493 (220.864)	210.279 (226.752)	210.279 (226.752)	10.919 (12.198)	10.919 (12.198)	12.954 (12.288)	12.954 (12.288)

Table 6A: Impacts on Water Transport, Collection and Handling Techniques (continued)

	Water Transport, Collection and Handling Techniques							
Dependent variable:	Total number of water trips in the past 7 days		Children 5-17 years fetch water		Children under 12 years fetch water		Total number of water trips in the past 3 days	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Panel A. ITT Estimation								
Treatment								-
	-2.231	-4.237**	0.049**	0.043*	-0.030	-0.060*	-0.340	1.775**
	(1.967)	(1.981)	(0.021)	(0.022)	(0.032)	(0.032)	(0.907)	(0.891)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	938	880	940	881	932	873	931	872
R-squared	0.001	0.109	0.006	0.071	0.001	0.116	0.000	0.102
Mean (SD) of dependent variable in the comparison group	44.227 (31.053)	44.227 (31.053)	0.856 (0.352)	0.856 (0.352)	0.396 (0.490)	0.396 (0.490)	18.568 (13.835)	18.568 (13.835)
Panel B. Instrumental variable estimation: “participated” instrumented with “treatment”								
Participated								-
	-3.068	-5.627**	0.067**	0.057*	-0.042	-0.079*	-0.471	2.365**
	(2.705)	(2.620)	(0.029)	(0.029)	(0.044)	(0.042)	(1.255)	(1.183)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	938	880	940	881	932	873	931	872
R-squared	-0.000	0.102	0.008	0.073	-0.000	0.112	-0.000	0.093
Mean (SD) dependent variable in the comparison group	44.227 (31.053)	44.227 (31.053)	0.856 (0.352)	0.856 (0.352)	0.396 (0.490)	0.396 (0.490)	18.568 (13.835)	18.568 (13.835)

Notes: Refer to Table 4A

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

3.5.B Differential Impacts on Water Transport, Collection and Handling Techniques

In Table 6B, we examine the differential treatment effects as a function of random allocation into the treatment arms using econometric specification analogous to Equations (4). We find evidence that the differential treatment effects for time and distance gains in water collection for both main drinking and general purpose water sources are largely driven by school children intervention group whilst reduction in water collection trips and less use of child labor in water collection are largely influenced by the adult household members intervention group. Panel A, column 1 reports impacts on the distance to main drinking water source. Distance to main drinking water source is 46.63 meters lower (significant at 99 percent) for households in school children intervention group (relative to average value of 179.49 meters of the comparison group). The result is robust to specifications including baseline household controls (Panel A, column 2). There is no statistically significant reduction in distance to main drinking water source for households in the adult household members intervention group.

Panel A, column 3, presents the impacts on the distance to main general purpose water source. Distance to main general purpose water source is 69.15 meters lower (significant at 99 percent) for households in school children intervention group (relative to average value of 210.28 meters of the comparison group). The result is robust to regressions including baseline household covariates. We find no statistically significant reduction in distance to main general purpose water source for households in the adult household members intervention group. We show that reduction in distance leads to commensurate reduction in the time taken to reach and return from both drinking and general purpose water sources (Panel A, columns (5)-(8)). Specifically, Panel A, column 5 shows that on average the comparison group spends 10.92 minutes travelling to and from main drinking water source. This proportion is decreased by 3.38 minutes among households in school children intervention group. The result is robust to regressions with the inclusion of baseline household controls. In the case of time taken to and from main general purpose water source, Panel A, column 7 shows that the comparison group spends on average 12.95 minutes. This proportion is reduced by 3.19 minutes for households in the school children intervention group. The result is robust to specifications including baseline household characteristics (Panel A, column 8). We do not find statistically significant reduction in minutes taken to and from both main drinking and general purpose water sources for households in the adult household members intervention group.

Panel A, column 9, examines the water fetching trips by the households in the past seven days preceding the surveys. Water fetching trips in the past seven days preceding the surveys are 4.96 lower for households in adult household members intervention group (relative to average value of 44.22 water fetching trips in the past seven days preceding the surveys in the comparison group). The result is robust to regressions including baseline household characteristics. There is no statistically significant reduction in water fetching trips during the past seven days preceding the surveys for households in the school children intervention group. In the case of water fetching trips in the past three days before the surveys, we find different results for the two treatment arms. In Panel A, column 15, we find that households in school children intervention group increase water fetching trips in the past three days preceding the surveys by 2.14 (significant at 90 percent, without baseline household controls but not significant with baseline household controls). The mean of water fetching trips in the past three days preceding the surveys for the comparison group is 18.57. However, households in the adult household members intervention group decreased their water fetching trips in the past three days preceding the surveys by 2.64. The result is robust to specifications including household baseline controls (Panel A, column 16).

Columns (11)-(14) examine the use of child labor in the fetching of water among the households. The use of children aged 5-17 years in water collection increase by 6 percentage points (significant at 95 percent, without baseline household controls but not significant with baseline household controls) in households in the school children intervention groups (relative to average value of 85.6 percent in the comparison group). Households in adult household members intervention group increased the use of children 5-17 years of age by 4.6 percentage points (significant at 90 percent, with household baseline controls but not significant without household baseline controls) for water collection. The use of children under 12 years of age for water collection decreased by 6.7 percentage points in households in adult household members intervention group (significant at 90 percent, with baseline household controls but not significant without baseline household controls). We find no statistically significant reduction in the use of children under 12 years of age in water collection for households in school children intervention group.

Table 6B: Differential Impacts on Water Transport, Collection and Handling Techniques

	Water Transport, Collection and Handling Techniques							
Dependent variable:	Distance to main drinking water (in meters)		Distance to main general purpose water (in meters)		Time to main drinking water source (in minutes)		Time to main general purpose water source (in minutes)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. ITT Estimation								
Child treatment	-46.628***	-56.518***	-69.149***	-73.186***	-3.381***	-3.401***	-3.185***	-3.235***
	(15.974)	(16.290)	(15.939)	(16.107)	(0.766)	(0.777)	(0.956)	(0.967)
Adult treatment	-1.530	-9.030	-7.314	-4.858	0.841	0.650	-0.393	-0.389
	(16.399)	(16.936)	(16.199)	(16.698)	(1.095)	(1.061)	(1.107)	(1.056)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	873	819	915	857	910	855	915	859
R-squared	0.009	0.076	0.018	0.068	0.017	0.075	0.010	0.046
Mean (SD) of dependent variable in the comparison group	179.493 (220.864)	179.493 (220.864)	210.279 (226.752)	210.279 (226.752)	10.919 (12.198)	10.919 (12.198)	12.954 (12.288)	12.954 (12.288)
Panel B. Instrumental variable estimation: "child participated" and "adult participated" instrumented with "child treatment" and "adult treatment"								
Child participated	-54.175***	-62.777***	-79.296***	-80.536***	-3.906***	-3.762***	-3.640***	-3.563***
	(18.506)	(18.014)	(18.166)	(17.697)	(0.890)	(0.863)	(1.083)	(1.055)
Adult participated	-2.515	-14.609	-12.120	-7.631	1.399	1.076	-0.655	-0.625
	(26.892)	(27.220)	(26.685)	(26.709)	(1.827)	(1.724)	(1.838)	(1.708)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	873	819	915	857	910	855	915	859
R-squared	0.010	0.075	0.024	0.065	0.010	0.068	0.016	0.047
Mean (SD) dependent variable in the comparison group	179.493 (220.864)	179.493 (220.864)	210.279 (226.752)	210.279 (226.752)	10.919 (12.198)	10.919 (12.198)	12.954 (12.288)	12.954 (12.288)

Table 6B: Differential Impacts on Water Transport, Collection and Handling Techniques (continued)

	Water Transport, Collection and Handling Techniques							
Dependent variable:	Total number of water trips in the past 7 days		Children 5-17 years fetch water		Children under 12 years fetch water		Total number of water trips in the past 3 days	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Panel A. ITT Estimation								
Child treatment	0.640	-1.599	0.060**	0.040	-0.012	-0.053	2.142*	0.135
	(2.518)	(2.426)	(0.025)	(0.026)	(0.040)	(0.039)	(1.241)	(1.128)
Adult treatment	-4.957**	-6.817***	0.038	0.046*	-0.048	-0.067*	-2.643***	-3.602***
	(2.257)	(2.391)	(0.026)	(0.027)	(0.038)	(0.040)	(0.970)	(1.035)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	938	880	940	881	932	873	931	872
R-squared	0.006	0.112	0.006	0.071	0.002	0.116	0.015	0.112
Mean (SD) of dependent variable in the comparison group	44.227	44.227	0.856	0.856	0.396	0.396	18.568	18.568
	(31.053)	(31.053)	(0.352)	(0.352)	(0.490)	(0.490)	(13.835)	(13.835)
Panel B. Instrumental variable estimation: “child participated” and “adult participated” instrumented with “child treatment” and “adult treatment”								
Child participated	0.727	-1.780	0.068**	0.044	-0.014	-0.058	2.454*	0.140
	(2.859)	(2.649)	(0.028)	(0.028)	(0.045)	(0.043)	(1.432)	(1.237)
Adult participated	-8.513**	-11.399***	0.065	0.075*	-0.082	-0.111*	-4.540***	-6.022***
	(3.922)	(4.041)	(0.044)	(0.044)	(0.066)	(0.066)	(1.705)	(1.771)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	938	880	940	881	932	873	931	872
R-squared	-0.004	0.096	0.008	0.073	-0.000	0.111	-0.008	0.085
Mean (SD) dependent variable in the comparison group	44.227	44.227	0.856	0.856	0.396	0.396	18.568	18.568
	(31.053)	(31.053)	(0.352)	(0.352)	(0.490)	(0.490)	(13.835)	(13.835)

Notes: Refer to Table 4B

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

3.6.A Impacts on Water Quantity, Consumption/Usage and Security

In Table 7A, we present the impacts of household water quality testing and information on water quantity, consumption and security. We find that households in the treatment group are 5.4 percentage points less likely of reporting of having enough water for drinking, cooking, bathing, etc in relation to the comparison group (Panel A, column 5). The result is robust to regressions including baseline household characteristics (Panel A, column 6). Other than this, there is no statistically significant additional effect on other water quantity, consumption and security indicators, consistent with water quality testing and information improving knowledge, awareness and beliefs on water quality but not water quantity. The results from the IV estimation (Panel B) are similar to those achieved with the ITT estimation (Panel A).

Table 7A: Impacts on Water Quantity, Consumption/Usage and Security

	Water Quantity, Consumption/Usage and Security			
Dependent variable:	Volume (liters) of drinking water consumed (past 2 days)		Volume (liters) of general purpose water consumed (past 2 days)	
	(1)	(2)	(3)	(4)
Panel A. ITT Estimation				
Treatment	1.303	-0.754	-5.268	-13.216
	(4.221)	(3.856)	(11.468)	(10.738)
Household Controls	No	Yes	No	Yes
Observations	955	896	963	904
R-squared	0.000	0.030	0.000	0.100
Mean (SD) of dependent variable in the comparison group	45.964	45.964	284.299	284.299
	(64.968)	(64.968)	(189.379)	(189.379)
Panel B. Instrumental variable estimation: "participated" instrumented with "treatment"				
Participated	1.789	-0.998	-7.238	-17.504
	(5.794)	(5.064)	(15.746)	(14.170)
Household Controls	No	Yes	N0	Yes
Observations	955	896	963	904
R-squared	-0.001	0.031	-0.000	0.096
Mean (SD) dependent variable in the comparison group	45.964	45.964	284.299	284.299
	(64.968)	(64.968)	(189.379)	(189.379)

Table 7A: Impact on Water Quantity, Consumption/Usage and Security (continued)

	Water Quantity, Consumption/Usage and Security					
Dependent variable:	Household have enough water for drinking, cook, etc in the past 30 days		Satisfied with time spent getting water		No problem with access to water in the past 30 days	
	(5)	(6)	(7)	(8)	(9)	(10)
Panel A. ITT Estimation						
Treatment	-0.054**	-0.060**	0.034	0.032	-0.034	-0.035
	(0.027)	(0.030)	(0.026)	(0.028)	(0.028)	(0.029)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	963	904	963	904	962	903
R-squared	0.004	0.015	0.002	0.033	0.002	0.046
Mean (SD) of dependent variable in the comparison group	0.789 (0.408)	0.789 (0.408)	0.777 (0.417)	0.777 (0.417)	0.766 (0.424)	0.766 (0.424)
Panel B. Instrumental variable estimation: "participated" instrumented with "treatment"						
Participated	-0.074**	-0.079**	0.047	0.042	-0.047	-0.047
	(0.038)	(0.039)	(0.036)	(0.036)	(0.038)	(0.038)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	963	904	963	904	962	903
R-squared	0.011	0.023	0.003	0.033	-0.002	0.045
Mean (SD) dependent variable in the comparison group	0.789 (0.408)	0.789 (0.408)	0.777 (0.417)	0.777 (0.417)	0.766 (0.424)	0.766 (0.424)

Notes: Refer to Table 4A

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

3.6.B Differential Impacts on Water Quantity, Consumption/Usage and Security

Table 7B shows the differential impacts on water quantity, consumption and security. Column (7) of Panel A shows that households in the adult household members intervention group are 5.8 percentage points less likely of reporting of having enough water for drinking, cooking, bathing, etc compared to the control group. The mean for the comparison group is 78.9 percent. We find no statistically significant additional effect for households in the school children intervention group. Likewise, Panel A, column 9 shows that households in the school children intervention group are 8.6 percentage points more likely of being satisfied with the time spent in getting water (relative to average value of 77.7 percent in the comparison group). The result is robust to specifications including baseline household controls. There is no statistically significant additional effect for households in the adult household members intervention group. Panel A, column 11 reports households indicating of having no problem with access to water in past 30 days preceding the surveys. Households in the adult household members intervention group are 6.8 percentage points (significant at 90 percent, without baseline household controls but not significant when including baseline household controls) less likely of reporting of having no problem with access to water in past 30 days preceding the surveys (relative to average value of 76.6 percent in the comparison group). We find no evidence of additional effect for households in the school children intervention group. The IV estimation (Panel B) generates similar estimates as the ITT estimation (Panel A).

Table 7B: Differential Impacts on Water Quantity, Consumption/Usage and Security

	First stage		Water Quantity, Consumption/Usage and Security			
Dependent variable:	Child Participated	Adult participated	Volume (liters) of drinking water consumed (past 2 days)		Volume (liters) of general purpose water consumed (past 2 days)	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. ITT Estimation						
Child treatment	0.912***	-0.001	2.517	-0.990	4.846	-3.343
	(0.019)	(0.006)	(4.830)	(4.726)	(13.174)	(11.913)
Adult treatment	0.003	0.601***	0.144	-0.523	-14.964	-22.959
	(0.003)	(0.032)	(5.496)	(5.144)	(14.283)	(14.048)
Household Controls	Yes	Yes	No	Yes	No	Yes
Observations	896	896	955	896	963	904
R-squared	0.886	0.530	0.000	0.030	0.002	0.102
Mean (SD) of dependent variable in the comparison group	0	0	45.964	45.964	284.299	284.299
	(0)	(0)	(64.968)	(64.968)	(189.379)	(189.379)
Panel B. Instrumental variable estimation: "child participated" and "adult participated" instrumented with "child treatment" and "adult treatment"						
Child participated			2.865	-1.086	5.511	-3.699
			(5.503)	(5.139)	(14.968)	(12.973)
Adult participated			0.246	-0.866	-25.683	-38.425
			(9.380)	(8.492)	(24.586)	(23.600)
Household Controls			No	Yes	No	Yes
Observations			955	896	963	904
R-squared			-0.001	0.031	-0.002	0.094
Mean (SD) dependent variable in the comparison group			45.964	45.964	284.299	284.299
			(64.968)	(64.968)	(189.379)	(189.379)

Table 7B: Differential Impacts on Water Quantity, Consumption/Usage and Security (continued)

	Water Quantity, Consumption/Usage and Security					
Dependent variable:	Household have enough water for drinking, cook, etc in the past 30 days		Satisfied with time spent getting water		No problem with access to water in the past 30 days	
	(7)	(8)	(9)	(10)	(11)	(12)
Panel A. ITT Estimation						
Child treatment	-0.051	-0.059	0.086***	0.080**	0.001	-0.013
	(0.034)	(0.036)	(0.029)	(0.032)	(0.034)	(0.035)
Adult treatment	-0.058*	-0.061*	-0.016	-0.015	-0.068*	-0.057
	(0.034)	(0.037)	(0.033)	(0.035)	(0.035)	(0.036)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	963	904	963	904	962	903
R-squared	0.004	0.015	0.010	0.039	0.005	0.048
Mean (SD) of dependent variable in the comparison group	0.789 (0.408)	0.789 (0.408)	0.777 (0.417)	0.777 (0.417)	0.766 (0.424)	0.766 (0.424)
Panel B. Instrumental variable estimation: "child participated" and "adult participated" instrumented with "child treatment" and "adult treatment"						
Child participated	-0.058	-0.065*	0.098***	0.087**	0.001	-0.015
	(0.039)	(0.039)	(0.034)	(0.035)	(0.038)	(0.038)
Adult participated	-0.099*	-0.102*	-0.028	-0.026	-0.117*	-0.096
	(0.058)	(0.060)	(0.057)	(0.058)	(0.061)	(0.061)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	963	904	963	904	962	903
R-squared	0.013	0.025	0.003	0.033	-0.004	0.044
Mean (SD) dependent variable in the comparison group	0.789 (0.408)	0.789 (0.408)	0.777 (0.417)	0.777 (0.417)	0.766 (0.424)	0.766 (0.424)

Notes: Refer to Table 4B

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

3.7.A Impacts on Water Storage

We estimate the impacts of water quality testing and information on a host of water storage behaviors (Table 8A). Empirically, we find statistically significant changes in water storage behaviors. In Panel A, column 1, we find that households in the treatment group on average decrease stocking drinking water in the house (not counting bottled/sachet water) by 4.7 percentage points compared to the control group. The result is robust to specifications including baseline household controls (Panel A, column 2). Panel A, column 4, shows that households in the treatment group are 5.6 percentage points (significant at 90 percent, with baseline household controls but not significant without baseline household controls) more likely of using clay pot for storing drinking water. The use of "other plastic container" such as pans, basins, etc for storing drinking water decrease by 7.2 percentage points (significant at 95 percent, with baseline household controls but not significant without baseline household controls) in households in the treatment group.

In Panel A, column 9 we find that households in the treatment group are 3.1 percentage points more likely to use storage containers closed by lids or cork. The result is robust to specifications with baseline household controls (Panel A, column 10). We also find that treated households decrease the use of soap/detergent in washing storage containers by 6.8 percentage points (significant at 95 percent, but not significant without baseline household control variables; Panel A, column 12). In Panel A, column 13 we find that treated households are 5.1 percentage points more likely of using only plain water for washing drinking water storage containers. The result is robust to specifications with baseline household controls (Panel A, column 14). Using field enumerator observations, we find that treated households are 3.4 percentage points more likely to have their drinking water storage containers covered (Panel A, column 15). The result is robust to specifications with baseline household controls (Panel A, column 16). This confirms the result found in Panel A, column 9 on storage containers having lids or cork. Surprisingly, treated households are on average 6.4 percentage points less likely of having stored general purpose water located on a platform (Panel A, column 25). The result is robust to regressions with baseline household control variables (Panel A, column 26). We find no statistically significant effects on other storage behavior indicators such as main drinking water storage container is set on the ground, interior of drinking water container is clean, among others.

Table 8A: Impacts on Water Storage

Dependent variable:	Water Storage							
	Usually stock drinking water in the house		Type of container (=Clay pot)		Type of container (=Other plastic container)		Container is set on the ground	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. ITT Estimation								
Treatment	-0.047**	-0.062***	0.018	0.056*	-0.044	-0.072**	0.007	-0.013
	(0.020)	(0.021)	(0.033)	(0.032)	(0.031)	(0.033)	(0.034)	(0.034)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	963	904	851	797	851	797	849	795
R-squared	0.005	0.110	0.000	0.192	0.002	0.047	0.000	0.141
Mean (SD) of dependent variable in the comparison group	0.910	0.910	0.338	0.338	0.320	0.320	0.576	0.576
	(0.287)	(0.287)	(0.474)	(0.474)	(0.467)	(0.467)	(0.495)	(0.495)
Panel B. Instrumental variable estimation: “participated” instrumented with “treatment”								
Participated	-0.064**	-0.082***	0.026	0.076*	-0.063	-0.100**	0.009	-0.018
	(0.028)	(0.027)	(0.047)	(0.043)	(0.045)	(0.045)	(0.049)	(0.046)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	963	904	851	797	851	797	849	795
R-squared	0.018	0.119	0.000	0.196	0.003	0.050	-0.000	0.142
Mean (SD) dependent variable in the comparison group	0.910	0.910	0.338	0.338	0.320	0.320	0.576	0.576
	(0.287)	(0.287)	(0.474)	(0.474)	(0.467)	(0.467)	(0.495)	(0.495)

Table 8A: Impacts on Water Storage (continued)

	Water Storage							
Dependent variable:	Container closed by a lid or cork		Used soap or detergent to wash container the last time		Used only plain water in washing the container the last time		Drinking water storage container is covered	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Panel A. ITT Estimation								
Treatment	0.031**	0.031*	-0.043	-0.068**	0.051*	0.075**	0.034**	0.036**
	(0.015)	(0.016)	(0.031)	(0.032)	(0.031)	(0.031)	(0.014)	(0.015)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	851	797	850	796	850	796	851	797
R-squared	0.005	0.032	0.002	0.075	0.003	0.073	0.007	0.032
Mean (SD) of dependent variable in the comparison group	0.932	0.932	0.735	0.735	0.252	0.252	0.937	0.937
	(0.252)	(0.252)	(0.442)	(0.442)	(0.434)	(0.434)	(0.244)	(0.244)
Panel B. Instrumental variable estimation: "participated" instrumented with "treatment"								
Participated	0.045**	0.043*	-0.061	-0.093**	0.074*	0.104**	0.049**	0.049**
	(0.022)	(0.022)	(0.045)	(0.043)	(0.044)	(0.043)	(0.021)	(0.021)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	851	797	850	796	850	796	851	797
R-squared	0.002	0.032	-0.000	0.075	-0.001	0.071	-0.001	0.028
Mean (SD) dependent variable in the comparison group	0.932	0.932	0.735	0.735	0.252	0.252	0.937	0.937
	(0.252)	(0.252)	(0.442)	(0.442)	(0.434)	(0.434)	(0.244)	(0.244)

Table 8A: Impacts on Water Storage (continued)

	Water Storage									
Dependent variable:	Interior of drinking water storage container is clean		Stored drinking water container is located on a platform		Object used to fetch drinking water from storage container is clean		Water for general purposes is stored in covered containers		Stored general purpose water is located on a platform	
	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
Panel A. ITT Estimation										
Treatment	0.015	0.015	0.004	0.024	0.003	-0.005	0.037	0.041	- 0.065**	- 0.064**
	(0.019)	(0.022)	(0.034)	(0.034)	(0.016)	(0.017)	(0.033)	(0.033)	(0.026)	(0.027)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	854	800	857	802	856	802	938	882	940	882
R-squared	0.001	0.022	0.000	0.125	0.000	0.019	0.001	0.085	0.007	0.034
Mean (SD) of dependent variable in the comparison group	0.907	0.907	0.431	0.431	0.939	0.939	0.519	0.519	0.233	0.233
	(0.290)	(0.290)	(0.496)	(0.496)	(0.239)	(0.239)	(0.500)	(0.500)	(0.423)	(0.423)
Panel B. Instrumental variable estimation: "participated" instrumented with "treatment"										
Participated	0.022	0.020	0.005	0.033	0.004	-0.007	0.051	0.054	- 0.089**	- 0.085**
	(0.027)	(0.030)	(0.049)	(0.047)	(0.023)	(0.023)	(0.045)	(0.044)	(0.036)	(0.036)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	854	800	857	802	856	802	938	882	940	882
R-squared	0.002	0.024	0.000	0.127	0.000	0.018	-0.002	0.080	0.000	0.030
Mean (SD) dependent variable in the comparison group	0.907	0.907	0.431	0.431	0.939	0.939	0.519	0.519	0.233	0.233
	(0.290)	(0.290)	(0.496)	(0.496)	(0.239)	(0.239)	(0.500)	(0.500)	(0.423)	(0.423)

Notes: Refer to Table 4A

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

3.7.B Differential Impacts on Water Storage

Assignment to water quality testing and information treatment leads to differential impacts on water storage behaviors. Respondents in the school children intervention group are 11.6 percentage points less likely of usually stocking drinking water in the house aside bottled/sachet water (relative to average value of 91 percent in the comparison group). There is no statistically significant additional effect for those households in the adult household members intervention group. The result is robust to specifications with baseline household controls (Panel A, column 2). In Panel A, column 3, we find that treated households in the school children intervention group are 7.3 percentage points more likely of using clay pot for stocking drinking water (relative to average value of 33.8 percent in the comparison group). The result is robust to specifications with baseline household characteristics (Panel A, column 4). There is no statistically significant additional effect for households in adult household members intervention group.

Panel A, column 5 shows that households in school children intervention group are 6.6 percentage points less likely of using "other plastic container" for storing drinking water (relative to average value of 32 percent in the comparison group). The result is robust to regressions with baseline household control variables (Panel A, column 6). We find no statistically significant additional effect for respondents in the adult household members intervention group. Panel A, columns (7) and (8) examines the impacts on household water storage container being set on the ground. We find that households in the adult household members intervention group are 6.8 percentage points (significant at 90, without baseline household controls but not significant with specifications including baseline household controls) more likely to have drinking water storage container set on the ground (relative to average value of 57.6 percent in the comparison group). Households in the school children intervention group are 9.1 percentage points (significant at 95 percent, with baseline household controls but not significant without household baseline controls) less likely of having stored drinking water container set on the ground than the control group. Panel A, column 9 reports differential impacts on household drinking water storage container closed by lid or cork. Households in the school children intervention group are 3.6 percentage points more likely of having drinking water storage container closed by lid or cork (relative to average value of 93.2 percent in the comparison group). The result is robust to regressions with baseline household controls (Panel A, column 10). There is no statistically significant effect for households in the adult household members intervention group. Panel A, column 12 shows that households in the school children intervention group are 7.2 percentage points (significant at 90 percent, with baseline household controls but not significant without baseline household controls) less likely of using soap/detergent in washing drinking water storage containers (relative to average value of 73.5 percent in the comparison group). Likewise, households in the adult household members intervention group are 6.5 percentage points (significant at 90 percent, with baseline household controls but not significant without baseline household controls) less likely of using soap/detergent in washing drinking water storage containers compared to the control group.

In Panel A, column 14, we find that households in the school children intervention group are 7.6 percentage points (significant at 90 percent, with baseline household controls but not significant without baseline household controls) more likely of using plain water in washing drinking water storage containers. In the same vein, households in the adult household members intervention group are 7.4 percentage points (significant at 90 percent, with baseline household controls but not significant without baseline household controls) more likely of using plain water in washing drinking water storage containers. The results in Panel A, column 15 shows that households in the school children intervention group are 3.7 percentage points more likely of having drinking water storage container covered based on field enumerator observation (relative to average value of 93.7 percent in the comparison group). Similarly, households in the adult household members intervention group are 3.2

percentage points more likely of having drinking water storage container covered based on field enumerator observation compared to the control group. The results obtained for the two intervention arms are robust to regressions with baseline household covariates.

Panel A, column 17 shows that households in the school children intervention group are 5 percentage points more likely of having interior of drinking water storage container being clean (relative to average value of 90.7 percent in the comparison group). The result is robust to specifications with baseline household controls. We do not find additional effect for households in the adult household members intervention group. We find that households in the school children intervention group are 8.2 percentage points (significant at 90 percent, with baseline household controls but not significant without baseline household controls) more likely to have stored drinking water container being located on a platform (relative to average value of 43.1 percent in the comparison group; Panel A, column 20). We do not find evidence of additional effect for households in the adult household members intervention group. In Panel A, column 21 we show that households in school children intervention group are 3.9 percentage points more likely to use “clean” object in fetching drinking water from storage container (relative to average value of 93.9 percent in the comparison group). The result is robust to regressions with baseline household controls (Panel A, column 22). We do not find additional effect for households in the adult household members intervention group.

Panel A, column 24 shows that households in the school children intervention group are 6.9 percentage points (significant at 90 percent, with baseline household controls but not significant without baseline household controls) more likely to have stored water for general purposes in covered containers. There is no statistically significant effect for households in the adult household members intervention group. Surprisingly, households in the school children intervention group are 11.1 percentage points less likely of having stored water for general purposes located on a platform (relative to average value of 23.3 percent in the comparison group; Panel A, column 25). The result is robust to regressions with baseline household controls (Panel A, column 26). We do not find statistically significant effect for households in the adult household members intervention group.

Table 8B: Differential Impacts on Water Storage

Dependent variable:	Water Storage							
	Usually stock drinking water in the house		Type of container (=Clay pot)		Type of container (=Other plastic container)		Container is set on the ground	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. ITT Estimation								
Child treatment	-0.116***	-0.133***	0.073*	0.117***	-0.066*	-0.109***	-0.068	-0.091**
	(0.030)	(0.028)	(0.043)	(0.039)	(0.039)	(0.041)	(0.044)	(0.043)
Adult treatment	0.020	0.009	-0.027	0.005	-0.026	-0.042	0.068*	0.052
	(0.021)	(0.023)	(0.038)	(0.038)	(0.038)	(0.040)	(0.040)	(0.040)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	963	904	851	797	851	797	849	795
R-squared	0.028	0.134	0.006	0.198	0.003	0.049	0.009	0.151
Mean (SD) of dependent variable in the comparison group	0.910	0.910	0.338	0.338	0.320	0.320	0.576	0.576
	(0.287)	(0.287)	(0.474)	(0.474)	(0.467)	(0.467)	(0.495)	(0.495)
Panel B. Instrumental variable estimation: “child participated” and “adult participated” instrumented with “child treatment” and “adult treatment”								
Child participated	-0.132***	-0.146***	0.086*	0.131***	-0.077*	-0.122***	-0.080	-0.102**
	(0.033)	(0.031)	(0.050)	(0.044)	(0.046)	(0.045)	(0.052)	(0.049)
Adult participated	0.034	0.015	-0.047	0.008	-0.046	-0.072	0.119*	0.089
	(0.036)	(0.038)	(0.067)	(0.064)	(0.065)	(0.068)	(0.070)	(0.068)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	963	904	851	797	851	797	849	795
R-squared	0.037	0.138	0.001	0.196	0.003	0.050	0.002	0.142
Mean (SD) dependent variable in the comparison group	0.910	0.910	0.338	0.338	0.320	0.320	0.576	0.576
	(0.287)	(0.287)	(0.474)	(0.474)	(0.467)	(0.467)	(0.495)	(0.495)

Table 8B: Differential Impacts on Water Storage (continued)

	Water Storage							
Dependent variable:	Container closed by a lid or cork		Used soap or detergent to wash container the last time		Used only plain water in washing the container the last time		Drinking water storage container is covered	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Panel A. ITT Estimation								
Child treatment	0.036**	0.037*	-0.048	-0.072*	0.056	0.076*	0.037**	0.039**
	(0.018)	(0.020)	(0.040)	(0.040)	(0.040)	(0.040)	(0.017)	(0.018)
Adult treatment	0.028	0.026	-0.038	-0.065*	0.047	0.074*	0.032*	0.033*
	(0.018)	(0.019)	(0.037)	(0.039)	(0.037)	(0.038)	(0.016)	(0.017)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	851	797	850	796	850	796	851	797
R-squared	0.005	0.033	0.002	0.075	0.003	0.073	0.007	0.032
Mean (SD) of dependent variable in the comparison group	0.932	0.932	0.735	0.735	0.252	0.252	0.937	0.937
	(0.252)	(0.252)	(0.442)	(0.442)	(0.434)	(0.434)	(0.244)	(0.244)
Panel B. Instrumental variable estimation: "child participated" and "adult participated" instrumented with "child treatment" and "adult treatment"								
Child participated	0.042**	0.042*	-0.057	-0.080*	0.066	0.086*	0.043**	0.044**
	(0.021)	(0.022)	(0.047)	(0.044)	(0.047)	(0.044)	(0.020)	(0.021)
Adult participated	0.049	0.044	-0.067	-0.110*	0.083	0.127*	0.056*	0.057*
	(0.031)	(0.033)	(0.065)	(0.065)	(0.065)	(0.065)	(0.029)	(0.030)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	851	797	850	796	850	796	851	797
R-squared	0.002	0.032	-0.000	0.075	-0.001	0.071	-0.001	0.028
Mean (SD) dependent variable in the comparison group	0.932	0.932	0.735	0.735	0.252	0.252	0.937	0.937
	(0.252)	(0.252)	(0.442)	(0.442)	(0.434)	(0.434)	(0.244)	(0.244)

Table 8B: Differential Impacts on Water Storage (continued)

	Water Storage									
Dependent variable:	Interior of drinking water storage container is clean		Stored drinking water container is located on a platform		Object used to fetch drinking water from storage container is clean		Water for general purposes is stored in covered containers		Stored general purpose water is located on a platform	
	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
Panel A. ITT Estimation										
Child treatment	0.050**	0.051**	0.064	0.082*	0.039**	0.035**	0.062	0.069*	-0.111***	-0.099***
	(0.020)	(0.023)	(0.043)	(0.043)	(0.016)	(0.016)	(0.040)	(0.041)	(0.029)	(0.031)
Adult treatment	-0.014	-0.016	-0.046	-0.025	-0.028	-0.039	0.013	0.013	-0.020	-0.029
	(0.025)	(0.027)	(0.040)	(0.041)	(0.022)	(0.024)	(0.040)	(0.040)	(0.033)	(0.034)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	854	800	857	802	856	802	938	882	940	882
R-squared	0.007	0.029	0.006	0.131	0.010	0.030	0.003	0.086	0.013	0.038
Mean (SD) of dependent variable in the comparison group	0.907	0.907	0.431	0.431	0.939	0.939	0.519	0.519	0.233	0.233
	(0.290)	(0.290)	(0.496)	(0.496)	(0.239)	(0.239)	(0.500)	(0.500)	(0.423)	(0.423)
Panel B. Instrumental variable estimation: "child participated" and "adult participated" instrumented with "child treatment" and "adult treatment"										
Child participated	0.059**	0.057**	0.075	0.092*	0.046**	0.039**	0.070	0.075*	-0.127***	-0.108***
	(0.024)	(0.026)	(0.051)	(0.047)	(0.018)	(0.017)	(0.045)	(0.045)	(0.033)	(0.034)
Adult participated	-0.024	-0.028	-0.081	-0.043	-0.049	-0.067*	0.023	0.021	-0.034	-0.048
	(0.044)	(0.046)	(0.070)	(0.070)	(0.039)	(0.041)	(0.069)	(0.067)	(0.057)	(0.057)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	854	800	857	802	856	802	938	882	940	882
R-squared	0.004	0.027	-0.001	0.126	0.018	0.039	-0.000	0.083	0.006	0.033
Mean (SD) dependent variable in the comparison group	0.907	0.907	0.431	0.431	0.939	0.939	0.519	0.519	0.233	0.233
	(0.290)	(0.290)	(0.496)	(0.496)	(0.239)	(0.239)	(0.500)	(0.500)	(0.423)	(0.423)

Notes: Refer to Table 4B

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

3.8 Gendered Treatment Effects of Household Water Quality Testing and Information on Safe Water Behaviors

3.8.A Gendered Treatment Effects on Water Source Choices

In Table 9A, we examine the gendered treatment effects of the water quality testing and information experiment on water source choices. The study design and sampling frame allows for the analysis of gendered treatment effects. We can therefore comfortably reject any accusation of data mining. Here the results should be interpreted with caution due to missing data issues, particularly among the adult household members intervention group. Therefore the results presented here are not as a whole and should be seen as limited evidence based on gender of the participants. The results presented are also the differences-in-differences treatment effect estimate between male and female participants using samples from households who participated in the water quality testing and information experiment.

We find gendered treatment impacts on choice of improved main drinking water source based on WHO's JMP classification, use of other improved drinking water source based on WHO's JMP categorization on the "drinking water ladder", use of surface water also based on WHO's JMP categorization on the "drinking water ladder", and use of improved general purpose based on the JMP's classification. In all of the cases, households with male participants were worse-off than their counterparts with female participants. For instance, households with male participants were 12.7 percentage points (significant at 95 percent, without baseline household controls but not significant with baseline household controls) less likely of using improved main drinking water source (relative to average value of 78.9 percent for households with female participants). In the case of choice of other improved drinking water source, households with male participants were 15.3 percentage points less likely (significant at 99 percent) to use this water source (relative to average value of 75 percent of the households with female participants). The result is robust to regression with baseline household controls. The choice of surface water as the main drinking water source was more pronounced in households with male participants in comparison with households with female participants. Households with male participants were 7.8 percentage points more (significant at 95 percent, without household baseline controls but not significant with household baseline controls) likely to use surface water as the main drinking water source (relative to average value of 7.8 percent of the households with female participants). Households with male participants were 11.8 percentage points less likely (significant at 95 percent, without household baseline controls but not significant with household baseline controls) to use improved general purpose water source (relative to average value of 61.1 percent of households with female participants). We find no evidence of gendered treatment effects for other water source choice outcomes such as use of unimproved main drinking water sources, household use of multiple drinking and general purpose water sources, use of improved secondary water sources, and use of sachet water as the main drinking water source.

Table 9A: Gendered Treatment Effects on Water Source Choices

	Water source choices					
Dependent variable:	Improved main drinking water based on JMP		Other improved drinking water source based on JMP		Unimproved main drinking water sources based on JMP	
	(1)	(2)	(3)	(4)	(5)	(6)
Male participated	-0.127**	-0.083	-0.153***	-0.107*	0.048	0.018
	(0.049)	(0.054)	(0.051)	(0.056)	(0.040)	(0.041)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	334	327	334	327	334	327
R-squared	0.020	0.113	0.027	0.089	0.004	0.161
Mean (SD) of dependent variable in the female participated group	0.789	0.789	0.750	0.750	0.133	0.133
	(0.409)	(0.409)	(0.434)	(0.434)	(0.341)	(0.341)

	Water source choices continued					
Dependent variable:	Surface water as main drinking water source		Household reports of multiple drinking water sources		Household reports of multiple general purpose water sources	
	(7)	(8)	(9)	(10)	(11)	(12)
Male participated	0.078**	0.066	-0.032	-0.048	-0.054	-0.027
	(0.036)	(0.040)	(0.053)	(0.057)	(0.055)	(0.059)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	334	327	334	327	334	327
R-squared	0.015	0.121	0.001	0.048	0.003	0.068
Mean (SD) of dependent variable in the female participated group	0.078	0.078	0.656	0.656	0.567	0.567
	(0.269)	(0.269)	(0.477)	(0.477)	(0.497)	(0.497)

	Water source choices continued					
Dependent variable:	Improved secondary drinking water source		Improved main general purpose water		Household use sachet water as the main drinking water	
	(13)	(14)	(15)	(16)	(17)	(18)
Male participated	0.045	0.030	-0.118**	-0.091	0.012	-0.012
	(0.062)	(0.069)	(0.054)	(0.059)	(0.047)	(0.046)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	214	207	334	327	334	327
R-squared	0.002	0.084	0.014	0.085	0.000	0.174
Mean (SD) of dependent variable in the female participated group	0.695	0.695	0.611	0.611	0.228	0.228
	(0.462)	(0.462)	(0.489)	(0.489)	(0.421)	(0.421)

Notes: Refer to Table 4A

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

3.8.B Gendered Treatment Effects on Water Quality, Treatment and Health Risk

Table 9B presents the gendered treatment effects of the water quality testing and information experiment on household perceptions on water quality, treatment and health risk. We do not find evidence on the effects of gender of participants on household perceptions on water quality, treatment and health risk.

Table 9B: Gendered Treatment Effects on Water Quality, Treatment and Health Risk

	Water Quality, Treatment and Health Risk					
Dependent variable:	Water from source is clear		Water from source was of good taste		No problem with main drinking water source	
	(1)	(2)	(3)	(4)	(5)	(6)
Male participated	-0.032	-0.005	0.043	0.071	0.058	0.019
	(0.041)	(0.044)	(0.053)	(0.053)	(0.055)	(0.059)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	334	327	334	327	328	321
R-squared	0.002	0.058	0.002	0.127	0.003	0.048
Mean (SD) of dependent variable in the female participated group	0.850	0.850	0.600	0.600	0.531	0.531
	(0.358)	(0.358)	(0.491)	(0.491)	(0.500)	(0.500)

	Water Quality, Treatment and Health Risk Continued					
Dependent variable:	Main drinking water source is dirty		No problem with main general purpose water source		Main general purpose water source is dirty	
	(7)	(8)	(9)	(10)	(11)	(12)
Male participated	0.018	0.052	0.083	0.068	0.024	0.033
	(0.036)	(0.036)	(0.055)	(0.060)	(0.043)	(0.045)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	328	321	331	324	331	324
R-squared	0.001	0.060	0.007	0.027	0.001	0.036
Mean (SD) of dependent variable in the female participated group	0.107	0.107	0.469	0.469	0.173	0.173
	(0.310)	(0.310)	(0.500)	(0.500)	(0.379)	(0.379)

Table 9B: Gendered Treatment Effects on Water Quality, Treatment and Health Risk (continued)

	Water Quality, Treatment and Health Risk Continued			
Dependent variable:	Satisfied with water quality		Household treat water to make it safer to drink	
	(13)	(14)	(15)	(16)
Male participated	-0.024	0.005	0.061	0.058
	(0.049)	(0.053)	(0.044)	(0.050)
Household Controls	No	Yes	No	Yes
Observations	334	327	323	316
R-squared	0.001	0.043	0.006	0.044
Mean (SD) of dependent variable in the female participated group	0.744 (0.437)	0.744 (0.437)	0.161 (0.369)	0.161 (0.369)

Notes: Refer to Table 4A

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

3.8.C Gendered Treatment Effects on Water Transport, Collection and Handling Techniques

In Table 9C, we examine the effects of gender of participants in the water quality testing and information experiment on water transport, collection and handling techniques. We find that there is limited evidence on gendered treatment effects on water transport, collection and handling techniques. The only statistically significant result we find is households with male participants spending 2.27 minutes less time to and from main drinking water source (relative to average value of 9.51 minutes for households with female participants). Other than this, household water quality testing and information experiment have no impact on water transport, collection and handling techniques. This means that the results obtained under the previous sub-sections on water transport, collection and handling techniques are not influenced by the gender of participants.

Table 9C: Gendered Treatment Effects on Water Transport, Collection and Handling Techniques

Dependent variable:	Water Transport, Collection and Handling Techniques					
	Distance to main drinking water (in meters)		Distance to main general purpose water (in meters)		Time to main drinking water source (in minutes)	
	(1)	(2)	(3)	(4)	(5)	(6)
Male participated	16.422	10.604	20.891	15.676	-1.658	-2.271**
	(19.688)	(19.518)	(18.123)	(17.249)	(1.172)	(1.121)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	293	286	309	302	308	301
R-squared	0.002	0.091	0.004	0.068	0.006	0.104
Mean (SD) of dependent variable in the female participated group	126.810 (163.235)	126.810 (163.235)	136.695 (156.140)	136.695 (156.140)	9.509 (12.903)	9.509 (12.903)

Dependent variable:	Water Transport, Collection and Handling Techniques					
	Time to main general purpose water source (in minutes)		Total number of water trips in the past 7 days		Children 5-17 years fetch water	
	(7)	(8)	(9)	(10)	(11)	(12)
Male participated	0.387	0.420	-1.247	-0.742	0.009	0.040
	(1.025)	(0.986)	(3.292)	(3.349)	(0.030)	(0.030)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	309	302	324	317	324	317
R-squared	0.000	0.047	0.000	0.113	0.000	0.115
Mean (SD) of dependent variable in the female participated group	9.541 (10.068)	9.541 (10.068)	43.424 (30.512)	43.424 (30.512)	0.916 (0.279)	0.916 (0.279)

Dependent variable:	Water Transport, Collection and Handling Techniques			
	Children under 12 years fetch water		Total number of water trips in the past 3 days	
	(13)	(14)	(15)	(16)
Male participated	-0.048	-0.041	0.689	0.731
	(0.054)	(0.060)	(1.507)	(1.443)
Household Controls	No	Yes	No	Yes
Observations	321	314	318	311
R-squared	0.002	0.110	0.001	0.091
Mean (SD) of dependent variable in the female participated group	0.395 (0.490)	0.395 (0.490)	18.443 (12.631)	18.443 (12.631)

Notes: Refer to Table 4A

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

3.8.D Gendered Treatment Effects on Water Quantity, Consumption/Usage and Security

Gendered treatment effects on water quantity, consumption and security are presented in Table 9D. While there are no statistically significant additional effects on most of the water quantity, consumption and security indicators, we find that households with male participants consume about 14.1 liters less of drinking water in the past two days preceding the surveys than households with female participants (Column 1). The mean in the households with female participants is 51.36 liters of drinking water in the past two days preceding the surveys. The result is robust to regressions including baseline household controls (Column 2).

Table 9D: Gendered Treatment Effects on Water Quantity, Consumption/Usage and Security

	Water Quantity, Consumption/Usage and Security					
Dependent variable:	Volume (liters) of drinking water consumed (past 2 days)		Volume (liters) of general purpose water consumed (past 2 days)		Household have enough water for drinking, cook, etc in the past 30 days	
	(1)	(2)	(3)	(4)	(5)	(6)
Male participated	-14.059**	-12.739*	9.715	13.498	-0.065	-0.080
	(6.375)	(6.884)	(18.392)	(18.743)	(0.050)	(0.055)
Household Controls	No	Yes	No	Yes	No	Yes
Observations	331	324	333	326	334	327
R-squared	0.013	0.062	0.001	0.117	0.005	0.045
Mean (SD) of dependent variable in the female participated group	51.355 (80.600)	51.355 (80.600)	282.346 (137.190)	282.346 (137.190)	0.733 (0.443)	0.733 (0.443)

	Water Quantity, Consumption/Usage and Security continued			
Dependent variable:	Satisfied with time spent getting water		No problem with access to water in the past 30 days	
	(7)	(8)	(9)	(10)
Male participated	-0.016	-0.015	0.059	0.037
	(0.042)	(0.046)	(0.047)	(0.050)
Household Controls	No	Yes	No	Yes
Observations	334	327	333	326
R-squared	0.000	0.020	0.005	0.058
Mean (SD) of dependent variable in the female participated group	0.828 (0.379)	0.828 (0.379)	0.726 (0.447)	0.726 (0.447)

Notes: Refer to Table 4A

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

3.8.E Gendered Treatment Effects on Water Storage

Table 9E presents the gendered treatment effects on water storage. Aside the result in Panel A, column 26 which shows that male participants are 7.9 percentage points (significant at 90 percent, with baseline household controls but not significant without baseline household controls) less likely of having stored general purpose water container located on a platform, we do not find any evidence of the effects of the gender of participants on water storage behaviors.

Table 9E: Gendered Treatment Effects on Water Storage

	Water Storage							
Dependent variable:	Usually stock drinking water in the house		Type of container (=Clay pot)		Type of container (=Other plastic container)		Container is set on the ground	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Male participated	-0.040	-0.036	0.031	0.049	-0.028	-0.000	0.087	0.066
	(0.042)	(0.043)	(0.059)	(0.056)	(0.053)	(0.060)	(0.060)	(0.061)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	334	327	274	267	274	267	274	267
R-squared	0.003	0.179	0.001	0.310	0.001	0.088	0.008	0.195
Mean (SD) of dependent variable in the female participated group	0.839	0.839	0.351	0.351	0.272	0.272	0.523	0.523
	(0.369)	(0.369)	(0.479)	(0.479)	(0.446)	(0.446)	(0.501)	(0.501)
	Water Storage							
Dependent variable:	Container closed by a lid or cork		Used soap or detergent to wash container the last time		Used only plain water in washing the container the last time		Drinking water storage container is covered	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Male participated	0.022	0.016	-0.070	-0.066	0.053	0.048	0.031	0.028
	(0.022)	(0.024)	(0.057)	(0.059)	(0.056)	(0.059)	(0.021)	(0.023)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	274	267	273	266	273	266	274	267
R-squared	0.003	0.037	0.006	0.160	0.003	0.141	0.007	0.075
Mean (SD) of dependent variable in the female participated group	0.954	0.954	0.720	0.720	0.28	0.28	0.953	0.953
	(0.211)	(0.211)	(0.451)	(0.451)	(0.451)	(0.451)	(0.212)	(0.212)

Notes: Refer to Table 4A

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 9E: Gendered Treatment Effects on Water Storage (continued)

	Water Storage									
Dependent variable:	Interior of drinking water storage container is clean		Stored drinking water container is located on a platform		Object used to fetch drinking water from storage container is clean		Water for general purposes is stored in covered containers		Stored general purpose water is located on a platform	
	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
Male participated	-0.021	-0.026	-0.029	-0.008	0.003	0.003	-0.082	-0.069	-0.059	-0.079*
	(0.031)	(0.034)	(0.060)	(0.059)	(0.028)	(0.031)	(0.056)	(0.059)	(0.041)	(0.042)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	275	268	277	270	275	268	325	318	326	319
R-squared	0.002	0.051	0.001	0.240	0.000	0.041	0.007	0.088	0.006	0.036
Mean (SD) of dependent variable in the female participated group	0.940	0.940	0.464	0.464	0.940	0.940	0.575	0.575	0.196	0.196
	(0.238)	(0.238)	(0.500)	(0.500)	(0.238)	(0.238)	(0.496)	(0.496)	(0.398)	(0.398)

Notes: Refer to Table 4A

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

4. Conclusions

Using a cluster-randomized evaluation design, this paper examined the impacts of granting households in southern Ghana the option of water quality self-testing and information. The methods applied in this study are rigorous to identify changes in safe water behaviors. The baseline household data are largely balanced based on the summary statistics and mean orthogonality tests. We find that there is high participation rate or take-up, with about 75 percent of the households engaging in water quality self-testing and also receiving water quality improvement messages (information), after been encouraged to attend the training sessions on water quality testing. Participation rate was high for school children intervention group compared to adult household members intervention group. Participation rate was slightly higher for females than males. After two follow-up surveys conducted in 2014 and 2015, we find evidence of changes in safe water behaviors. Specifically, we find evidence of increases in the choice of improved drinking and general purpose water sources; increases in making cash-intensive water source choices; declines in using surface water sources; making time gains in looking for safer water sources; increases in knowledge and awareness on water safety; declines in using child labor in water collection; and increases in safe water storage behaviors such as covering of stored drinking water. The findings show that household water quality testing and information could be used as a social marketing strategy in convincing households in poor resource settings in adopting safe water behaviors. Furthermore, differential impacts exist with households in the school children intervention group being better-off in most of the safe water behavior indicators than their counterparts in the adult household members intervention group.

The results suggest that school children could be used as “agents of change” in improving safe water behaviors in many developing countries. These results have implications on the Sustainable Development Goals, particularly on improvement in safe water behaviors and microbial analysis of water quality by providing practical experiences from poor resource settings. Finally, we also find limited evidence based on the gender of participants, with households with male participants being worse-off than households with female participants.

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Appendix

Table A1: Sample Frame Summaries and Observation Counts

Panel A: Experimental Blocks and Sample Frame 1				
AG-WATSAN Experiment	**Public Basic Schools**	**WATSAN Committee**	**Households**	
Water quality testing and information	8	-	256	
Control	8	-	256	
Total	**16**	**-**	**512**	
Panel B: Surveys				
AG-WATSAN Baseline				
Targeted	-	-	512	
Completed	48	35	505	
First Follow-up Survey				
Targeted	-	-	505	
Completed	-	-	486	
Second Follow-up Survey				
Targeted	-	-	505	
Completed	-	-	478	
Third Follow-up Survey/Endline Survey				
Targeted	-	-	505	
Completed	-	-	463	
Panel C: Sample Size Explanations for Each AG-WATSAN Experiment Block (Households)				
Segregation	**Water testing intervention**		**Control**	**Total**
Boys	64		64	**128**
Girls	64		64	**128**
Male parents	64		64	**128**
Female parents	64		64	**128**
Total	**256**		**256**	512