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The Impacts of Household Water Quality Testing and Information on Safe Water Behaviors: Evidence from a 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. In 2014, a group of 512 households relying on unimproved water, sanitation and hygiene practices in the Greater Accra region of Ghana were randomly selected to participate in the intervention on water quality self-testing and to receive water quality improvement messages (information). The treatment group was separated into two groups: (1) a school children intervention group and (2) an adult household members intervention group, to identify the role of intra-household decision making or resource allocation in the delivery of water quality information. The comparison group neither participated in the water quality self-testing nor received information. The impacts of the experiment are estimated using intention-to-treat (ITT), instrumental variable (IV) and differences-in-differences (DiD) estimators. Participation rate, which is used as a proxy for uptake, is higher among the school children intervention group in comparison to the adult intervention group. The results show that the household water quality testing and information experiment increase the choice of improved water sources and other 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 school children intervention group is more effective 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 also finds limited evidence of gender differentiated impacts based on the gender of the participants, especially in terms of improved water source choices. The findings have implications on the Sustainable Development Goals (SDGs), particularly on improvement in safe water behaviors and microbial analysis of water quality by providing practical experiences from resource poor settings.

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

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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 for consumption.

In many developing countries, provision of water is mainly regarded as public good while 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. Furthermore, "formal" household water quality testing is virtually non-existent in many developing countries including Ghana, with many households relying on the physical properties (or traditional approaches) including odor of the water as indicators for the quality of drinking and general purpose water while 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 a given water sample.

The study examines whether water quality testing and information can increase safe water behaviors such as choice of improved water sources, covering of storage water containers, and satisfaction with water quality among households in southern Ghana. Specifically, households in southern Ghana were randomly allocated to participate in water quality self-testing and also received information in the form handouts on water quality improvement techniques.

This study relates to other works and also makes several contributions to literature. First, the study uses data from four 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 water quality self-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 resource poor settings.

The study being the first (based on our knowledge) to apply cluster-randomized evaluation design to evaluate intra-household decision making or resource allocation on water quality testing and information, the data allow us to analyze the impacts on safe water behaviors based on school children versus adults and male versus female. The major finding of the study is that intra-household decision making or resource allocation matters when it comes to dissemination of information on water quality: In the study settings freely given water quality test kits and information on water quality generate different uptake rates. The uptake rate is higher for school children compared to adult household members. Also, the uptake rate is slightly high for females compared to males. Despite different uptake rates, the study finds that water quality testing and information increase the choice of improved water sources and covering of stored drinking water, while there is reduction in satisfaction with water quality and distance taken in collecting water. In most of the outcomes, the study finds that school children were more effective than adults; indicating that school children could be used as "agents of change" in improving safe water behaviors. However, the study finds limited treatment effects based on the gender of participants.

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 the 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 the Institute of Statistical, Social and Economic Research (ISSER) of the University of Ghana, Legon. 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 exercise.

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 water quality self-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 water quality self-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, while 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 was 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 baseline household 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 baseline household 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 baseline household 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 while 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. While 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 while 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 Bonferroni multiple comparison 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).

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 eight years, anthropometric measurements. The household survey data was conducted on four different time periods (survey rounds) making it possible to estimate both short-run and medium term impacts of the water quality testing and information experiment. The survey rounds 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. endline survey) was undertaken in May-June 2015. We completed 437 out of 505 surveys for fourth round survey for overall success rate of 86.53 percent. In total there were 1,906 households in the four rounds of data collection. About 87.30 percent of the households were enumerated in all the four survey rounds, 11.49 percent in three, 0.73 percent in two and finally, 0.47 percent in only one. The data analysis for this study relies on households with baseline data and at least one follow-up data.

2.4 Baseline Summary Statistics and Bonferroni Multiple Comparison Tests

Table 2 presents baseline descriptive statistics and Bonferroni multiple comparison tests for household safe water behaviors and socioeconomic characteristics. 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 using Bonferroni multiple comparison test among the treatment arms (column 5). 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. The pairwise comparison tests draw heavily on approach by Karlan *et al.*, (2014). 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.

The mean tests show that most of the covariates are not 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 largely 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 while 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 41 *F-tests* performed, 17 were statistically significantly different from zero at the various confidence levels. This was largely influenced by the variations in water quality, treatment and health risk and multipurpose water systems indicators at the household level where most of the variables were statistically significantly different from zero. We address these biases by running separate regressions for all outcome variables including baseline household and basic school covariates (results with even number columns under the impacts sub-section). This is expected to deal with any biases (both observed and unobserved) during data collection and randomization.

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.

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. The outcome variables were selected based on previous studies (Günther and Schipper (2013); Madajewicz *et al*., 2007; Hamoudi *et al*., 2012; Devoto *et al*., (2012); Kremer *et al.* 2011; Lucas *et al.*, (2011); Brown *et al*., 2014) and were pre-specified in an earlier unpublished article and workshop presentations before commencement of the follow-up surveys. For ease of reference, the selected outcomes on safe water behaviors have being classified into five categories: water source choices; water quality, treatment and health risk; water transport, collection and handling techniques; water quantity, and consumption/usage; and water storage behaviors. The estimation strategy and presentation of results also follow previous studies (Okyere (2017); Devoto *et al*., (2012); Karlan *et al*., (2011); Karlan *et al*., (2014); and Kremer *et al*. 2011)). In the case of each outcome for the five categories of safe water behaviors, 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:

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

where Y_i is the outcome variable of interest (for example improved drinking water) for household i at time $t(t \in \{1,2,3\}$ for the three follow-up survey rounds), $Treatment_{it}$ 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 $E(\varepsilon_{it1} \,|\, X_{it}, Treatment_{it}) = 0$, 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:

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

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 ($t \in \{1,2,3\}$ for the three follow-up surveys), and is used as instrumental variable with Treatment$_{it}$ as follows:

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

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 and basic school 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 while 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:

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

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 and basic school 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 and basic school 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:

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

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 3.4.

3.3 Impacts on Safe Water Behaviors

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 and basic school covariates (columns with odd numbers) and (2) with baseline household and basic school covariates (columns with even numbers). The results presented include the intention-to-treat (ITT) estimation (Panel A) and instrumental variable (IV) estimation (Panel B) of the impact of the treatment on water source choices. 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) while 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 of 71.2 percentage points (Panel A, column 1). The result is robust to specifications including baseline household and basic school covariates (Panel A, column 2).

Based on ITT estimation (Panel A), we 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 3.4 percentage points (significant at 90 percent, without baseline household and basic school controls). The result is similar for regressions including baseline controls (Panel A, column 6). We find that households offered the water quality testing and information used on average 6.6 percentage points more of improved secondary drinking water sources (using WHO's joint monitoring program (JMP) classification; Panel A, column 7). The result is robust when baseline household and basic school controls are included in the regression (Panel A, column 8).

We find no statistically significant additional effect of household water quality testing and information on other water source choice indicators such as use of improved drinking and general purpose water sources, and finally on the use of sachet water as the main 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.

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 three 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 strong. The treatment allocation of households into water quality testing and information experiment increases school children's participation or take-up by 85.2 percentage points (s.e. 1.2 percentage points) while participation or take-up increases by 57.2 percentage points (s.e. 1.9 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 and basic school controls (columns with odd numbers) and (2) with baseline household and basic school 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 8.4 percentage points higher for households in the school children intervention group (relative to average value of the comparison group of 69.1 percent), but this is not robust to the inclusion of the baseline covariates. There is no statistically significant additional effect for households in adult household members intervention group. The choice of surface water as the main drinking water source is 9.1 percentage points lower for households in the school children group (relative to average value of 18.4 percent in the comparison group). The result is robust when baseline household and basic school controls are included in the regression (Panel A, column 6). There is no statistically significant reduction for households in the adult household members intervention group.

Panel A, column 7 reports the choice of improved secondary drinking water sources based on WHO's JMP classification. Choice of other improved secondary drinking water sources is 14.4 percentage points higher (significant at 99 percent) for the households in adult household members treatment group (relative to average value of 66.3 percent in the comparison group). The result is robust to regression specifications including baseline covariates (Panel A, column 8). There is no statistically significant additional effect for households in the school children intervention group. Panel A, column 9 presents the impacts on choice of improved general purpose water sources. The choice of improved general purpose water sources is 12.6 percentage points higher for the households in the school children intervention group (relative to average value of 53.2 percent in the comparison group). The result is robust to regression specifications including baseline covariates (Panel A, column 10). There is no statistically significant additional effect for households in the adult household members intervention group.

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/bottled 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). For household main drinking water sources, we observe significant changes in making cash-intensive choices. Specifically, Panel A, column 11 indicates 14.9 percent of households in the comparison group use sachet water as the main drinking water source.

This proportion is increased by 4.7 percentage points among households in the school children intervention group. The result is robust to regression including baseline household and basic school controls (Panel A, column 12). 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.

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 and basic school 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 7.3 percentage points less likely to report of being satisfied with water quality (Panel A, column 5; relative to average value of comparison group of 77 percent). The result is robust to regressions including baseline household and basic school controls. In Panel A, column 8, household self-report of water treatment is lower by 3.7 percentage points in the intervention group (significant at 90 percent, with baseline covariates but not significant without baseline covariates). 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 main drinking water source being dirty, among others.

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.

In Panel A, column 1, households in the school children intervention group are on average 3.4 percentage points (significant at 90 percent, without baseline household and basic school controls but not significant with baseline household and basic school controls) less likely of reporting that the main drinking water source is dirty (relative to average value of 13 percent of the comparison group). Similarly, households in the adult household members intervention group are on average 5.8 percentage more likely of reporting dirty water from main drinking water source (significant at 95 percent, without baseline household and basic school controls but not significant with baseline household and basic school controls).

The results in Panel A, column 3 shows that households in the school children intervention group are 9.3 percentage points less likely of reporting that their main general purpose water source is dirty (relative to average value of 22.3 percent in the comparison group). Households in the adult household members intervention group are 8.4 percentage points more likely of reporting that the main general purpose water source is dirty compared to the comparison group. The results are robust to regressions including baseline household and basic school controls (Panel A, column 4).

Based on Panel A, column 5, satisfaction with water quality in households in the adult household members intervention group are 18.4 percentage points lower (relative to average value of 77 percent in the comparison group). There is no statistically significant additional effect for households in the school children intervention group. Panel A, column 7 presents impacts on household water treatment. Water treatment is 8.2 percentage points lower in households in school children intervention group compared to the control group. The average value for the comparison group is 19.2 percent. The result is robust to regressions including household and basic school baseline controls (Panel A, column 8). We do not find statistically significant additional effect for households in adult household members intervention group.

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.A there were gains in water source choices, particularly in terms of improved secondary drinking water sources, 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 32.46 meters less for households in the treatment group (relative to average value of 188.92 meters of the comparison group). The result is robust to regressions including baseline household and basic school characteristics (Panel A, column 2). Likewise, Panel A, column 3 shows that households in the treatment group travel on average 38.1 meters less in fetching main general purpose water (relative to the average value of 208.82 meters of the comparison group). The result is robust to regression specifications including household and basic school characteristics. In terms of time savings, households in the treatment group travel on average 1.40 minutes less (significant at 95 percent, with regressions including baseline controls) to and from main drinking water source (relative to average value of 11.31 minutes of the comparison group). Similarly, there is reduction in time spent travelling to and from main general purpose water source of about 1.51 minutes for households in the treatment group (Panel A, column 7). The result is robust to regression specifications including baseline covariates. The time and distance gains are substantial since households in the comparison group have on average 42.58 water fetching trips per week preceding the surveys.

Panel A, Columns (9) and (10) examine the households' use of children as labor for water fetching. Column 10 shows that households in the treatment group are on the average 5.6 percentage points less (significant at 95 percent, with baseline household and basic school controls but not significant without baseline household and basic school controls) likely to use children less than 12 years of age in water collection (relative to average value of 40 percent 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.

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 of differential treatment effects for time and distance gains in water collection for households in school children and adult household members intervention groups. Panel A, column 1 reports impacts on the distance to main drinking water source. Distance to main drinking water source is 55.01 meters lower (significant at 99 percent) for households in school children intervention group (relative to average value of 188.92 meters of the comparison group). The result is robust to specifications including baseline household and basic school controls (Panel A, column 2). There is reduction of 38.11 meters in distance to main drinking water source for households in the adult household members intervention group (significant at 95 percent, with baseline household and basic school controls but not significant without baseline household and basic school controls).

Panel A, column 3, presents the impacts on the distance to main general purpose water source. Distance to main general purpose water source is 59.53 meters lower (significant at

99 percent) for households in school children intervention group (relative to average value of 208.82 meters of the comparison group). The result is robust to regressions including baseline household covariates. We find statistically significant reduction of 53.82 meters in distance to main general purpose water source for households in the adult household members intervention group (significant at 99 percent, with baseline household and basic school controls but not significant without baseline household and basic school controls).

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 11.31 minutes travelling to and from main drinking water source. This proportion is decreased by 3.23 minutes among households in school children intervention group. The result is robust to regressions with the inclusion of baseline household and basic school controls (Panel A, column 6). We do not find statistically significant reduction in minutes taken to and from main drinking water source for households in the adult household members intervention group. 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 13.26 minutes. This proportion is reduced by 2.75 minutes for households in the school children intervention group. The result is robust to specifications including baseline household and basic school characteristics (Panel A, column 8). Households in the adult household members intervention group make time savings of 2.49 minutes (significant at 95 percent, with baseline household and basic school controls but not significant without baseline household and basic school controls).

Columns (9) and (10) examine the differential impacts on use of child labor in the fetching of water among the households. The use of children under 12 years of age for water collection decrease by 6.1 percentage points in households in school children intervention group (significant at 90 percent, with baseline household and basic school controls but not significant without baseline household and basic school controls). We find no statistically significant reduction in the use of children under 12 years of age in water collection for households in adult household members intervention group. This means the results in columns 11 and 12 show that households in the school children intervention 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 school children intervention group rely on “older” children (i.e. those above 12 years of age in fetching water) compared to their counterparts in the comparison group.

Impacts on Water Quantity and Consumption/Usage

In Table 7A, we present the impacts of household water quality testing and information on water quantity and consumption/usage. We find that there is no statistically significant additional effect on water quantity, and consumption 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).

Differential Impacts on Water Quantity and Consumption/Usage

Table 7B shows the differential impacts on water quantity and consumption/usage. We find no evidence of additional effect of water quality testing and information on household water quantity and consumption/usage. This is consistent with the idea that household water quality testing and information affects water quality related issues and not that of water quantity. . The IV estimation (Panel B) generates similar estimates as the ITT estimation (Panel 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 3, we find that treated households are 4.2 percentage points more likely of using only plain water for washing drinking water storage containers (significant at 90 percent, without baseline household and basic school controls but not significant with baseline household and basic school controls).

Using field enumerator observations, we find that treated households are 2.7 percentage points more likely to have their drinking water storage containers covered (Panel A, column 5). The result is robust to specifications with baseline household controls (Panel A, column 6). Treated households are on average 3 percentage points (significant at 90 percent, with baseline household and basic school controls but not significant without baseline household and basic school controls) more likely of having interior of drinking water storage container observed to be clean (Panel A, column 8). Households in the intervention group are 4.7 percent (significant at 90 percent, with baseline household and basic school controls but not significant without baseline household and basic school controls) more likely to store general purpose water in covered containers (Panel A, column 12). We find no statistically significant effects on other storage behavior indicators such as main drinking water storage container is set on the ground, among others.

Differential Impacts on Water Storage

Assignment to water quality testing and information treatment leads to differential impacts on water storage behaviors (Table 8B). Panel A, column 2 shows that households in the school children intervention group are 7.7 percentage points (significant at 95 percent, with baseline household and basic school controls but not significant without baseline household and basic school controls) less likely of using soap/detergent in washing drinking water storage containers (relative to average value of 74.1 percent in the comparison group). There is no additional effect for households in the adult household members intervention group.

In Panel A, column 3, we find that households in the school children intervention group are 5.9 percentage points more likely of using plain water in washing drinking water storage containers (relative to average value of 24 percent in the comparison group). The result is robust to regression specifications including baseline controls (Panel A, column 4). We find no statistically significant additional effect for households in the adult household members intervention group. The results in Panel A, column 5 shows that households in the school children intervention group are 4 percentage points more likely of having drinking water storage container covered based on field enumerator observation (relative to average value of 93.8 percent in the comparison group). The result obtained is robust to regressions with baseline household and basic school covariates (Panel A, column 6). There is no statistically significant additional effect for households in the adult household members intervention group.

Panel A, column 7 shows that households in the school children intervention group are 4.7 percentage points more likely of having interior of drinking water storage container being clean (relative to average value of 90.4 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.

In Panel A, column 9 we show that households in school children intervention group are 3.7 percentage points more likely to use "clean" object in fetching drinking water from storage container (relative to average value of 93.1 percent in the comparison group). The result is robust to regressions with baseline household and basic school controls (Panel A, column 10). We do not find additional effect for households in the adult household members intervention group. Panel A, column 11 shows that households in the school children intervention group are 6.4 percentage points (significant at 90 percent, without baseline household and basic school controls but not significant with baseline household and basic school 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.

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

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 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 11.5 percentage points (significant at 99 percent, without baseline household and basic school controls but not significant with baseline household and basic school controls) less likely of using improved main drinking water source (relative to average value of 78.2 percent for households with female participants).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 6.6 percentage points (significant at 95 percent, without baseline household and basic school controls but not significant with baseline household and basic school controls) more likely to use surface water as the main drinking water source (relative to average value of 9.3 percent of the households with female participants). Households with male participants were 10.3 percentage points less likely (significant at 95 percent, without baseline household and basic school controls but not significant with baseline household and basic school controls) to use improved general purpose water source (relative to average value of 61.9 percent of households with female participants). We find no evidence of gendered treatment effects for use of improved secondary water sources, and use of sachet water as the main drinking water source.

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 find no evidence of gendered treatment effects for water quality, treatment and health risk indicators.

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 results we find are households with male participants spending 2.21 minutes (significant at 95 percent, with baseline household and basic school controls but not significant without baseline household and basic school controls) less time to and from main drinking water source (relative to average value of 10.27 minutes for households with female participants). In column 9, households with male participants are 7.5 percentage points (significant at 90 percent, without baseline household and basic school controls but not significant with baseline household and basic school controls) less likely to use children under 12 years of age in collecting water (relative to average value of 38.9 percent for households with female participants). Other than these, 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 mainly influenced by the gender of participants.

Gendered Treatment Effects on Water Quantity and Consumption/Usage

Gendered treatment effects on water quantity and consumption are presented in Table 9D. While there are no statistically significant additional effects on most of the water quantity, consumption and usage indicators, we find that households with male participants consume about 9.56 liters (significant at 95 percent, without baseline household and basic school controls but not significant with baseline household and basic school controls) 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 51.99 liters of drinking water in the past two days preceding the surveys. Interestingly, volume of water for general purposes in the past two days preceding the surveys increased by 29.61 liters (significant at 90 percent, with baseline household and basic school controls but not significant without baseline household and basic school controls) (relative to average value of 287.38 liters of the households with female participants).

Gendered Treatment Effects on Water Storage

Table 9E presents the gendered treatment effects on water storage. We do not find evidence of the effects of the gender of participants on most of water storage behavior indicators. In column 7, households with male participants are 4.8 percentage points less likely of having interior of drinking water storage container observed to be clean (relative to average value of 95 percent of the households with female participants). The result is robust to regressions including baseline covariates (column 8). The result in column 11 shows that households with male participants are 10.5 percentage points less likely of having water for general purposes stored in covered containers (relative to average value of 62.5 percent of the households with female participants). The result is robust to regression including baseline covariates (12).

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 study answers an important question of does water quality testing and information increases safe water behaviors i.e. risk avoidance behavior of poor water quality? The study also provides evidence of the importance of intra-household resource allocation or decision making on the dissemination of water quality information. Households in southern Ghana were randomly given water quality testing toolkits and information on water quality improvement. The treatment group was separated into two groups: an intervention run on school children (i.e. child treatment) and one run on adults (i.e. adult treatment). 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 Bonferroni multiple comparison tests. We find that there is high participation rate or take-up, with about 71 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. The differences in uptake show different roles played by different actors on resource allocation or decision making in many traditional households in southern Ghana.

After three follow-up surveys conducted in 2014 and 2015, we find evidence of changes in safe water behaviors. Specifically, we find evidence of 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. While treated households undertake many safe water behaviors, there is less treatment of water. One possible explanation is that in the study context, we find that households opted for the safest option (i.e. sachet/bottled water) based on microbial analysis. Therefore households switched from cheap, long distance sources to the closer, expensive ones. In addition, limited options in water treatment in the study sites may also be contributing factor to less water treatment. The result on water treatment is also consistent with Hamoudi *et al*., (2012) in which water quality testing and information leads to did not increase in household water treatment. The findings show that household water quality testing and information could be used as a social marketing strategy in convincing households in resource poor settings in adopting safe water behaviors.

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. Generally, statistically significant treatment effects come from the school children intervention group not the adult household members intervention group. In comparison with the adult household members intervention group, treating school children leads to: more use of improved drinking water; less use of surface water as main source; more sachet water use; less treating of water; less distance to the main source of water; no real change in volume of water consumed; more closing and covering of containers, more clean containers and clean fetching equipment. The differential impacts also show different perception and knowledge on water quality for the two treatment groups. The results are in tandem with the different water source choices based on the treatment groups. In the study sites, there are multiple sources of water. Therefore the trade-off between water sources as result of the intervention generated considerable time gain in terms of distance and minutes saved on water collection trips. The results suggest that school children could be used as "agents of change" in improving safe water behaviors in many developing countries. This partly confirms a previous prospective study by Onyango-Ouma *et al.,* 2005 on the potential of using school children as "agents of change" in health.

A policy relevant question that arises is why school children are better at changing the behavior of their households rather than parents are at changing their own behavior and that of the household? In this study context, children play various roles in the household including: (1) providing labor and time in collecting/fetching water and also performing other household chores and (2) disseminating information on water quality to households. In both cases, greater knowledge leads to collecting water from high quality sources and raising awareness on the importance of choosing averting behavior. In many developing countries with high illiteracy rate, school children could be an important source of information. Therefore school children play critical roles in safe water behaviors and are not "passive" members in the households. In this study context, the learning experience of children was enough in convincing their parents and other household members to adopt safe water behaviors. In addition, parents/adults may be preoccupied with other social and economic issues and their experiences, illiteracy, previous knowledge and perceptions on water quality may hinder assimilation of the experiment.

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 resource poor settings. Finally, we also find limited evidence based on the gender of participants, with households with male participants in most cases being worse-off than households with female participants. In other words, less is achieved by treating males. Improvement in safe water behaviors could be achieved by targeting females instead of males. The policy implication is that traditional or cultural barriers in many developing countries on gender differentiated roles on household or domestic chores needs to be addressed in order to improve safe water behaviors.

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Appendix

Table 1: Observational Counts and Attrition

Surveys	**Baseline Survey (Round one)**	**First Follow-up (Round Two)**	**Second Follow-up (Round Three)**	**Endline Survey (Round Four)**
Targeted	512	505	505	505
Completed	505	486	478	437
Variation	7	19	27	68
Percent of variation (Attrition)	**1.37**	**3.76**	**5.35**	**13.47**

Table 2: Baseline Descriptive Statistics and Bonferroni Multiple Comparison Tests (April-May, 2014 Survey)

	(1) All	(2) Child treatment	(3) Adult treatment	(4) Comparison group	(5) F-test (p-value) from Bonferroni multiple comparison test
Panel A: Household composition and socio-economic status					
Household size	6.083	6.056	5.976	6.150	**0.21**
	(2.540)	(2.512)	(2.767)	(2.440)	**(0.813)**
Number of female members 15 years or older	1.848	1.824	1.843	1.862	**0.05**
	(1.123)	(1.071)	(1.178)	(1.124)	**(0.953)**
Number of female children under 15 years	1.210	1.344	1.189	1.154	**1.34**
	(1.074)	(1.101)	(1.045)	(1.075)	**(0.263)**
Household has electricity	0.764	0.832	0.776	0.724	**2.78***
	(0.425)	(0.375)	(0.419)	(0.448)	**(0.063)**
Household resides in Ga South Municipal (1=Urban district, 0=Shai-Osudoku)	0.499	0.496	0.496	0.502	**0.01**
	(0.500)	(0.502)	(0.502)	(0.501)	**(0.991)**
Value of household annual expenditure (GHS)	6503.065	5925.958	6133.156	6973.883	**2.70***
	(4633.969)	(3443.383)	(4572.425)	(5118.861)	**(0.068)**
Value of household assets (GHS)	31163.378	27726.128	28396.111	34276.706	**0.49**
	(70098.564)	(60779.650)	(54793.614)	(80626.820)	**(0.611)**
Panel B: Head of the household					
Head is a male	0.743	0.696	0.803	0.735	**1.97**
	(0.438)	(0.462)	(0.399)	(0.442)	**(0.141)**
Head's age (Years)	48.811	47.816	48.315	49.558	**0.95**
	(12.459)	(12.160)	(12.613)	(12.529)	**(0.387)**
Head is married	0.688	0.720	0.764	0.635	**3.69****
	(0.464)	(0.451)	(0.426)	(0.482)	**(0.026)**
Head can read and write in English	0.408	0.407	0.432	0.396	**0.22**
	(0.492)	(0.493)	(0.497)	(0.490)	**(0.800)**
Farming is current primary occupation of the household head	0.501	0.472	0.551	0.490	**0.91**
	(0.500)	(0.501)	(0.499)	(0.501)	**(0.404)**
Head's Christian	0.778	0.760	0.738	0.806	**1.24**
	(0.416)	(0.429)	(0.441)	(0.397)	**(0.290)**
Head is Ga/Adangbe ethnic group	0.445	0.488	0.344	0.474	**3.51****
	(0.497)	(0.502)	(0.477)	(0.500)	**(0.031)**

Table 2: Baseline Descriptive Statistics and Bonferroni Multiple Comparison Tests (April-May, 2014 Survey) (continued)

	(1) All	(2) Child treatment	(3) Adult treatment	(4) Comparison group	(5) F-test (p-value) from Bonferroni multiple comparison test
Panel C: Multipurpose water systems, irrigated agriculture and fishing characteristics					
Presence of irrigated fields in the community	0.452	0.400	0.535	0.434	**2.61***
	(0.498)	(0.492)	(0.501)	(0.497)	**(0.075)**
Household participates in irrigated agriculture	0.253	0.136	0.402	0.237	**12.63*****
	(0.435)	(0.344)	(0.492)	(0.426)	**(0.000)**
Presence of fishing waters in the community	0.730	0.774	0.774	0.685	**2.48***
	(0.444)	(0.420)	(0.420)	(0.465)	**(0.084)**
Household has access to fishing waters	0.626	0.645	0.642	0.607	**0.35**
	(0.484)	(0.480)	(0.481)	(0.489)	**(0.705)**
Household engage in fishing	0.159	0.112	0.216	0.154	**2.58***
	(0.366)	(0.317)	(0.413)	(0.362)	**(0.077)**
Panel D: Water quality, treatment and health risk					
Main drinking water source is dirty	0.127	0.065	0.159	0.142	**3.04****
	(0.334)	(0.247)	(0.367)	(0.350)	**(0.049)**
Main general purpose water source is dirty	0.207	0.121	0.206	0.250	**4.26****
	(0.406)	(0.327)	(0.406)	(0.434)	**(0.015)**
Satisfied with water quality	0.648	0.758	0.452	0.692	**15.77*****
	(0.478)	(0.430)	(0.500)	(0.463)	**(0.000)**
Household treat water to make it safer to drink	0.120	0.082	0.146	0.127	**1.28**
	(0.326)	(0.275)	(0.355)	(0.333)	**(0.278)**
Panel E: Water source choices					
Improved main drinking water source (based on JMP classification)	0.731	0.696	0.669	0.779	**3.10****
	(0.444)	(0.462)	(0.472)	(0.416)	**(0.046)**
Surface water (based on drinking water ladder)	0.160	0.096	0.220	0.162	**3.66****
	(0.367)	(0.296)	(0.416)	(0.369)	**(0.026)**
Improved **secondary** drinking water source	0.677	0.745	0.590	0.676	**1.22**
	(0.469)	(0.440)	(0.498)	(0.470)	**(0.299)**
Improved **main** general purpose water source (JMP classification)	0.586	0.552	0.591	0.601	**0.42**
	(0.493)	(0.499)	(0.494)	(0.491)	**(0.660)**
Main drinking water is sachet/bottle	0.147	0.192	0.126	0.134	**1.40**
	(0.354)	(0.395)	(0.333)	(0.342)	**(0.249)**

Table 2: Baseline Descriptive Statistics and Bonferroni Multiple Comparison Tests (April-May, 2014 Survey) (continued)

	(1) All	(2) Child treatment	(3) Adult treatment	(4) Comparison group	(5) F-test (p-value) from Bonferroni multiple comparison test
Panel F: Water transport, collection and handling techniques					
Distance to main drinking water (one way, in meters)	197.878	138.887	262.360	195.155	**5.17*****
	(306.804)	(235.978)	(360.939)	(303.646)	**(0.006)**
Distance to main general purpose water (one way, in meters)	225.608	165.313	240.385	248.308	**2.98***
	(321.237)	(275.865)	(305.525)	(346.417)	**(0.052)**
Time to main drinking water source (round trip, in minutes)	12.347	9.811	15.556	11.992	**7.46*****
	(12.000)	(8.554)	(15.981)	(10.778)	**(0.001)**
Time to main general purpose water source (round trip, in minutes)	12.881	11.091	13.184	13.598	**2.22**
	(10.927)	(9.632)	(10.053)	(11.844)	**(0.110)**
Children under 12 years fetch water	0.418	0.411	0.409	0.425	**0.06**
	(0.494)	(0.494)	(0.494)	(0.495)	**(0.945)**
Panel G: Water quantity and consumption/usage					
Volume (liters) of drinking water consumed (past 2 days)	81.746	81.275	75.248	85.198	**0.70**
	(76.776)	(75.473)	(56.178)	(85.773)	**(0.495)**
Volume (liters) of general purpose water consumed (past 2 days)	247.348	244.445	240.312	252.248	**0.33**
	(141.796)	(141.806)	(146.547)	(139.754)	**(0.721)**

Table 2: Baseline Descriptive Statistics and Bonferroni Multiple Comparison Tests (April-May, 2014 Survey) (continued)

	(1) **All**	**(2)** **Child treatment**	**(3)** **Adult treatment**	**(4)** **Comparison group**	**(5)** **F-test (p-value) from Bonferroni multiple comparison test**
Panel H: Water storage behaviors					
Used soap or detergent to wash container the last time	0.648	0.621	0.704	0.633	**0.99**
	(0.478)	(0.487)	(0.459)	(0.483)	**(0.372)**
Used only plain water in washing the container	0.337	0.350	0.287	0.357	**0.83**
	(0.473)	(0.479)	(0.454)	(0.480)	**(0.438)**
Drinking water storage container is covered	0.915	0.902	0.966	0.898	**2.66***
	(0.278)	(0.299)	(0.181)	(0.304)	**(0.071)**
Interior of drinking water storage container is clean	0.882	0.910	0.901	0.858	**1.32**
	(0.323)	(0.288)	(0.300)	(0.349)	**(0.268)**
Object used to fetch drinking water from storage container is clean	0.829	0.787	0.860	0.834	**1.18**
	(0.377)	(0.411)	(0.349)	(0.373)	**(0.309)**
Water for general purposes is stored in covered containers	0.699	0.736	0.717	0.672	**0.94**
	(0.459)	(0.443)	(0.452)	(0.470)	**(0.392)**

Notes: *** p<0.01, ** p<0.05, and * p<0.1. Standard deviations 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 164 tests in total for all the baseline covariates.

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

Table 4A: Impacts on Water Source Choices

	First stage		Water source choices			
Dependent variable:	Participated		Improved main drinking water based on JMP		Surface water as main drinking water source	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. ITT Estimation						
Treatment	0.712***	0.747***	0.035	0.028	-0.034*	-0.034*
	(0.017)	(0.016)	(0.024)	(0.024)	(0.020)	(0.019)
Household Controls	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes
Observations	1397	1364	1,397	1,364	1,397	1,364
R-squared	0.556	0.597	0.001	0.091	0.002	0.111
Mean (SD) of dependent variable in the comparison group	0	0	0.691	0.691	0.184	0.184
	(0)	(0)	(0.463)	(0.463)	(0.388)	(0.388)
Panel B. Instrumental variable estimation: “participated” instrumented with “treatment”						
Participated			0.049	0.037	-0.048*	-0.046*
			(0.034)	(0.033)	(0.028)	(0.026)
Household Controls			No	Yes	No	Yes
Basic School Controls			No	Yes	No	Yes
Observations			1,397	1,364	1,397	1,364
R-squared			0.000	0.088	0.005	0.111
Mean (SD) dependent variable in the comparison group			0.691	0.691	0.184	0.184
			(0.463)	(0.463)	(0.388)	(0.388)

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	
	(7)	(8)	(9)	(10)	(11)	(12)
Panel A. ITT Estimation						
Treatment	0.066**	0.066**	0.036	0.040	0.016	0.027
	(0.030)	(0.031)	(0.027)	(0.027)	(0.019)	(0.019)
Household Controls	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes
Observations	915	892	1,401	1,368	1,397	1,364
R-squared	0.005	0.083	0.001	0.087	0.000	0.184
Mean (SD) of dependent variable in the comparison group	0.663	0.663	0.532	0.532	0.149	0.149
	(0.473)	(0.473)	(0.499)	(0.499)	(0.356)	(0.356)
Panel B. Instrumental variable estimation: "participated" instrumented with "treatment"						
Participated	0.095**	0.091**	0.051	0.054	0.022	0.036
	(0.044)	(0.043)	(0.037)	(0.035)	(0.027)	(0.026)
Household Controls	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes
Observations	915	892	1,401	1,368	1,397	1,364
R-squared	-0.004	0.070	0.001	0.083	0.003	0.187
Mean (SD) of dependent variable in the comparison group	0.663	0.663	0.532	0.532	0.149	0.149
	(0.473)	(0.473)	(0.499)	(0.499)	(0.356)	(0.356)

Notes: Robust standard errors in parentheses. Baseline household and household head controls include: household head is a male, head's age, head is married, 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 irrigated agriculture, household has electricity, and number of female members under 15 years of age. Basic school controls include: school project contact person (i.e. SHEP coordinator) is a male.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Source: First, second and third follow-up survey rounds in November/December 2014, January/February 2015, and May/June 2015.

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		Surface water as main drinking water source	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. ITT Estimation						
Child treatment	0.852***	0.008	0.084***	0.026	-0.091***	-0.072***
	(0.012)	(0.017)	(0.029)	(0.028)	(0.022)	(0.022)
Adult treatment	0.030**	0.572***	-0.014	0.030	0.021	0.014
	(0.013)	(0.019)	(0.030)	(0.036)	(0.026)	(0.030)
Household Controls	Yes	Yes	No	Yes	No	Yes
Basic School Controls	Yes	Yes	No	Yes	No	Yes
Observations	1364	1364	1,397	1,364	1,397	1,364
R-squared	0.831	0.516	0.007	0.091	0.013	0.115
Mean (SD) of dependent variable in the comparison group	0	0	0.691	0.691	0.184	0.184
	(0)	(0)	(0.463)	(0.463)	(0.388)	(0.388)
Panel B. Instrumental variable estimation: "child participated" and "adult participated" instrumented with "child treatment" and "adult treatment"						
Child participated			0.098***	0.030	-0.106***	-0.085***
			(0.034)	(0.032)	(0.025)	(0.025)
Adult participated			-0.024	0.050	0.037	0.030
			(0.053)	(0.063)	(0.046)	(0.053)
Household Controls			No	Yes	No	Yes
Basic School Controls			No	Yes	No	Yes
Observations			1,397	1,364	1,397	1,364
R-squared			0.004	0.088	0.010	0.113
Mean (SD) dependent variable in the comparison group			0.691	0.691	0.184	0.184
			(0.463)	(0.463)	(0.388)	(0.388)

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	
	(7)	(8)	(9)	(10)	(11)	(12)
Panel A. ITT Estimation						
Child treatment	-0.019	-0.013	0.126***	0.075**	0.047*	0.079***
	(0.040)	(0.041)	(0.032)	(0.033)	(0.025)	(0.022)
Adult treatment	0.144***	0.163***	-0.052	-0.004	-0.015	-0.041
	(0.034)	(0.044)	(0.033)	(0.038)	(0.023)	(0.027)
Household Controls	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes
Observations	915	892	1,401	1,368	1,397	1,364
R-squared	0.020	0.093	0.017	0.089	0.004	0.192
Mean (SD) of dependent variable in the comparison group	0.663	0.663	0.532	0.532	0.149	0.149
	(0.473)	(0.473)	(0.499)	(0.499)	(0.356)	(0.356)
Panel B. Instrumental variable estimation: "child participated" and "adult participated" instrumented with "child treatment" and "adult treatment"						
Child participated	-0.023	-0.018	0.148***	0.088**	0.055*	0.093***
	(0.047)	(0.048)	(0.037)	(0.039)	(0.029)	(0.025)
Adult participated	0.261***	0.305***	-0.090	-0.012	-0.026	-0.076
	(0.064)	(0.085)	(0.057)	(0.066)	(0.039)	(0.047)
Household Controls	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes
Observations	915	892	1,401	1,368	1,397	1,364
R-squared	-0.003	0.054	0.012	0.086	0.008	0.193
Mean (SD) dependent variable in the comparison group	0.663	0.663	0.532	0.532	0.149	0.149
	(0.473)	(0.473)	(0.499)	(0.499)	(0.356)	(0.356)

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 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 irrigated agriculture, household has electricity, and number of female members under 15 years of age. Basic school controls include: school project contact person (i.e. SHEP coordinator) is a male.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Source: First, second and third follow-up survey rounds in November/December 2014, January/February 2015, and May/June 2015.

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

	Water Quality, Treatment and Health Risk							
Dependent variable:	Main drinking water source is dirty		Main general purpose water source is dirty		Satisfied with water quality		Household treat water to make it safer to drink	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. ITT Estimation								
Treatment	0.013	-0.000	-0.004	-0.026	-0.073***	-0.052**	-0.022	-0.037*
	(0.018)	(0.019)	(0.022)	(0.022)	(0.024)	(0.024)	(0.021)	(0.021)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	1,383	1,351	1,390	1,357	1,400	1,367	1,373	1,340
R-squared	0.000	0.043	0.000	0.057	0.007	0.058	0.001	0.042
Mean (SD) of dependent variable in the comparison group	0.130	0.130	0.223	0.223	0.770	0.770	0.192	0.192
	(0.336)	(0.336)	(0.416)	(0.416)	(0.421)	(0.421)	(0.394)	(0.394)
Panel B. Instrumental variable estimation: “participated” instrumented with “treatment”								
Participated	0.018	-0.000	-0.005	-0.035	-0.103***	-0.070**	-0.031	-0.050*
	(0.026)	(0.025)	(0.031)	(0.030)	(0.033)	(0.032)	(0.029)	(0.028)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	1,383	1,351	1,390	1,357	1,400	1,367	1,373	1,340
R-squared	-0.002	0.043	0.001	0.058	-0.012	0.051	0.003	0.041
Mean (SD) dependent variable in the comparison group	0.130	0.130	0.223	0.223	0.770	0.770	0.192	0.192
	(0.336)	(0.336)	(0.416)	(0.416)	(0.421)	(0.421)	(0.394)	(0.394)

Notes: Refer to Table 4A
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

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

Dependent variable:	Water Quality, Treatment and Health Risk							
	Main drinking water source is dirty		Main general purpose water source is dirty		Satisfied with water quality		Household treat water to make it safer to drink	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. ITT Estimation								
Child treatment	-0.034*	-0.031	-0.093***	-0.096***	0.040	0.036	-0.082***	-0.073***
	(0.021)	(0.021)	(0.024)	(0.025)	(0.026)	(0.028)	(0.023)	(0.023)
Adult treatment	0.058**	0.039	0.084***	0.071**	-0.184***	-0.180***	0.036	0.024
	(0.025)		(0.029)	(0.030)	(0.031)	(0.032)	(0.027)	(0.028)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	1,383	1,351	1,390	1,357	1,400	1,367	1,373	1,340
R-squared	0.009	0.046	0.022	0.064	0.039	0.064	0.012	0.038
Mean (SD) of dependent variable in the comparison group	0.130	0.130	0.223	0.223	0.770	0.770	0.192	0.192
	(0.336)	(0.336)	(0.416)	(0.416)	(0.421)	(0.421)	(0.394)	(0.394)
Panel B. Instrumental variable estimation: "child participated" and "adult participated" instrumented with "child treatment" and "adult treatment"								
Child participated	-0.040*	-0.038	-0.109***	-0.102***	0.047	0.023	-0.096***	-0.063**
	(0.024)	(0.025)	(0.028)	(0.031)	(0.031)	(0.033)	(0.027)	(0.028)
Adult participated	0.100**	0.073	0.146***	0.095	-0.321***	-0.250***	0.063	-0.023
								(0.057)
	(0.043)	(0.050)	(0.052)	(0.061)	(0.057)	(0.065)	(0.048)	
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	1,383	1,351	1,390	1,357	1,400	1,367	1,373	1,340
R-squared	-0.003	0.038	0.007	0.057	-0.019	0.033	0.005	0.041
Mean (SD) dependent variable in the comparison group	0.130	0.130	0.223	0.223	0.770	0.770	0.192	0.192
	(0.336)	(0.336)	(0.416)	(0.416)	(0.421)	(0.421)	(0.394)	(0.394)

Notes: Refer to Table 4B

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 6A: Impacts 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)
Panel A. ITT Estimation						
Treatment	-32.459***	-46.035***	-38.052***	-50.502***	-1.018	-1.404**
	(11.922)	(12.115)	(11.446)	(11.600)	(0.669)	(0.618)
Household Controls	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes
Observations	1,294	1,263	1,343	1,310	1,339	1,307
R-squared	0.006	0.060	0.008	0.075	0.002	0.057
Mean (SD) of dependent variable in the comparison group	188.920	188.920	208.815	208.815	11.311	11.311
	(238.309)	(238.309)	(235.758)	(235.758)	(12.443)	(12.443)
Panel B. Instrumental variable estimation: “participated” instrumented with “treatment”						
Participated	-45.734***	-61.828***	-53.273***	-67.412***	-1.439	-1.888**
	(16.726)	(16.178)	(15.919)	(15.370)	(0.943)	(0.826)
Household Controls	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes
Observations	1,294	1,263	1,343	1,310	1,339	1,307
R-squared	0.012	0.058	0.019	0.075	0.006	0.058
Mean (SD) dependent variable in the comparison group	188.920	188.920	208.815	208.815	11.311	11.311
	(238.309)	(238.309)	(235.758)	(235.758)	(12.443)	(12.443)

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

Dependent variable:	Water Transport, Collection and Handling Techniques			
	Time to main general purpose water source (in minutes)		Children under 12 years fetch water	
	(7)	(8)	(9)	(10)
Panel A. ITT Estimation				
Treatment	-1.511**	-2.334***	-0.037	-0.056**
	(0.697)	(0.670)	(0.026)	(0.026)
Household Controls	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes
Observations	1,348	1,316	1,359	1,326
R-squared	0.003	0.055	0.001	0.113
Mean (SD) of dependent variable in the comparison group	13.263 (12.411)	13.263 (12.411)	0.400 (0.490)	0.400 (0.490)
Panel B. Instrumental variable estimation: “participated” instrumented with “treatment”				
Participated	-2.124**	-3.122***	-0.052	-0.075**
	(0.975)	(0.889)	(0.037)	(0.035)
Household Controls	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes
Observations	1,348	1,316	1,359	1,326
R-squared	0.010	0.054	0.003	0.114
Mean (SD) dependent variable in the comparison group	13.263 (12.411)	13.263 (12.411)	0.400 (0.490)	0.400 (0.490)

Notes: Refer to Table 4A

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

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)	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. ITT Estimation						
Child treatment	-55.064***	-52.098***	-59.533***	-47.901***	-3.234***	-3.208***
	(13.574)	(13.123)	(13.554)	(12.808)	(0.643)	(0.666)
Adult treatment	-10.909	-38.114**	-17.538	-53.816***	1.022	0.875
	(14.484)	(17.938)	(13.321)	(17.089)	(0.928)	(1.026)
Household Controls	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes
Observations	1,294	1,263	1,343	1,310	1,339	1,307
R-squared	0.011	0.060	0.013	0.075	0.016	0.065
Mean (SD) of dependent variable in the comparison group	188.920	188.920	208.815	208.815	11.311	11.311
	(238.309)	(238.309)	(235.758)	(235.758)	(12.443)	(12.443)
Panel B. Instrumental variable estimation: "child participated" and "adult participated" instrumented with "child treatment" and "adult treatment"						
Child participated	-65.819***	-61.449***	-70.378***	-55.973***	-3.849***	-3.823***
	(16.149)	(15.543)	(15.911)	(15.077)	(0.766)	(0.795)
Adult participated	-18.529	-62.546**	-29.797	-88.674***	1.746	1.686
	(24.518)	(30.486)	(22.482)	(28.615)	(1.590)	(1.754)
Household Controls	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes
Observations	1,294	1,263	1,343	1,310	1,339	1,307
R-squared	0.014	0.058	0.020	0.075	0.012	0.059
Mean (SD) dependent variable in the comparison group	188.920	188.920	208.815	208.815	11.311	11.311
	(238.309)	(238.309)	(235.758)	(235.758)	(12.443)	(12.443)

Notes: Refer to Table 4B

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

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

Dependent variable:	Water Transport, Collection and Handling Techniques			
	Time to main general purpose water source (in minutes)		Children under 12 years fetch water	
	(7)	(8)	(9)	(10)
Panel A. ITT Estimation				
Child treatment	-2.749***	-2.209***	-0.027	-0.061*
	(0.791)	(0.810)	(0.033)	(0.032)
Adult treatment	-0.355	-2.492**	-0.046	-0.050
	(0.921)	(1.069)	(0.032)	(0.037)
Household Controls	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes
Observations	1,348	1,316	1,359	1,326
R-squared	0.008	0.056	0.002	0.113
Mean (SD) of dependent variable in the comparison group	13.263 (12.411)	13.263 (12.411)	0.400 (0.490)	0.400 (0.490)
Panel B. Instrumental variable estimation: "child participated" and "adult participated" instrumented with "child treatment" and "adult treatment"				
Child participated	-3.243***	-2.569***	-0.032	-0.071*
	(0.929)	(0.953)	(0.038)	(0.037)
Adult participated	-0.607	-4.153**	-0.080	-0.083
	(1.572)	(1.823)	(0.056)	(0.064)
Household Controls	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes
Observations	1,348	1,316	1,359	1,326
R-squared	0.011	0.054	0.003	0.114
Mean (SD) dependent variable in the comparison group	13.263 (12.411)	13.263 (12.411)	0.400 (0.490)	0.400 (0.490)

Notes: Refer to Table 4B

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

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

	Water Quantity and Consumption/Usage			
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	-1.639	-2.020	-5.987	-7.204
	(3.175)	(2.846)	(9.679)	(8.752)
Household Controls	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes
Observations	1,391	1,358	1,398	1,365
R-squared	0.000	0.040	0.000	0.128
Mean (SD) of dependent variable in the comparison group	50.895 (60.824)	50.895 (60.824)	296.584 (190.170)	296.584 (190.170)
Panel B. Instrumental variable estimation: "participated" instrumented with "treatment"				
Participated	-2.301	-2.704	-8.409	-9.645
	(4.453)	(3.789)	(13.585)	(11.665)
Household Controls	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes
Observations	1,391	1,358	1,398	1,365
R-squared	0.001	0.041	0.000	0.127
Mean (SD) dependent variable in the comparison group	50.895 (60.824)	50.895 (60.824)	296.584 (190.170)	296.584 (190.170)

Notes: Refer to Table 4A

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

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

Dependent variable:	Water Quantity and Consumption/Usage			
	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				
Child treatment	0.292	-1.326	5.168	-7.143
	(3.607)	(3.809)	(11.448)	(11.440)
Adult treatment	-3.514	-2.911	-16.856	-7.281
	(4.085)	(4.423)	(11.856)	(13.226)
Household Controls	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes
Observations	1,391	1,358	1,398	1,365
R-squared	0.001	0.040	0.002	0.128
Mean (SD) of dependent variable in the comparison group	50.895	50.895	296.584	296.584
	(60.824)	(60.824)	(190.170)	(190.170)
Panel B. Instrumental variable estimation: "child participated" and "adult participated" instrumented with "child treatment" and "adult treatment"				
Child participated	0.342	-1.514	6.056	-8.280
	(4.228)	(4.453)	(13.411)	(13.361)
Adult participated	-6.102	-4.994	-29.351	-12.291
	(7.087)	(7.681)	(20.688)	(23.040)
Household Controls	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes
Observations	1,391	1,358	1,398	1,365
R-squared	0.000	0.040	-0.001	0.127
Mean (SD) dependent variable in the comparison group	50.895	50.895	296.584	296.584
	(60.824)	(60.824)	(190.170)	(190.170)

Notes: Refer to Table 4B

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Table 8A: Impacts on Water Storage

Dependent variable:	Water Storage							
	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		Interior of drinking water storage container is clean	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. ITT Estimation								
Treatment	-0.037	-0.025	0.042*	0.030	0.027**	0.033**	0.019	0.030*
	(0.025)	(0.026)	(0.025)	(0.025)	(0.012)	(0.013)	(0.016)	(0.018)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	1,246	1,214	1,246	1,214	1,240	1,208	1,241	1,209
R-squared	0.002	0.088	0.002	0.084	0.004	0.030	0.001	0.021
Mean (SD) of dependent variable in the comparison group	0.741	0.741	0.240	0.240	0.938	0.938	0.904	0.904
	(0.438)	(0.438)	(0.428)	(0.428)	(0.240)	(0.240)	(0.295)	(0.295)
Panel B. Instrumental variable estimation: “participated” instrumented with “treatment”								
Participated	-0.054	-0.034	0.062*	0.041	0.039**	0.045**	0.027	0.040*
	(0.037)	(0.035)	(0.036)	(0.034)	(0.018)	(0.017)	(0.023)	(0.024)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	1,246	1,214	1,246	1,214	1,240	1,208	1,241	1,209
R-squared	0.001	0.089	-0.001	0.085	-0.003	0.023	0.002	0.020
Mean (SD) dependent variable in the comparison group	0.741	0.741	0.240	0.240	0.938	0.938	0.904	0.904
	(0.438)	(0.438)	(0.428)	(0.428)	(0.240)	(0.240)	(0.295)	(0.295)

Table 8A: Impacts on Water Storage (continued)

Dependent variable:	Water Storage			
	Object used to fetch drinking water from storage container is clean		Water for general purposes is stored in covered containers	
	(9)	(10)	(11)	(12)
Panel A. ITT Estimation				
Treatment	0.001	0.003	0.033	0.047*
	(0.014)	(0.014)	(0.027)	(0.027)
Household Controls	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes
Observations	1,248	1,216	1,353	1,321
R-squared	0.000	0.018	0.001	0.080
Mean (SD) of dependent variable in the comparison group	0.931 (0.253)	0.931 (0.253)	0.548 (0.498)	0.548 (0.498)
Panel B. Instrumental variable estimation: “participated” instrumented with “treatment”				
Participated	0.002	0.004	0.046	0.063*
	(0.021)	(0.019)	(0.038)	(0.036)
Household Controls	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes
Observations	1,248	1,216	1,353	1,321
R-squared	0.000	0.018	-0.000	0.075
Mean (SD) dependent variable in the comparison group	0.931 (0.253)	0.931 (0.253)	0.548 (0.498)	0.548 (0.498)

Notes: Refer to Table 4A

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

Table 8B: Differential Impacts on Water Storage

	Water Storage							
Dependent variable:	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		Interior of drinking water storage container is clean	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. ITT Estimation								
Child treatment	-0.047	-0.077**	0.059*	0.080**	0.040***	0.042***	0.047***	0.040**
	(0.033)	(0.032)	(0.032)	(0.032)	(0.013)	(0.013)	(0.017)	(0.020)
Adult treatment	-0.028	0.043	0.028	-0.034	0.015	0.022	-0.006	0.016
	(0.031)	(0.037)	(0.030)	(0.036)	(0.015)	(0.019)	(0.021)	(0.027)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	1,246	1,214	1,246	1,214	1,240	1,208	1,241	1,209
R-squared	0.002	0.093	0.003	0.090	0.006	0.030	0.005	0.021
Mean (SD) of dependent variable in the comparison group	0.741 (0.438)	0.741 (0.438)	0.240 (0.428)	0.240 (0.428)	0.938 (0.240)	0.938 (0.240)	0.904 (0.295)	0.904 (0.295)
Panel B. Instrumental variable estimation: "child participated" and "adult participated" instrumented with "child treatment" and "adult treatment"								
Child participated	-0.057	-0.093**	0.071*	0.097**	0.049***	0.050***	0.057***	0.048**
	(0.039)	(0.038)	(0.039)	(0.038)	(0.016)	(0.016)	(0.021)	(0.024)
Adult participated	-0.049	0.082	0.050	-0.066	0.027	0.036	-0.010	0.026
	(0.054)	(0.067)	(0.053)	(0.065)	(0.027)	(0.033)	(0.036)	(0.048)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	1,246	1,214	1,246	1,214	1,240	1,208	1,241	1,209
R-squared	0.000	0.084	-0.001	0.083	-0.001	0.024	0.002	0.019
Mean (SD) dependent variable in the comparison group	0.741 (0.438)	0.741 (0.438)	0.240 (0.428)	0.240 (0.428)	0.938 (0.240)	0.938 (0.240)	0.904 (0.295)	0.904 (0.295)

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

Dependent variable:	Water Storage			
	Object used to fetch drinking water from storage container is clean		Water for general purposes is stored in covered containers	
	(9)	(10)	(11)	(12)
Panel A. ITT Estimation				
Child treatment	0.037**	0.025*	0.064*	0.052
	(0.014)	(0.015)	(0.033)	(0.035)
Adult treatment	-0.030	-0.026	0.002	0.041
	(0.019)	(0.022)	(0.033)	(0.039)
Household Controls	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes
Observations	1,248	1,216	1,353	1,321
R-squared	0.008	0.021	0.003	0.080
Mean (SD) of dependent variable in the comparison group	0.931 (0.253)	0.931 (0.253)	0.548 (0.498)	0.548 (0.498)
Panel B. Instrumental variable estimation: "child participated" and "adult participated" instrumented with "child treatment" and "adult treatment"				
Child participated	0.045**	0.031*	0.075*	0.060
	(0.017)	(0.018)	(0.038)	(0.041)
Adult participated	-0.052	-0.048	0.004	0.069
	(0.034)	(0.040)	(0.058)	(0.068)
Household Controls	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes
Observations	1,248	1,216	1,353	1,321
R-squared	0.013	0.024	0.003	0.075
Mean (SD) dependent variable in the comparison group	0.931 (0.253)	0.931 (0.253)	0.548 (0.498)	0.548 (0.498)

Notes: Refer to Table 4B
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 9A: Gendered Treatment Effects on Water Source Choices

Dependent variable:	Water source choices					
	Improved main drinking water based on JMP		Surface water as main drinking water source		Improved secondary drinking water source	
	(1)	(2)	(3)	(4)	(5)	(6)
Male participated	-0.115***	-0.072	0.066**	0.051	0.033	-0.004
	(0.041)	(0.045)	(0.031)	(0.035)	(0.054)	(0.055)
Household Controls	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes
Observations	476	468	476	468	290	283
R-squared	0.017	0.097	0.010	0.112	0.001	0.096
Mean (SD) of dependent variable in the female participated group	0.782 (0.414)	0.782 (0.414)	0.093 (0.292)	0.093 (0.292)	0.696 (0.462)	0.696 (0.462)

Table 9A: Gendered Treatment Effects on Water Source Choices (continued)

Dependent variable:	Water source choices continued			
	Improved main general purpose water		Household use sachet water as the main drinking water	
	(7)	(8)	(9)	(10)
Male participated	-0.103**	-0.060	-0.002	-0.030
	(0.045)	(0.049)	(0.037)	(0.035)
Household Controls	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes
Observations	476	468	476	468
R-squared	0.011	0.061	0.000	0.196
Mean (SD) of dependent variable in the female participated group	0.619 (0.487)	0.619 (0.487)	0.198 (0.400)	0.198 (0.400)

Notes: Refer to Table 4A
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

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

Dependent variable:	Water Quality, Treatment and Health Risk							
	Main drinking water source is dirty		Main general purpose water source is dirty		Satisfied with water quality		Household treat water to make it safer to drink	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Male participated	0.013	0.039	0.001	0.009	0.008	0.017	0.024	0.017
	(0.030)	(0.033)	(0.036)	(0.038)	(0.041)	(0.045)	(0.034)	(0.038)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	467	459	471	463	476	468	464	456
R-squared	0.000	0.050	0.000	0.060	0.000	0.036	0.001	0.034
Mean (SD) of dependent variable in the female participated group	0.112 (0.315)	0.112 (0.315)	0.184 (0.389)	0.184 (0.389)	0.732 (0.444)	0.732 (0.444)	0.144 (0.352)	0.144 (0.352)

Notes: Refer to Table 4A
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 9C: Gendered Treatment Effects 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)	
	(1)	(2)	(3)	(4)	(5)	(6)
Male participated	24.011	25.035	6.432	3.907	-1.755	-2.210**
	(18.297)	(19.416)	(15.691)	(15.927)	(1.075)	(1.070)
Household Controls	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes
Observations	428	420	448	440	445	437
R-squared	0.004	0.060	0.000	0.056	0.006	0.095
Mean (SD) of dependent variable in the female participated group	128.692 (161.583)	128.692 (161.583)	147.363 (169.442)	147.363 (169.442)	10.273 (13.974)	10.273 (13.974)

	Water Transport, Collection and Handling Techniques			
Dependent variable:	Time to main general purpose water source (in minutes)		Children under 12 years fetch water	
	(7)	(8)	(9	(10)
Male participated	-0.361	-0.517	-0.075*	-0.046
	(1.055)	(1.027)	(0.045)	(0.050)
Household Controls	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes
Observations	448	440	459	451
R-squared	0.000	0.042	0.006	0.115
Mean (SD) of dependent variable in the female participated group	10.873 (12.619)	10.873 (12.619)	0.389 (0.488)	0.389 (0.488)

Notes: Refer to Table 4A

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

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

	Water Quantity and Consumption/Usage			
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)
Male participated	-9.562**	-5.753	15.181	29.605*
	(4.774)	(4.892)	(16.213)	(16.358)
Household Controls	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes
Observations	473	465	475	467
R-squared	0.008	0.075	0.002	0.146
Mean (SD) of dependent variable in the female participated group	51.986	51.986	287.383	287.383
	(69.472)	(69.472)	(141.366)	(141.366)

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

	Water Storage							
Dependent variable:	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		Interior of drinking water storage container is clean	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Male participated	-0.047	-0.047	0.023	0.035	0.018	0.012	-0.048*	-0.056*
	(0.047)	(0.048)	(0.046)	(0.047)	(0.020)	(0.022)	(0.027)	(0.030)
Household Controls	No	Yes	No	Yes	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	399	391	399	391	401	393	402	394
R-squared	0.003	0.167	0.001	0.161	0.002	0.063	0.009	0.056
Mean (SD) of dependent variable in the female participated group	0.716	0.716	0.275	0.275	0.950	0.950	0.950	0.950
	(0.452)	(0.452)	(0.448)	(0.448)	(0.219)	(0.219)	(0.219)	(0.219)

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

Dependent variable:	Water Storage			
	Object used to fetch drinking water from storage container is clean		Water for general purposes is stored in covered containers	
	(9)	(10)	(11)	(12)
Male participated	-0.017	-0.023	-0.105**	-0.082*
	(0.025)	(0.027)	(0.046)	(0.049)
Household Controls	No	Yes	No	Yes
Basic School Controls	No	Yes	No	Yes
Observations	402	394	461	453
R-squared	0.001	0.053	0.011	0.090
Mean (SD) of dependent variable in the female participated group	0.941 (0.237)	0.941 (0.237)	0.625 (0.485)	0.625 (0.485)

Notes: Refer to Table 4A
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

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	-	-	437	
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

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