WORKING PAPER

COMMUNAL TAPS, A DROP IN THE BUCKET?

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March 2025
2025/1113

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Abstract

Lack of access to safe drinking water remains one of the greatest challenges faced by rural regions in Sub-Saharan Africa. A potential remedy lies in the improvement of local water sources. This study investigates the impact of communal taps on household drinking water quality, childhood diarrhea incidence, and water disinfection practices in rural Western Uganda. Using a quasi-experimental design, 244 households and 169 children under five were observed, with data collected through household surveys and water samples before and after the deployment of communal taps. Households closer to the taps were compared to those farther away, with geographical distance as an exogenous determinant of tap water adoption. The findings indicate a clear improvement in microbiological water quality at home, especially for households that can supplement tap water with rainwater harvesting. No reductions in the incidence of diarrhea in children were observed. Benefits are limited by supply and demand barriers that restrict exclusive tap use. Additionally, households might substitute water disinfection at home with tap water, undermining the full potential of the intervention.

Keywords: Drinking water, Communal taps, E.coli, Diarrhea incidence, Water treatment, Quasi-experiment, Uganda

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Funding

This work was supported by the Vlaamse Interuniversitaire Raad-Universitaire Ontwikkelingssamenwerking (VLIRUOS) (BE2017GMUUG0A103 and GMF.OPG.2021.0002.01) and the Research Foundation-Flanders (FWO.3F0.2022.0078.01).

Acknowledgments

The researcher especially thanks the team of enumerators and lab technicians from the Mountains of the Moon University in Fort Portal, Uganda. The researcher thanks Professor William Parienté and Professor Bart Cockx for reviewing, and Professor Violet Kisakye and Professor Bart Defloor for field work assistance.

1 Introduction

Lack of access to safe drinking water in low-income rural areas is widely recognized as a key factor contributing to poor living conditions and high rates of waterborne diseases. Diarrheal diseases, linked to inadequate water, sanitation, and hygiene (WASH) services, account for over one million deaths annually, disproportionately affecting children under five (Wolf et al., 2023). In response, the United Nations' Sustainable Development Goal (SDG) 6.1, established in 2015, seeks to ensure "universal and equitable access to safe and affordable drinking water for all" by 2030 (WHO & UNICEF, 2021). However, global progress remains off track, with 2.2 billion people still lacking access to safely managed water sources, and rural areas, particularly in Sub-Saharan Africa, are the most affected. In these regions, only 15% of the rural population has access to basic water services, compared to 53% of urban populations (WHO & UNICEF, 2023).

"Can safely managed communal taps improve drinking water quality at home and health for rural under-served populations?", is the central question of this study. This paper investigates the water quality and health impacts of improving basic water services through a point-of-source (POS) intervention—specifically, communal taps— in rural Western Uganda. The taps provide water for four hours daily at 100 Ugandan Shillings (UGX) or 0.0028 US Dollars (USD)[1] for one jerrycan containing 20 liters of drinking water. The study assesses how these taps influence drinking water quality in the household at the point-of-use (POU), childhood diarrhea incidence, and household water disinfection practices. The analysis uses a quasi-experimental design based on the geographical distance of the households from the taps. A placebo test supports the causal interpretation of the findings.

While the urgent need for improved drinking water services is universally acknowledged, there is little consensus on the most effective strategies. Source-based interventions, such as communal taps, have received mixed reviews, with studies suggesting limited improvements in household water quality and inconsistent reductions in childhood diarrhea (Clasen et al., 2015; Zwane & Kremer, 2007). For example, the randomized controlled trial by Kremer, Leino, Miguel, and Zwane (2011) found that spring protection yielded minor improvements

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[1] Prices are converted based on the 2021 average exchange rate.

in household water quality and small reductions in childhood diarrhea, despite high adherence to the intervention. Similarly, a meta-analysis by Wolf et al. (2014) reported some reduction in diarrhea incidence from communal taps and a randomized trial including water source chlorination found significant impacts on diarrhea incidence, due to the long-lasting disinfection properties of chlorine (Pickering et al., 2019). However, systematic reviews by Clasen et al. (2015), Waddington and Snilstveit (2009), and Fewtrell et al. (2005) emphasize that evidence on the consistent effectiveness of such POS interventions remains unsatisfactory. The recent randomized trial by Gross, Guenther, and Schipper (2022) even found no significant impact on point-of-use water quality following the introduction of public standpipes, citing recontamination during transport and storage as a key issue. This study also finds mixed results: households closer to the communal taps clearly show improved water quality at home, but there is no significant reduction in childhood diarrhea.

The varied outcomes are likely due to an interplay of supply, management, and demand side issues of drinking water. Specifically, this paper examines two key mechanisms identified in the literature that help explain these results.

First, exclusive consumption of uncontaminated water sources is of utter importance (Clasen et al., 2015; Daly & Harris, 2022; Enger, Nelson, Rose, & Eisenberg, 2013). Despite access to safely managed sources, households might be unable to utilize them consistently. A systematic review by Daly, Lowe, Hornsby, and Harris (2021) reveals that multiple water source use (MWSU) and supplemental unimproved source use (SUSU) are widespread. Reasons for MWSU and SUSU include the cost of safely managed drinking water (Witt, 2019; Daly et al., 2021; Deal & Sabatini, 2020) and unreliable supply due to technical issues (Hunter, Zmirou-Navier, & Hartemann, 2009; Majuru, Mokoena, Jagals, & Hunter, 2011; Daly et al., 2021). Additionally, the walking distance from the water source to the home plays a crucial role. Collecting water is a time-consuming and physically demanding task, typically undertaken by women and children, making households farther from the improved source less likely to use it consistently (Gross, Günther, & Schipper, 2018; Daly et al., 2021; Koolwal & van de Walle, 2013; Cook, Kabubo-Mariara, & Kimuyu, 2023).

In this study, walking distance serves as an exogenous variable to gauge the intensity of tap use, with households living within 400 meters considered more likely to adopt tap water than those living further away. However, I show that financial constraints and technical issues hinder exclusive tap usage, even among proximate households. Furthermore, households that can supplement tap water with rainwater, an improved water source with comparable microbiological quality, tend to have better overall water quality.

Second, the introduction of a clean water source can result in a substitution effect, where traditional household water disinfection practices, such as boiling, chlorination, and filtration, are discontinued (Gross et al., 2022). Households assume that tap water is immediately safe to drink, despite the risk of recontamination during transport and storage. Recontamination of drinking water through unhygienic handling often occurs, leading to poorer water quality at the point of use compared to the point of source (Esrey, 1996; Wright, Gundry, & Conroy, 2004; Wapenaar & Kollamparambil, 2019; Clasen & Bastable, 2003; Eshcol, Mahapatra, & Keshapagu, 2009). The use of contaminated containers for transport and storage, refraining from covering the transport and storage containers with a lid, or dipping contaminated utensils in the containers before consumption are all behaviors that contribute to this issue (Günther & Schipper, 2013; Mazengia et al., 2002; Roberts et al., 2001).

This quasi-experiment encourages the existence of substitution effects by supporting a causal impact of improved drinking water source quality on reduced disinfection practices at home. Furthermore, it suggests seasonal variation in the substitution effect by distinguishing between weather and intervention-induced substitution effects.

This study contributes to the literature in three significant ways. First, it employs a novel dataset from 244 households and 169 children in rural Western Uganda. Second, it adds to the ongoing debate about the effectiveness of point-of-source interventions by using an instrumental variable approach to estimate the intention-to-treat (ITT) and local average treatment effect (LATE) of communal taps. Third, it explores the behavioral mechanisms, such as non-exclusive water source use and the substitution of household disinfection practices driving the mixed results observed in the literature.

The rest of the paper is structured as follows. Section 2 discusses the context of the drinking water intervention in Western Uganda. Section 3 describes the sample selection and data collection process. Section 4 outlines the empirical strategy and Section 5 presents the results. Sections 6 and 7 discuss the behavioral mechanisms and provide concluding thoughts. Finally, Section 8 reports on limitations and further avenues of research.

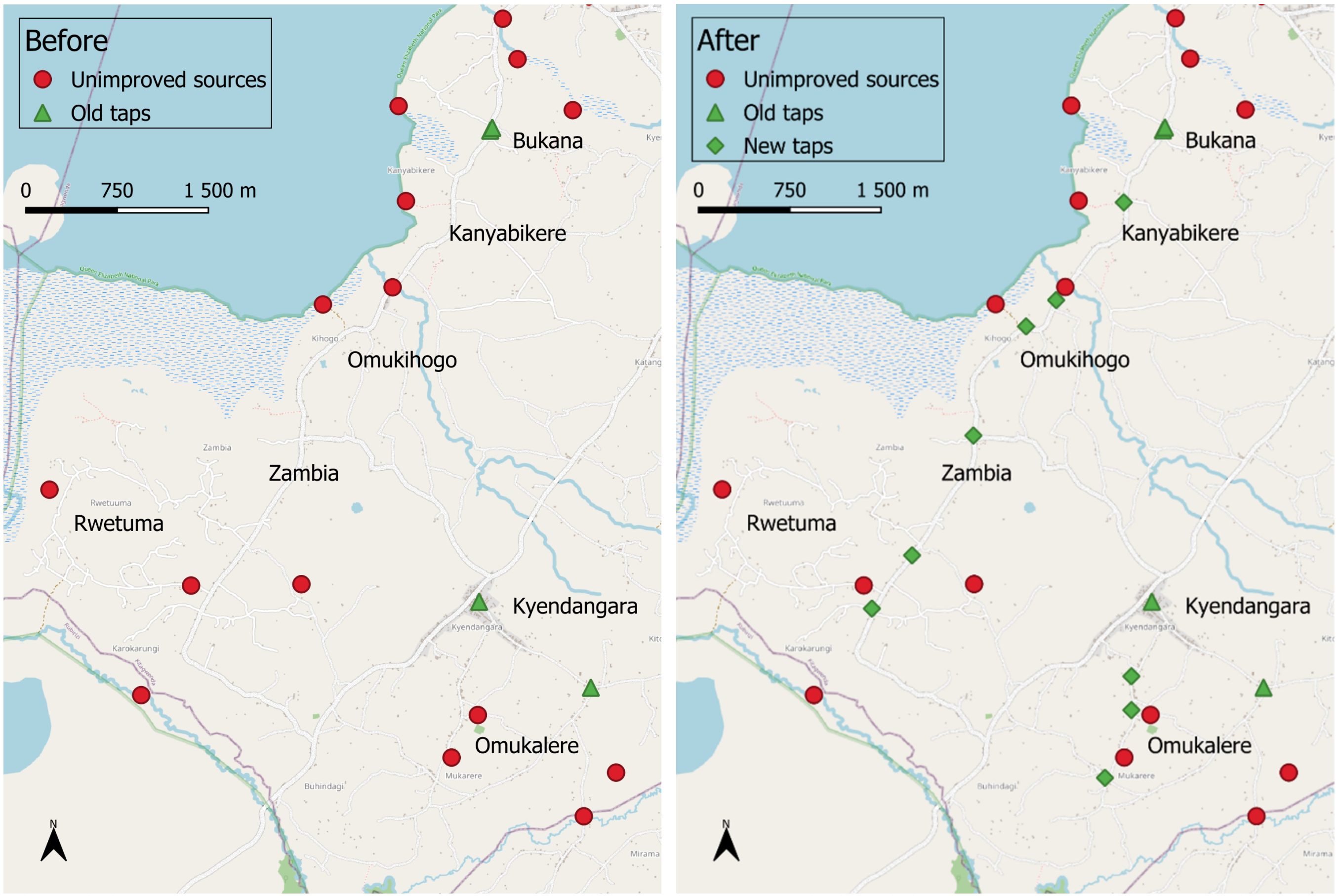
2 Intervention

2.1 Village selection

This research is conducted in the Kamwenge district of the Rwenzori region in Western Uganda. The area's drinking water sources encompass protected springs, formal rainwater harvesting systems, unprotected wells, deep boreholes, and gravity flow schemes that provide communal piped water. Although the region has seen improvements in safe drinking water coverage rates over recent years, access to safe drinking water remains limited, particularly for the rural population. The national water and sewerage grid system primarily serves towns, leaving many rural residents dependent on unsafe water supplies (Kisakye, 2021).

The studied intervention is part of the drinking water strategy implemented by the Ugandan NGO Health Through Water And Sanitation (HEWASA), with the support of the Belgian NGO Join For Water (JFW). The targeted villages -Bukana, Kanyabikere, Omukihogo, Zambia, Rwentuma, Kyendangara, and Omukalere- were selected by HEWASA based on three main criteria: lack of reliable uncontaminated drinking water sources, favorable geographical features, and community demand for safely managed drinking water. Initially, these villages only had access to contaminated unimproved sources, such as lakes, rivers, hand-dug wells, and contaminated improved sources, like protected boreholes and shallow wells. A few communal taps provided clean drinking water, but their coverage and quantity were insufficient to cover the communities' needs. The region's climate, characterized by distinct wet and dry seasons, also plays a role in drinking water choices. During the wet season, households often rely on rainwater harvesting, an improved water source with low bacterial contamination. However, rainwater harvesting is unreliable and limited to the wet season. The extension of safely managed communal taps is justified both by the insufficient coverage of the pre-existing

Figure 1: Overview maps of the intervention area before and after the intervention



The red dots represent the pre-existing unimproved water sources, including lakes, rivers, and unprotected hand-dug wells, as well as improved sources such as protected boreholes and shallow wells. Safely managed tap stands are marked with green triangles and squares. The four green triangles, with two located in Bukana and two in Kyendangara, signify the pre-existing taps. The nine green squares, dispersed across the villages, denote the taps constructed as part of the current intervention.

taps and the unreliability of rainwater harvesting (Figure 1).

Furthermore, the selected villages were geographically suitable for constructing a gravity-based water scheme. All are located in the low-lying plain near Lake George, which supports the gravity design's functionality.

Last, the intervention was planned in collaboration with the political leaders and had strong community support.

2.2 Information campaign and communal taps

The village-level water source intervention in this study comprises two main components. First, an information campaign was conducted to educate the communities about the benefits of safe drinking water. HEWASA facilitated discussions during community meetings in all the selected villages to highlight the advantages of safely managed communal taps. Second, the intervention included the installation of nine new communal taps to supplement the four pre-existing taps (Figure 1). The new tap stands are part of a gravity-fed system that delivers clean drinking water from a protected spring located at a higher elevation to the villages through a network of pipes. The existing four taps operate similarly, drawing water from a nearby sediment tank fed by a protected well. Figure 2 summarizes the water quality from a subset of communal taps and other sources. Each communal tap is managed by the household on whose property it is installed. These households sell drinking water for 100 UGX or 0.0028 USD for 20 liters, equivalent to one jerrycan[2] The taps are accessible for four hours daily, from 7 AM to 9 AM and from 5 PM to 7 PM. The construction of the taps was carried out by HEWASA with the assistance of the communities throughout November 2021. By the end of the month, all the new taps were fully operational.

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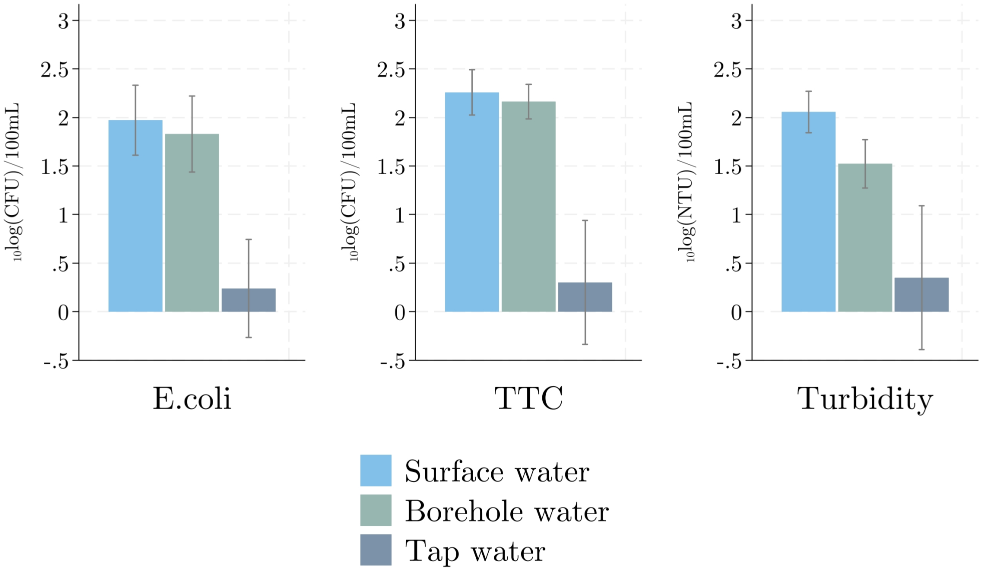
[2] Prices are converted based on the average 2021 exchange rate. For reference, 100 UGX is approximately the price of the charcoal needed for cooking one hot meal for an average household.

Figure 2: POS water quality



Point-of-source (POS). Total Thermotolerant Coliforms (TTC). E.coli and TTC are measured in Colony Forming units (CFU). Turbidity is measured in Nephelometric Turbidity Units (NTU). The water source quality is based on six samples of surface water, nine samples of boreholes, and two samples of communal taps. The same water quality by type of source is assumed for the unobserved sources in the region.

3 Data

Data collection for this study occurred in two phases: one month before the intervention, in October 2021, and four months afterward, in April 2022. A span of four months is presumed an adequate duration for households to habituate to the novel circumstances and measure the short-term impacts. Both the baseline and end-line data collections were strategically timed at the onset of the wet season to minimize variations in outcomes due to seasonal changes in weather conditions.

3.1 Household selection

Initially, 360 households were assessed for eligibility, selected by randomly choosing 70% from each village's population registers (see Section 2.1). For this study, a household is defined as a group of people living together, sharing meals, water, and sanitation facilities. The sample is divided into an intervention group that lives within a 400-meter radius of a communal tap and a control group residing farther away. Following the intervention, 12 households relocated and could not be traced. Additionally, observations from 30 households that relied on preexisting communal taps before the intervention and 30 households that negotiated a private water connection on their premises or utilized the private connection from an acquaintance after the intervention were excluded from the sample. This strategy was implemented to isolate the impact of the usage of communal taps due to the intervention on households that had not previously relied on piped communal water supply. Additionally, 44 households were excluded due to missing baseline or end-line data for the outcome variables. These excluded households lacked survey data or a water sample at the baseline or end-line. The absence of data on the outcome variables at baseline is an excluding factor since the credibility of the empirical strategy relies on a placebo test on these variables (Section 4.1.3). The final sample includes 244 households and their 169 children under five[3]. Figure 3 provides an overview of the sample selection process and

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[3] Additionally, I perform the analysis on a less restrictive sample. Negotiating a private connection or using a private connection from another household could be considered an endogenous decision induced by the intervention. Therefore, the analysis also is performed including those households. Table B.2 shows no substantial differences in treatment effects compared to the regressions with the restrictive sample

household attrition throughout the study. The overall attrition rate following the intervention due to relocation and otherwise missing end-line outcome values is 16%. Attrition is 19% in the group of households living further than 400 meters from a communal tap and 14% in the group of households living within this radius. There is no significant differential attrition between both groups[4]. Missing outcome variables in the baseline study are also unrelated to treatment assignment status. There was 17% drop out for the group living away from a future tap and 15% for the group living near a future tap [5].

3.2 Surveys and water samples

All sampled households participated in standardized interviews to gain an in-depth understanding of water-related behavior at the household level. A team of twelve enumerators, fluent in the local language, conducted these interviews and observed water-handling practices within the homes. Each survey topic was addressed by the household member most knowledgeable about the subject, ensuring the inclusion of female perspectives. This approach is particularly significant when researching water practices and child health since water-handling and childcare tasks are traditionally assigned to women.

Following the interviews, a water sample was collected from the household's water storage container for laboratory analysis. Enumerators, trained by a lab technician, followed strict hygienic guidelines for sample collection[6]. The samples were stored and transported on ice, and analyzed in the lab within 24 hours. The coordinating researchers collected water samples from a subset of water sources using the same hygienic procedures.

3.3 Descriptive characteristics

The relevant characteristics of all the included households and children before the intervention are presented in the fourth column of the balance tables

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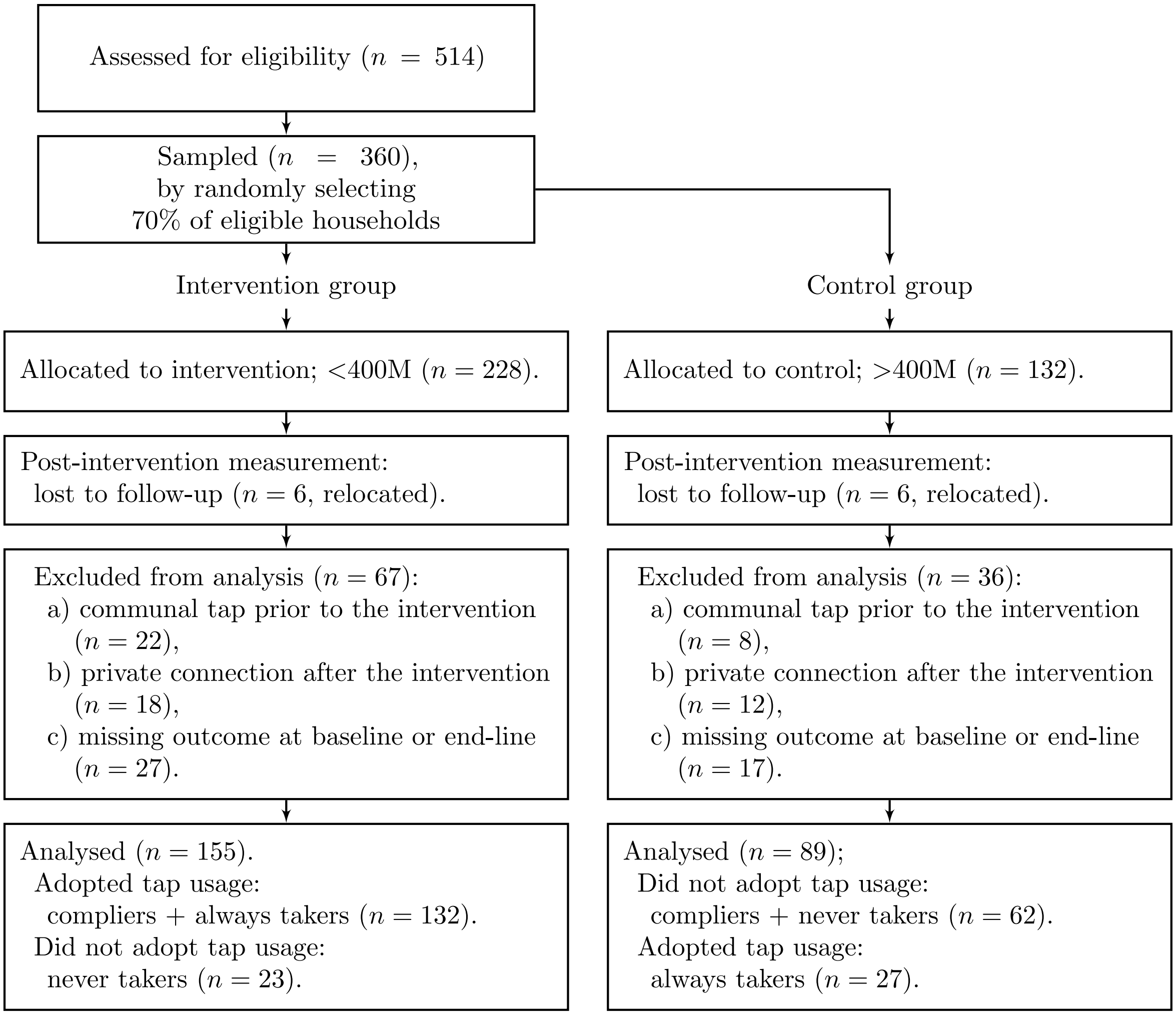
[4] The T-statistic of regressing follow-up attrition on treatment assignment status is -1.23, corresponding to the p-value of 0.220.

[5] The T-statistic of regressing baseline attrition on treatment assignment status is -1.44, corresponding to the p-value of 0.659.

[6] These guidelines involve disinfection of hands with hand sanitizer before sampling, removing the outer cap and the inner cap of the bottle and holding it in one hand while sampling to avoid contamination from other surfaces, and replacing both caps without touching the sampled water.

Figure 3: Sample selection and evolution



This figure illustrates the household selection process and household attrition throughout the study. The final sample consists of 155 households living within 400 meters of a communal tap and 89 living further away.

(Tables 1 and 2).

Most households exhibit an intermediate to high risk of bacterial contamination and excessive turbidity in their drinking water[7]. Consistent with these microbiological measurements, households' reported water quality, based on Likert scales of taste, odor, and appearance, is below average and notably lower in the dry season compared to the wet season.

Overall, the households report high rates of drinking water disinfection by boiling. About 83% of the households disinfect the drinking water of their primary source before consumption in the dry season, and 72% do so in the wet season. Taking into account as well secondary and tertiary drinking water sources, 78% disinfects all water sources used in the dry season, and 65% in the wet season. A significant share of households also apply a mixed disinfection practice. Approximately 22% indicate disinfecting only water from specific sources in the dry season and 34% practice selective disinfection in the wet season. There is thus a clear seasonal pattern in perceived drinking water quality and disinfection practices. During the dry season, households perceive their water sources as lower quality and consequently engage in more disinfection. Conversely, in the wet season, the perceived water quality improves, leading to less disinfection. This pattern is also evident in the changing nature of the water sources utilized by households across the seasons. During the dry season, 79% of households rely solely on unimproved water sources, while this decreases to 40% in the wet season due to the prevalence of rainwater harvesting, which is considered an uncontaminated improved water source. The higher quality of rainwater presumably substitutes disinfection in the wet season, while disinfection becomes crucial in the dry season. The proximity of rainwater harvesting to the dwelling explains as well the difference in average walking time to water sources: 56 minutes for a round trip in the dry season, compared to 33 minutes in the wet season. After fetching and disinfecting, drinking water is stored in a covered container in 70% households for approximately one day.

Most households have a male head, typically around 44 years old, who has completed at least the first year of primary education. Only 25% of households had a member participating in WASH education. The average household size

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[7] Colony Forming Units (CFU). Total Thermotolerant Coliforms (TTC). Nephalometric Turbidity Units (NTU). Risk categories for TTC, including E.coli, are WHO guideline (0 CFU/100mL), small risk (1-9 CFU/100mL), medium risk (10-99 CFU/100mL), and high risk (100 or more CFU/100mL). Risk categories for turbidity are WHO guideline (less than 1 NTU/100mL), acceptable (1-4 NTU/100mL), and too high (5 or more NTU/100mL).

is five persons, and 19% of households have experienced the loss of a child under five years. Predominantly engaged in self-sustained agriculture, these households often cannot report a regular income. The constructed wealth index, therefore, ranks households based on asset ownership and consumption patterns[8]. Trust in institutions is measured through an index compiled from Likert scales evaluating trust in the local district council, village chief, and the NGOs conducting the intervention. Overall, households rate their trust in local institutions above average. Basic sanitation coverage is high, with 96% of households using a pit latrine, but only about half have access to a hand washing facility equipped with water and soap.

Table 2 details diarrhea incidence and the average age of children under five, in addition to the characteristics elaborated above. The children are, on average, two years old, with about 15% having suffered from diarrheal disease in the preceding seven days.

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[8] The wealth index is a consumption-augmented asset index (Ngo & Christiaensen, 2019). Asset ownership is surveyed for furniture (table or bed), electronics (TV or radio), cook stove, solar panel, cattle (cow), other animals (pig, duck, chicken, etc.), housing characteristics (house ownership and quality of the floor, roof and walls). Consumption of beans, maize, cassava, sweet potato, matooke, oil, milk, beef, fish, and eggs in the last week is also surveyed. Each asset and consumption good is weighted by principal component analysis, and households are ranked in quintiles based on the linear combination of their weighted assets and consumption goods.

Table 1: Balance table at household level

	Distance from a communal tap			
	>400M	**<400M**	**Total**	**Test**
N	89 (36.5%)	155 (63.5%)	244 (100.0%)	
Drinking water quality				
E.coli ($_{10}logCFU/100mL$)	1.401 (0.610) 89	1.436 (0.659) 155	1.424 (0.641) 244	0.682
TTC ($_{10}logCFU/100mL$)	1.820 (0.591) 89	1.876 (0.646) 155	1.856 (0.626) 244	0.507
Turbidity ($_{10}logNTU/100mL$)	1.477 (0.573) 89	1.381 (0.542) 155	1.416 (0.554) 244	0.197
Risk categories E.coli				
WHO guideline	(6.7%) 6	(8.4%) 13	(7.8%) 19	0.853
Small risk	(14.6%) 13	(12.3%) 19	(13.1%) 32	
Intermediate risk	(61.8%) 55	(59.4%) 92	(60.2%) 147	
High risk	(16.9%) 15	(20.0%) 31	(18.9%) 46	
Risk categories TTC				
WHO guideline	(2.2%) 2	(5.2%) 8	(4.1%) 10	0.303
Small risk	(6.7%) 6	(2.6%) 4	(4.1%) 10	
Intermediate risk	(49.4%) 44	(48.4%) 75	(48.8%) 119	
High risk	(41.6%) 37	(43.9%) 68	(43.0%) 105	
Risk categories turbidity				
WHO guideline	(3.4%) 3	(3.9%) 6	(3.7%) 9	0.334
Acceptable	(4.5%) 4	(9.7%) 15	(7.8%) 19	
Too high	(92.1%) 82	(86.5%) 134	(88.5%) 216	
Reported quality (1-10)				
Primary source dry season	4.037 (2.271) 89	3.676 (2.226) 155	3.808 (2.244) 244	0.227
Primary source wet season	4.788 (3.363) 89	4.789 (3.417) 155	4.789 (3.390) 244	0.998
Multiple sources dry season	4.135 (2.044) 89	3.733 (2.174) 155	3.880 (2.132) 244	0.156
Multiple sources wet season	5.060 (2.962) 89	5.088 (2.945) 155	5.078 (2.945) 244	0.943
Water-handling practices				
Disinfection primary source				
Dry season				
No	(24.7%) 22	(16.8%) 26	(19.7%) 48	0.133
Yes	(75.3%) 67	(83.2%) 129	(80.3%) 196	
Wet season				
No	(30.3%) 27	(27.7%) 43	(28.7%) 70	0.666
Yes	(69.7%) 62	(72.3%) 112	(71.3%) 174	
Disinfection of multiple sources				
Dry season				
Mixed	(24.7%) 22	(20.0%) 31	(21.7%) 53	0.110
No	(2.2%) 2	(0.0%) 0	(0.8%) 2	
Yes	(73.0%) 65	(80.0%) 124	(77.5%) 189	
Wet season				
Mixed	(38.2%) 34	(32.3%) 50	(34.4%) 84	0.577
No	(1.1%) 1	(0.6%) 1	(0.8%) 2	
Yes	(60.7%) 54	(67.1%) 104	(64.8%) 158	
Improved primary source				
Dry season				
No	(84.9%) 73	(85.1%) 126	(85.0%) 199	0.959
Yes	(15.1%) 13	(14.9%) 22	(15.0%) 35	
Wet season				
No	(60.5%) 52	(61.3%) 92	(61.0%) 144	0.895
Yes	(39.5%) 34	(38.7%) 58	(39.0%) 92	
Improved multiple sources				
Dry season				

Table 1 continued.

	Distance from a communal tap			
	>400M	<400M	Total	Test
Mixed	(9.3%) 8	(6.1%) 9	(7.3%) 17	0.645
No	(77.9%) 67	(79.7%) 118	(79.1%) 185	
Yes	(12.8%) 11	(14.2%) 21	(13.7%) 32	
Wet season				
Mixed	(41.9%) 36	(31.5%) 47	(35.3%) 83	0.281
No	(36.0%) 31	(42.3%) 63	(40.0%) 94	
Yes	(22.1%) 19	(26.2%) 39	(24.7%) 58	
Covered storage container				
No	(30.3%) 27	(28.7%) 43	(29.3%) 70	0.784
Yes	(69.7%) 62	(71.3%) 107	(70.7%) 169	
Number of days stored	1.326 (1.268) 89	1.277 (1.176) 155	1.295 (1.208) 244	0.764
Reported walking time (min.)				
Dry season	53.55 (37.40) 89	57.11 (44.25) 155	55.81 (41.84) 244	0.523
Wet season	31.01 (34.08) 89	33.98 (36.72) 154	32.89 (35.74) 243	0.533
Demographics				
Age (years)	46.99 (16.03) 88	42.74 (14.97) 154	44.29 (15.47) 242	0.040**
Sex				
Female	(21.6%) 19	(27.1%) 42	(25.1%) 61	0.341
Male	(78.4%) 69	(72.9%) 113	(74.9%) 182	
Household size	5.102 (2.519) 88	4.310 (2.155) 155	4.597 (2.320) 243	0.010**
Child death <5y				
No	(83.0%) 73	(79.4%) 123	(80.7%) 196	0.495
Yes	(17.0%) 15	(20.6%) 32	(19.3%) 47	
Education				
No formal education	(26.1%) 23	(26.6%) 41	(26.4%) 64	0.813
P1-P3	(17.0%) 15	(15.6%) 24	(16.1%) 39	
P4-P7	(46.6%) 41	(42.2%) 65	(43.8%) 106	
S1-S3	(5.7%) 5	(5.8%) 9	(5.8%) 14	
S4-S6	(3.4%) 3	(7.1%) 11	(5.8%) 14	
Higher education	(1.1%) 1	(2.6%) 4	(2.1%) 5	
Wash education				
No	(81.6%) 71	(70.3%) 109	(74.4%) 180	0.054*
Yes	(18.4%) 16	(29.7%) 46	(25.6%) 62	
Wealth index quintiles				
1st	(23.9%) 21	(20.0%) 31	(21.4%) 52	0.951
2nd	(21.6%) 19	(20.6%) 32	(21.0%) 51	
3d	(17.0%) 15	(17.4%) 27	(17.3%) 42	
4th	(18.2%) 16	(20.0%) 31	(19.3%) 47	
5th	(19.3%) 17	(21.9%) 34	(21.0%) 51	
Improved roof	(85.2%) 88	(89.0%) 155	(87.7%) 243	0.388
Trust in institutions (1-10)	5.924 (2.615) 87	6.575 (2.617) 150	6.336 (2.630) 237	0.066*
Sanitation and hygiene				
Sanitation				
Open defecation	(5.7%) 5	(3.2%) 5	(4.1%) 10	0.226
Pit latrine with slab	(3.4%) 3	(8.4%) 13	(6.6%) 16	
Pit latrine without slab	(90.9%) 80	(88.4%) 137	(89.3%) 217	
Hand hygiene				
Equipped washing facility	(52.3%) 46	(52.9%) 82	(52.7%) 128	0.925
No equipped washing facility	(47.7%) 42	(47.1%) 73	(47.3%) 115	

Mean, (SD), and N are reported for continuous variables and (frequency) and N for categorical variables. P-values stem from T-tests for the continuous variables and Chi2-tests for the categorical variables. *** p<0.01, ** p<0.05, * p<0.1

Table 2: Balance table at child level

	Distance from a communal tap **>400M**	**<400M**	**Total**	**Test**
N	69 (40.8%)	100 (59.2%)	169 (100.0%)	
Demographics				
Age	2.217 (1.423) 69	2.140 (1.263) 100	2.172 (1.327) 169	0.711
Health				
Diarrhea incidence last 7 days				
No	(81.2%) 56	(88.0%) 88	(85.2%) 144	0.218
Yes	(18.8%) 13	(12.0%) 12	(14.8%) 25	

Mean, (SD), and N are reported for continuous variables and (frequency) and N for categorical variables. P-values stem from T-tests for the continuous variables and Chi2-tests for the categorical variables. *** p<0.01, ** p<0.05, * p<0.1

4 Empirical strategy

This paper investigates the causal impact of communal taps on drinking water quality at home, diarrhea incidence in children under five, and household disinfection practices. Following the intervention, households in the study area were self-selected into two groups: tap users and non-tap users. Due to this self-selection bias, a simple comparison between these groups would not yield a causal effect of the intervention. To address this issue, the walking distance between the dwelling and the communal tap is used as an instrument for tap water adoption. Walking distance has been proven a major determinant of water source adoption as fetching drinking water is a physically burdensome and time-consuming activity (Gross et al., 2018; Martínez-Santos, 2017). The variation in geographical distance between the dwelling and the nearest communal tap can be used as an exogenous determinant of treatment assignment since households included in the analysis did not relocate after the deployment of the taps. The validity of the instrument is substantiated in Section 4.1.

The World Health Organization's definition of access to basic drinking water services is used as a guideline to determine the cut-off distance at which households are encouraged to adopt tap water. Access to basic services is formulated as "being able to fetch water from an improved water source within 30 minutes for a round trip, including queuing" (WHO & UNICEF, 2023). In this study, the walking time is approximated by the straight line distance between the dwelling and the nearest tap[9]. These distances are calculated in QGIS based on coordinates. Dwellings should be located within a 400-meter radius of the nearest communal tap to be considered as having adequate access. This estimate accounts for the time needed for queuing and filling[10]. The analysis is also performed using varying cut-off distances between 100 and 500 meters as a sensitivity check.

The analysis focuses first on the reduced form. The ITT is estimated by comparing differences in outcomes between households living within 400 meters of a communal tap and households living further away, using ordinary least squares (OLS) regression. The following regression model is applied:

$$y_{ij} = \alpha + \beta Z_i + \epsilon_{ij} \tag{1}$$

Where y_{ij} represents the outcomes of interest, namely water quality at POU, diarrhea incidence in children, and disinfection at POU for a household or child i, after the deployment of the taps at time j=1. Water quality is measured in counts of Colony Forming Units (CFU) for E.coli and Total Thermotolerant Coliforms (TTC), and Nephelometric Turbidity Units (NTU) for turbidity. Both counts are logarithmically transformed with base ten to approximate a normal distribution, after adding one. Diarrhea incidence in the last seven days is a binary indicator measured at the child level for the age category 0-4 years. Diarrhea is defined according to the WHO criteria, as the passage of three or more loose or liquid stools per day or more frequent passage than is normal for the individual. The diarrhea incidence for each child is reported by the primary caregiver. Disinfection practices are studied both for the primary water source and multiple water sources used for drinking purposes. For the primary water source, the disinfection variable is binary coded with "Yes"=1 if the household boils and "No"=0 if the household does not boil at home. Disinfection of multiple water sources is also binary-coded, accounting for behavioral patterns before and after the intervention. A household is assigned 0 if its disinfection practices decreased or remained

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[9] Contrary to the reported walking time in the baseline data, there is no such information in the end-line data. Therefore, I rely on geographical data to approximate 30 minutes of walking time.

[10] The estimation is based on an average walking pace of 4 km/h and an additional 20 minutes to compensate for measurement errors, queuing, and filling time.

"No" or "Mixed" for all sources, and 1 if its disinfection practices increased or remained "Yes" for all sources, after the intervention. The linear probability model is applied for all binary outcome variables. β is the coefficient of interest which represents the intention-to-treat effect on the outcome variables, with Z_i as the binary indicator for living within a 400-meter radius from a community tap. ϵ_{ij} is the error term. Standard errors are robust for heteroskedasticity, and clustered at household level when children are the unit of observation.

The estimation is initially performed without control variables. In a second instance, the controls X_i are added to the regression to account for any baseline imbalances:

$$y_{ij} = \alpha + \beta Z_i + \gamma X_i + \epsilon_{ij} \tag{2}$$

with θ being the coefficient vector on a vector of time-independent household or child characteristics X_i measured at baseline.

To explore heterogeneity in the ITT, I incorporate interaction terms between baseline variables and the treatment indicator:

$$y_{ij} = \alpha + \beta Z_i + \gamma X_i' + \delta Z_i * X_i' + \epsilon_{ij} \tag{3}$$

I explore two potentially moderating factors in the relationship between communal taps and household drinking water quality: pre-intervention drinking water quality and the ability to supplement tap water with rainwater during the wet season.

Baseline water quality reflects household decisions regarding water sources, disinfection practices, and storage methods before the intervention. Households with initially high water quality may benefit more from the intervention due to their existing hygienic handling practices or greater interest in maintaining safe drinking water. Conversely, households with lower initial water quality might experience greater improvements as they gain access to a safer source or adopt better water management practices through the intervention. Rainwater harvesting could moderate the relationship by serving as a supplementary water source. Since rainwater has similar microbiological properties to tap water, households with access to it may maintain better overall water quality during the wet season, particularly when tap water is unavailable or unreliable. To measure rainwater harvesting capacity, I use the presence of an improved iron-sheet roof as a proxy, given that effective rainwater collection depends on roof quality. These moderating factors are included as a subset of baseline covariates, denoted as X_i' in equation 3.

Second, the analysis builds on two-staged least-squares (2SLS) to estimate the local average treatment effect (LATE) of the intervention. This is the treatment effect on the compliers: those households that are induced to collect tap water because a communal tap was installed within 400 meters of their home. The choice for tap water is given in the survey by the main water fetcher of the household and is understood as the positive reply to the question "Do you make use of a communal tap?". A sensitivity analysis on the results of the LATE is performed by varying the cut-off distance used to determine the treatment assignment status.

4.1 Instrument validity

The validity of walking distance as an exogenous instrument for tap water adoption is supported by three tests. The strong F-test in the first stage of the 2SLS, the balance test on the baseline variables, and the placebo test of the instrument on the baseline outcomes for several cut-off distances underpin the credibility of the empirical strategy.

4.1.1 F-test first stage

The theoretical relevance of walking distance as a physical barrier for tap water adoption is supported by a strong F-test in the first stage of the 2SLS. In the first stage, the instrument, walking distance, is regressed on the endogenous variable, tap water adoption. The F-statistics of the first stage are strong with a value of 93.5 for the household sample and 75.1 for the child sample (Tables 3 and 4).

4.1.2 Balance test

Table 1 presents the relevant baseline characteristics for households located within 400 meters of a communal tap compared to those living further than 400 meters away. The p-values in the final column assess the statistical significance of differences between the two groups. No significant differences are observed in baseline variables related to drinking water quality at home, such as bacterial contamination, turbidity, and self-reported water quality. Similarly, both groups demonstrate comparable water fetching routines, disinfection practices, and storage methods, with no substantial differences in their choices of water sources or boiling behavior across the dry and wet seasons. Demographic characteristics also show few discrepancies between the groups. Both groups are similar in terms of age, education, and wealth. Minor differences include the slightly younger average age of the household head and smaller household size among those within 400 meters of a communal tap. Additionally, 30% of these households participated in WASH education compared to 18% of those further away, and they report marginally higher trust in local institutions. There are no significant differences in sanitation and hand-washing facilities.

Table 2 demonstrates no imbalances in diarrhea incidence in the previous seven days, nor in the age of the children under five.

It can be concluded that households and children living within and beyond a 400-meter radius of a communal tap exhibit no discernible differences in observed relevant characteristics, making them suitable for comparison. Yet, the ITT is presented both with and without baseline covariates to account for remaining imbalances.

4.1.3 Placebo test

Since a sensitivity analysis for the LATE is performed across different cut-off distances, it is essential to ensure that none of these instruments are directly related to any of the outcomes. A placebo test is conducted to examine varying cut-off distances as instruments for tap water adoption. The hypothesis states that living within a certain distance of a communal tap should not be associated with the outcome variables before the taps are deployed. If the baseline outcome variables remain unaffected by residing within a certain radius of a future access point, this provides strong evidence that the instrument is not correlated with unobserved factors that directly influence the outcomes of interest. To assess the independence of the instruments from the baseline outcomes, the following regressions are estimated:

$$y_{ij} = \alpha + \beta Z_i + \epsilon_{ij} \tag{4}$$

$$y_{ij} = \alpha + \beta Z_i + +\gamma X_i' + \delta Z_i * X_i' + \epsilon_{ij} \tag{5}$$

These regressions are analogous to equations 1 and 3, but differ in the timing of the outcome variables. Here j=0, since the baseline measurements are of interest. Figures A.1 and A.2 show that living within a 100 to 500-meter radius of a future communal tap has no significant effect on any of the outcomes before the intervention. There are some significant negative effects on turbidity and disinfection of the primary water source during the dry season at cut-off distances of respectively 550 meters and 700 meters onward. Consequently, the sensitivity analysis will be limited to cut-off scores of 500 meters and below. Table A.1 excludes a pre-intervention interaction effect of rainwater harvesting.

5 Results

First, the ITT is estimated by comparing all households living within a 400-meter radius of a communal tap with those living farther away. Panels A of Tables 3 and 4 display the estimated impacts on drinking water quality at point-of-use, diarrhea incidence in children under five, and disinfection practices at home.

Households within the 400-meter radius show significantly lower bacterial contamination, with a log reduction of 0.3 for CFUs of E.coli and 0.6 for CFUs of TTC, corresponding to reductions of 53% and 77%, respectively. Turbidity levels are also significantly reduced by 66%, with a log reduction value of 0.5. However, there is no impact on diarrhea incidence in children under five. Additionally, there is no evidence of substitution of disinfection practices at home by using the improved water source during the wet season. The coefficients are close to zero and insignificant. There is a small negative impact on reported disinfection in the dry season, with households living near a communal tap having a 14% lower rate of disinfection for their primary water source and 20% lower when considering multiple water sources. Nonetheless, these substitution effects are not significant, probably due to low sample power.

Second, the ITT is rescaled by the percentage of compliers to estimate the LATE, using 2SLS. Tap usage, defined as a positive reply by the main water fetcher on the survey question ”Do you make use of a communal tap?”, is instrumented with living within 400 meters of a communal tap. The F-statistics of the first stage are 93.5 for the household sample and 75.1 for the child sample, underscoring the instrument's strength. The treatment effects are estimated in the second stage displayed in Panels B of Table 3 and Table 3. Household drinking water quality improved significantly. The estimated log reduction for CFUs of E.coli is 0.6, equivalent to a 74% decrease for compliers. For CFUs of TTC, the log reduction for compliers is 1.1, or a 93% reduction. Turbidity, measured in NTUs, also decreased significantly by 86%, with a log reduction value of 0.9. However, the geometric means of E.coli (0.4) and TTC (0.5) in the household storage containers of the compliers are slightly higher than at the communal taps (0.2 for E.coli and 0.3 for TTC), indicating recontamination due to unhygienic transport and storage or non-exclusive usage of improved sources. There is no observed impact on diarrhea incidence in children under five. Again, there is a negative treatment effect on reported disinfection practices solely in the dry season. The rate of households maintaining low or decreasing disinfection practices is 23% higher for those near a communal tap when considering their primary water source, and 33% higher when accounting for multiple water sources. However, these effects are not significant likely due to low sample power.

Table 5 explores heterogeneous treatment effects for drinking water quality. The presence of an improved roof moderates the impact of the intervention on microbiological water quality. Households living near a communal tap and efficiently collecting rainwater demonstrate significantly better drinking water quality at point-of-use. They experience 80% lower E.coli growth than households near a tap that do not have an improved roof. This result underscores the importance of exclusive reliance on improved sources for optimal water quality outcomes. There is no moderating effect of baseline drinking water quality on post-intervention household water quality.

Table 3: Treatment effects on water quality and diarrhea incidence in children under five

	E.coli		TTC		Turbidity		Diarrhea incidence	
	$_{10}logCFU/100mL$		$_{10}logCFU/100mL$		$_{10}logNTU/100mL$		*Yes/No*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PANEL A: ITT								
<400 meters	-0.325***	-0.396***	-0.630***	-0.727***	-0.467***	-0.542***	0.0516	0.0697
	(0.107)	(0.133)	(0.127)	(0.154)	(0.083)	(0.098)	(0.064)	(0.085)
Mean >400 meters	0.808	0.813	1.305	1.306	0.724	0.717	0.188	0.176
Observations	244	217	244	217	244	217	169	159
Clusters	Na	Na	Na	Na	Na	Na	115	107
R-squared	0.038	0.217	0.092	0.271	0.135	0.359	0.004	0.368
Controls	No	Yes	No	Yes	No	Yes	No	Yes
PANEL B: LATE								
<400 meters	-0.592***		-1.149***		-0.851***		0.077	
	(0.196)		(0.246)		(0.167)		(0.093)	
Mean >400 meters	0.988		1.653		0.982		0.171	
Observations	244		244		244		169	
Clusters	Na		Na		Na		115	
F-stat. 1st stage	93.45		93.45		93.45		75.1	

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 4: Treatment effects on disinfection practices

	Disinfection primary water source				Disinfection multiple water sources			
	Dry season		Wet season		Dry season		Wet season	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PANEL A: ITT								
<400 meters	-0.0686	-0.0582	0.0292	0.0352	-0.0929	-0.0802	-0.00971	0.00438
	(0.067)	(0.074)	(0.065)	(0.074)	(0.066)	(0.075)	(0.062)	(0.075)
Mean >400 meters	0.494	0.500	0.371	0.375	0.461	0.462	0.326	0.325
Observations	244	217	244	217	244	217	244	217
R-squared	0.004	0.290	0.001	0.261	0.008	0.290	0.000	0.255
Controls	No	Yes	No	Yes	No	Yes	No	Yes
PANEL B: LATE								
<400 meters	-0.125		0.053		-0.170		-0.018	
	(0.121)		(0.118)		(0.119)		(0.113)	
Mean >400 meters	0.532		0.355		0.512		0.331	
Observations	244		244		244		244	
F-stat. 1st stage	93.45		93.45		93.45		93.45	

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 5: Heterogenous ITT

	E.coli $_{10}logCFU/100mL$			TTC $_{10}logCFU/100mL$			Turbidity $_{10}logNTU/100mL$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
<400 meters	-0.379	0.285	0.267	-0.702*	0.0865	0.0629	-0.651***	-0.233	-0.419
	(0.257)	(0.345)	(0.431)	(0.424)	(0.402)	(0.581)	(0.218)	(0.272)	(0.320)
E.coli$_b$	0.00999		0.0285						
	(0.142)		(0.140)						
<400 meters*E.coli$_b$	0.0375		0.00559						
	(0.165)		(0.164)						
TTC$_b$				-0.00932		0.0143			
				(0.187)		(0.187)			
<400 meters*TTC$_b$				0.0387		0.0104			
				(0.217)		(0.220)			
Turbidity$_b$							-0.117		-0.122
							(0.122)		(0.122)
c*Turbidity$_b$							0.126		0.124
							(0.144)		(0.141)
Improved roof		-0.0166	-0.0232		0.0835	0.0805		-0.0827	-0.0857
		(0.265)	(0.262)		(0.310)	(0.309)		(0.201)	(0.196)
<400 meters*Improved roof		-0.694*	-0.685*		-0.825*	-0.822		-0.268	-0.265
		(0.363)	(0.362)		(0.424)	(0.424)		(0.286)	(0.282)
Mean >400 meters	0.794	0.831	0.797	1.322	1.248	1.225	0.897	0.803	0.986
Observations	244	243	243	244	243	243	244	243	243
R-squared	0.039	0.090	0.090	0.093	0.131	0.131	0.139	0.160	0.165

$_b$ indicates the outcome variable at baseline.
Robust standard errors in parentheses.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Last, a sensitivity analysis is performed on the LATE for varying cut-off distances between 100 and 500 meters. Figures 4 and 5 below show the coefficients of the LATE for the different cut-off scores. The F-statistic of the first stage, percentage of the population assigned to treatment, the take-up rate in the population assigned to treatment and the percentage of compliers[11] are specified for each cut-off distance. The estimated coefficients for drinking water quality are found to be insensitive to varying definitions of the treatment assignment. Similar significant negative estimates for E.coli, TTC, and turbidity as the specification with the 400-meter cut-off distance are shown for varying distances. There are also no clear deviations from the null effect on diarrhea incidence over the different distances. Also for disinfection practices, comparable estimates are observed over the varying cut-off distances. There are no significant effects in the wet season. In the dry season, on the contrary, the treatment effect is consistently negative. Significant effects at the 10% confidence level are present at 100, 150, 200, 300, and 500 meters for disinfection practices when taking into account multiple water source usage. These results support the existence of an intervention-induced substitution effect between source water quality and boiling behavior in the dry season. This effect might be hidden in the specification with the 400-meter cut-off distance due to the low sample power. Small fluctuations in the different estimates can be explained by the variation in the percentage of compliers over the different cut-off distances.

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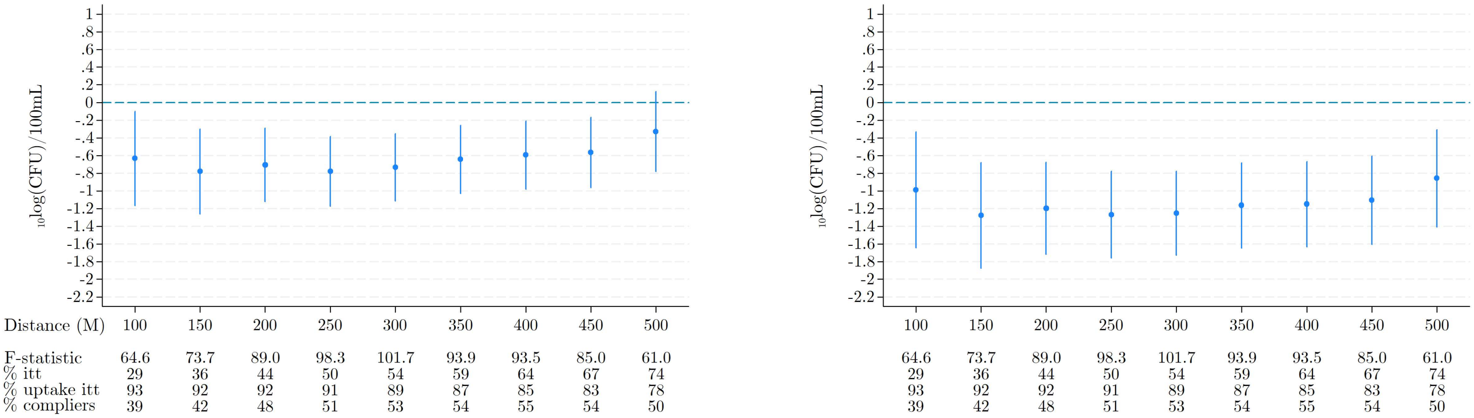
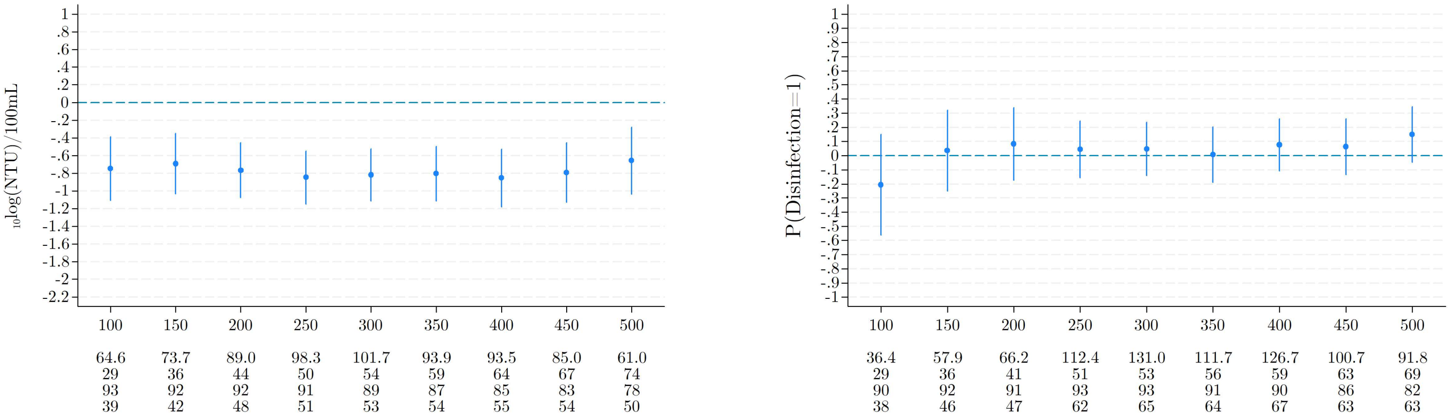
[11] The percentage of compliers is calculated as the difference in tap-using households that are intended to be treated (compliers and always-takers) and the tap-using households that are not intended to be treated (always-takers), under the assumption that there are no defiers.

Figure 4: LATE on water quality and diarrhea incidence for varying cut-off distances

(a) E.coli (b) TTC

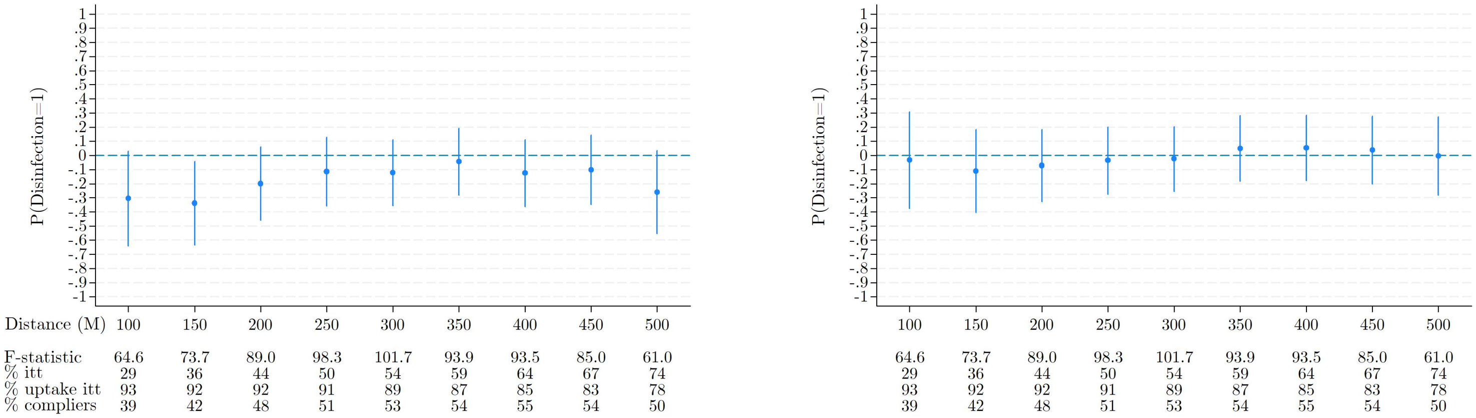


(c) Turbidity (d) Diarrhea incidence



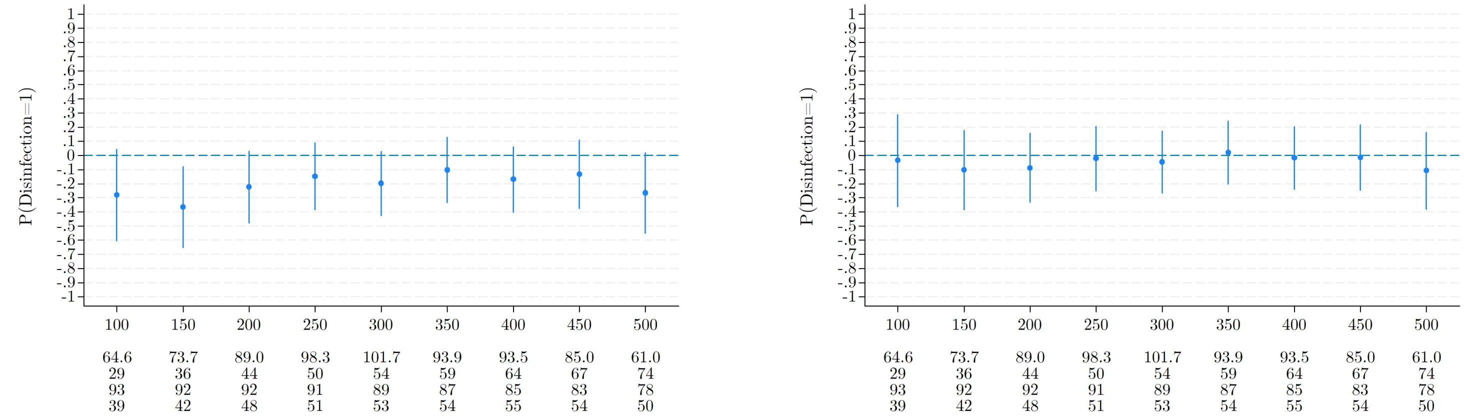
F-statistic: F-statistic of the first stage of the two-staged least-squares. % itt: percentage intended to be treated; those living within the indicated radius to the nearest tap. % uptake in itt: percentage of the intended to be treated that adopted tap water. % compliers: the difference in tap-using households that are intended to be treated (compliers and always-takers) and the tap-using households that are not intended to be treated (always-takers), under the assumption that there are no defiers.

Figure 5: LATE on disinfection practices for varying cut-off distances



(a) Primary source, dry season

(b) Primary source, wet season



(c) Multiple sources, dry season

(d) Multiple sources, wet season

F-statistic: F-statistic of the first stage of the two-staged least-squares. % itt: percentage intended to be treated; those living within the indicated radius to the nearest tap. % uptake in itt: percentage of the intended to be treated that adopted tap water. % compliers: the difference in tap-using households that are intended to be treated (compliers and always-takers) and the tap-using households that are not intended to be treated (always-takers), under the assumption that there are no defiers.

6 Discussion

6.1 Microbiological water quality

In this study, the communal taps were found to reduce bacterial contamination by 53% for E.coli and by 77% for TTC and decrease turbidity by 66% in the drinking water of households in their proximity. The effects are stronger for the compliers to communal tap usage, with reductions of 74% for E.coli, 93% for TTC, and 86% for turbidity. These findings reinforce previous research, such as Kremer et al. (2011), who observed a significant but smaller reduction of 24%-58% in E. coli following spring protection using a randomized controlled trial and a similar instrumental variable approach based on proximity to the protected well[12].

While household drinking water quality improved following the deployment of the communal taps, the geometric means of E.coli and TTC in the household storage containers of the compliers are still slightly higher than at the communal taps. This difference can be explained by WASH behaviors such as non-exclusive improved source usage, unhygienic handling, and household disinfection practices.

6.1.1 Non-exclusive communal tap usage

Following the intervention, 65% of all studied households reported consumption of communal tap water. Notably, 85% of households within 400 meters of a communal tap and 30% of those living further away reported regular usage. However, regular consumption does not equate to exclusive reliance on communal taps for drinking water. Among the 159 households consuming communal tap water regularly, only 7% of those living farther away and 60% of those nearby considered the communal taps as their primary drinking water source during the dry season. These rates declined in the wet season, with no distant households relying primarily on the taps and about 43% of nearby households doing so. Some households used the public taps as a secondary source: 21% of those close and 4% of those farther away in the dry season. During the wet season, the tap served as a secondary source for none of the

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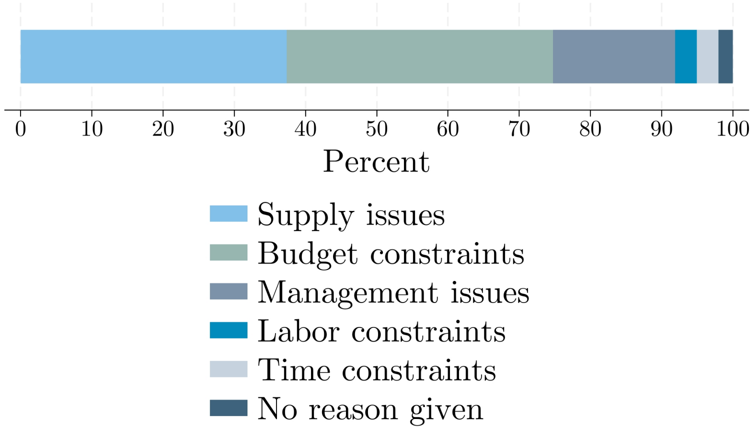
[12] The difference in reduction percentages between both studies can be attributed to differences in water quality between both control groups after the intervention. The control group in this study has noticeably better water quality after the intervention, giving rise to higher reduction percentages in the treatment effect.

distant households and 15% of the nearby ones. This reliance on multiple water sources post-intervention is attributed to various challenges. Despite a desire to access tap water, 66% of households reported occasional inaccessibility, averaging two instances in the last two weeks before the end-line interview and six instances since the taps were deployed. The inaccessibility of tap water arose from several supply and demand-side issues (Figure 6). First, 36% of households experienced interruptions in the water supply due to technical issues. Additionally, 21% encountered locked taps because the responsible household was unavailable during usual operating hours. Last, a small percentage of 2% cited long waiting queues as a limiting factor. On the demand side, financial constraints were significant, with 36% of households citing household budget constraints as a barrier to purchasing tap water, and 2% lacking the labor force for the trip to the tap. Consequently, when communal tap water was inaccessible, households had no alternative but to revert to traditional often contaminated water sources for drinking purposes. Uncontaminated communal tap water and contaminated water from other sources are used complementary or interchangeably and often transported and stored in the same containers, potentially giving rise to contamination.

The contamination from multiple water source usage is assumed rather limited in the studied household water samples since the samples were collected at the beginning of the wet season. In the wet season rainwater harvesting, an improved uncontaminated water source, provides an alternative water source of similar microbiological quality as the communal taps. This study confirms this finding by showing that the presence of an improved roof for efficient rainwater harvesting moderates the impact of the intervention in a beneficial way. In the dry season, however, multiple water source usage is expected to be a greater concern, since rainwater is no longer available to supplement tap water.

Figure 6: Barriers to communal tap usage



6.1.2 Recontamination and disinfection practices

Furthermore, the perception of water safety when using the communal taps, despite potential recontamination due to mixing with contaminated water sources and unhygienic handling during transport and storage, remains a concern. Although disinfection at home remains beneficial in the presence of a safe source to avoid recontamination issues, this research suggests a substitution effect between source water quality and household disinfection practices. In the wet season, disinfection at point-of-use is often substituted by rainwater harvesting, as observed in the baseline data on household disinfection practices. The reported disinfection practices for the wet season are low in both the intervention and control groups, making it impossible to observe a potential intervention-induced substitution effect. A weather-induced substitution effect in the control group might hide an intervention-induced substitution effect in the treatment group in the wet season. However, an intervention-induced substitution effect between source water quality and disinfection at point-of-use is suggested for the dry season. This study identifies a 13 percentage points reduction in reported disinfection of the primary water source after the deployment of communal taps and pumps, closely aligning with Gross et al. (2022), who reported an 11 percentage points reduction in household water treatment following the installation of improved water points. When taking into account the use of multiple water sources, as households might consider the communal taps as a secondary water source, the reduction in disinfection practices even increases to 17 percentage points[13]. On the one hand, this might be due to the perception that the water is instantly safe for consumption, despite the ongoing risk of contamination during transport and storage. On the other hand, financial constraints faced by households could lead to reduced disinfection at home, even when the household is aware of potential recontamination. In the latter case, the household budget is reallocated from the purchase of materials for disinfection, in this experiment mainly wood fuel and charcoal for boiling, to the purchase of drinking water from the communal tap. When financial constraints lead to reduced disinfection, distributing and subsidizing disinfection products should be considered (Luoto, Levine, Albert, & Luby, 2014).

6.2 Diarrhea incidence

The improved drinking water quality at point-of-use in this study did not reduce overall diarrhea incidence in children under five, contrary to Kremer et al. (2011) where diarrhea incidence fell somehow, by 4.5 percentage points. Many other authors also do not detect reductions in childhood diarrhea incidence following water source improvements, as indicated by the systematic reviews of Zwane and Kremer (2007) and Clasen et al. (2015). In this study, the non-effect of the water source intervention on diarrhea incidence can mainly be explained by the relatively well water quality at point-of-use in both comparison groups. Both groups have rather low geometric means of E.coli after the intervention and fall therefore into the small risk category of the WHO. At the same time, diarrhea incidence after the intervention did not decrease in any of the groups compared to the baseline. Some authors therefore stress the need for complementary interventions in sanitation (Esrey, 1996) and hygiene (Wapenaar & Kollamparambil, 2019; Esrey, Potash, Roberts, & Shiff4, 1991) to improve child health, as many pathways of diarrheal disease should be tackled at once.

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[13] However, these effects lack statistical significance due to the limited power caused by the small sample size. The minimal detectable effect size is 19% for both variables for the given sample size. Significant effects, however, are obtained in the sensitivity analysis for varying cut-off distances which suggests the existence of an intervention-induced substitution effect.

7 Conclusion

This study underscores the potential of communal taps as an initial measure toward achieving universal and equitable access to safe and affordable drinking water. The intervention leads to significant improvements in bacterial contamination and turbidity of drinking water quality at home. There is a particularly positive effect on households that complement tap water with rainwater harvesting when tap water is inaccessible. However, the intervention might give rise to a substitution effect where household disinfection practices are substituted for improved water source quality, even though there is an ongoing risk of recontamination due to non-exclusive tap usage and during transport and storage. This is mainly a concern in the dry season since households have no longer access to rainwater harvesting as an improved water source to complement tap water. Data on household water quality in this study is limited to the onset of the wet season, as water samples for the dry season are unavailable. Further research should investigate the mediating role of disinfection practices on drinking water quality at home for dry periods.

This study finds no impact of communal taps on diarrhea incidence in children under five. Diarrhea incidence in children under five is reported twice, before and after the intervention, for two weeks in this study. This limited measurement is insufficient to draw definitive conclusions regarding the intervention's impact on diarrheal disease. Further research, incorporating more frequent and extended measurements, is necessary to provide a robust assessment of the intervention's effects on diarrhea incidence in young children.

Policymakers are encouraged to continue investing in public drinking water infrastructure to enhance access for rural communities in developing countries. Addressing access frictions, however, is crucial for the success of these interventions. Clear communication about water availability and maintenance schedules, accountable management of tap stands, and socially sensitive pricing mechanisms can help ensure more exclusive use of communal taps. Additionally, local transportation solutions, such as bodas in Uganda, could extend the benefits of communal taps to households beyond the immediate proximity, as long walking distances remain a limiting factor. Furthermore, education on recontamination pathways during transport and storage, along with the use of clean containers and proper handling practices, is essential. Encouraging continuous disinfection at home, even when using tap water, is vital to prevent water quality deterioration at home due to recontamination. Interventions that overcome all the stated barriers to consistent tap water adoption and consider the complementary need for water disinfection before consumption are necessary to avoid communal taps remaining just “a drop in the bucket”.

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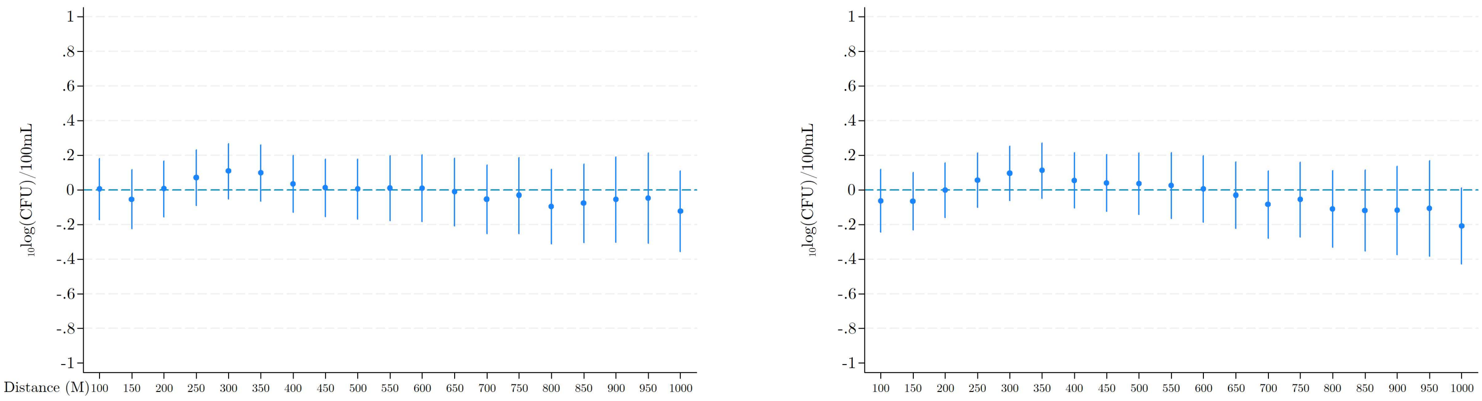
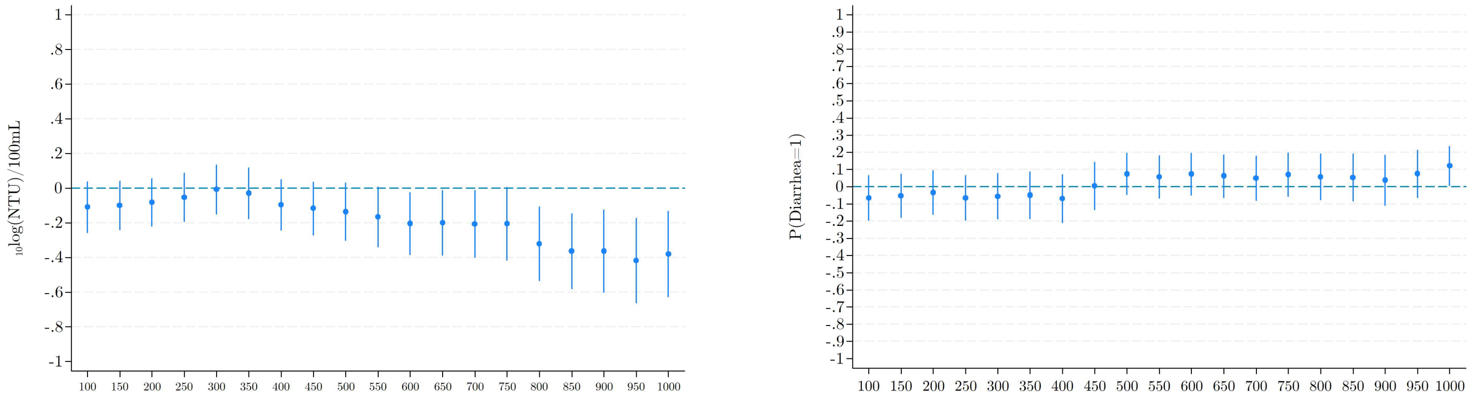
A

Figure A.1: Placebo test on water quality and diarrhea incidence for varying cut-off distances



(a) E.coli

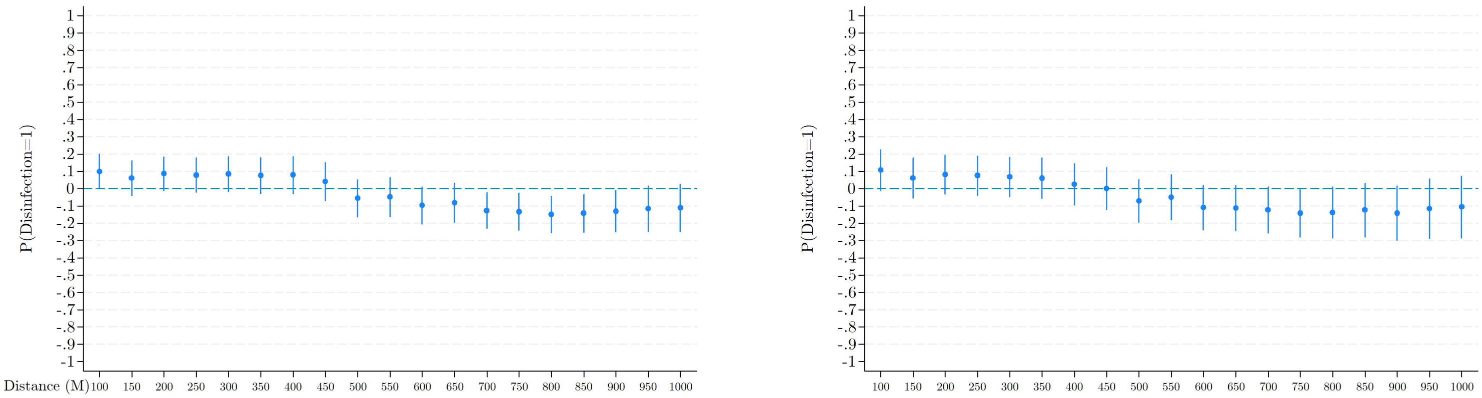
(b) TTC



(c) Turbidity

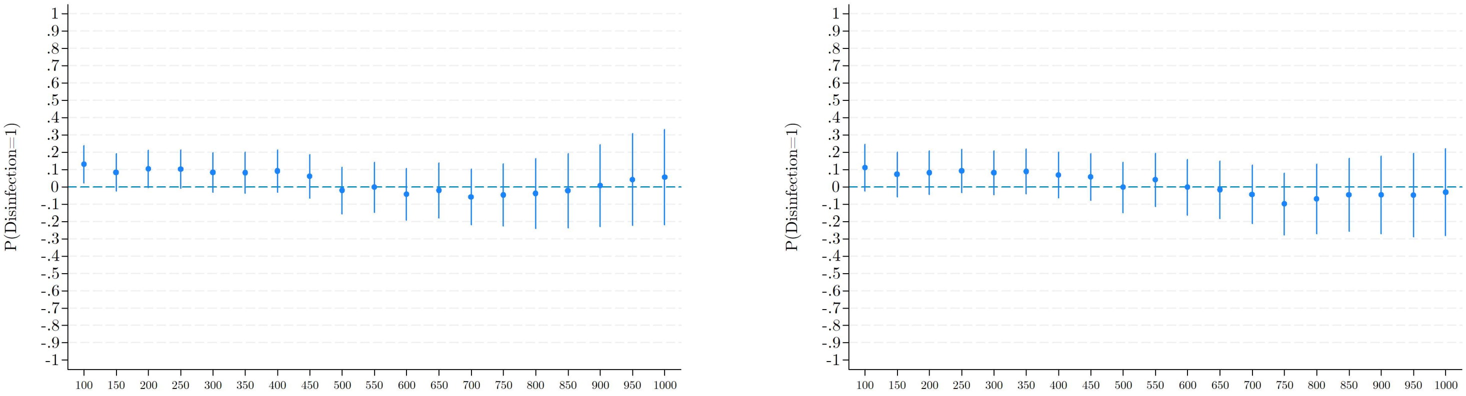
(d) Diarrhea incidence

Figure A.2: Placebo test on disinfection practices for varying cut-off distances



(a) Primary source, dry season

(b) Primary source, wet season



(c) Multiple sources, dry season

(d) Multiple sources, wet season

Table A.1: Placebo test - heterogeneous ITT

OUTCOMES baseline	$_{10}log CFU/100mL$		$_{10}log NTU/100mL$
	E.coli	TTC	Turbidity
	(1)	(2)	(3)
<400 meters	0.316	0.265	-0.0697
	(0.233)	(0.238)	(0.197)
Improved roof	0.233	0.209	-0.0247
	(0.173)	(0.180)	(0.134)
<400 meters*Improved roof	-0.317	-0.235	-0.0297
	(0.250)	(0.253)	(0.213)
Constant	1.196***	1.635***	1.500***
	(0.158)	(0.166)	(0.114)
Observations	243	243	243
R-squared	0.008	0.008	0.008

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

B

Table B.2: Treatment effects on water quality, diarrhea incidence in children under five and disinfection practices

	E.coli $_{10}logCFU/100mL$ (1)	TTC $_{10}logCFU/100mL$ (2)	Turbidity $_{10}logNTU/100mL$ (3)	Diarrhea incidence *Yes/No* (4)
<400 meters	-0.311***	-0.611***	-0.455***	0.063
	(0.103)	(0.121)	(0.0787)	(0.061)
Mean >400 meters	0.804	1.301	0.707	0.184
Observations	263	263	263	181
Clusters	Na	Na	Na	124
R-squared	0.035	0.088	0.133	0.006

	Disinfection primary water source		Disinfection multiple water sources	
	Dry season (5)	Wet season (6)	Dry season (7)	Wet season (8)
<400 meters	-0.104	-0.00621	-0.102	-0.0287
	(0.0638)	(0.0626)	(0.0631)	(0.0598)
Mean >400 meters	0.526	0.392	0.464	0.330
Observations	263	263	263	263
R-squared	0.010	0.000	0.010	0.001

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1