Spring 5-22-2015

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The Impact of Borehole Wells and a Hygiene and Sanitation Program on Diarrhea Evidence from Rural Southwest Uganda

Key Words: Sanitation, Water, Difference-in-Difference
Triple Difference, Fixed Effects

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May 14, 2015

Abstract

Diarrheal disease is the second leading cause of death for children under age five, killing approximately 2,089 children a day (WHO, 2013). Clean water access, sanitation facilities, and good hygiene behavior are solutions to decreasing child mortality and morbidity caused by fecal contamination. I estimate the impact of borehole wells and a hygiene and sanitation program on diarrhea by creating a retrospective panel. I ask mothers to rank children from the most to least diarrhea when under the age of two and use this ranking to compare siblings, where at least one had been exposed to the program. The methodology causes bias in the dependent variable and I therefore do not find a statistically significant impact of borehole wells or the hygiene and sanitation program on diarrhea. I explore the program's ability to change water and sanitation behavior and find the program increases water access and use. However, many households use multiple water sources and do not consistently treat water, which likely diminishes the effect of clean water.

1   Introduction

Universal access to water and sanitation is the "lifeblood to good health" (Chan, 2013). Poor water, sanitation infrastructure, and hygiene behavior causes "profound, debilitating, and dehumanizing misery" (Chan, 2013). Approximately 760,000 children under the age of five die from diarrheal disease every year (WHO, 2014). Even more children suffer from environmental enteropathy, a subclinical disorder caused by digesting fecal bacteria. Environmental enteropathy negatively affects the intestines, reducing nutrient absorption, causing malnutrition, stunting, and cognitive deficits (Humphrey, 2009; Korpe & Petri, 2012). The goal of water, sanitation, and hygiene programs is to break the fecal-oral transmission pathways as seen in Figure 1, which will improve health outcomes for participants.

The Millennium Development Goals aimed to reduce by half the proportion of people without access to sustainable safe drinking water and basic sanitation by 2015 (WHO, 2014). As of 2012, 89% of the global population used an improved water source and 64% of the global population used an improved sanitation facility (WHO, 2014). The gains in improved water access in Uganda and the developing world have been in 'other improved sources,' such as community borehole wells, one of the focuses of this research. Unfortunately, the empirical literature indicates one of the leading problems of community water sources is contamination between the source and use.

The second focus of this research is a hygiene and sanitation program using Community Led Total Sanitation (CLTS) and Participatory Hygiene and Sanitation Transformation (PHAST). These programs mobilize communities to eliminate open defecation and improve hygiene behaviors. The empirical literature indicates that these programs have the potential to break the fecal-oral transmission pathways and improve health outcomes; but behavioral change is slow and costly to the participant (Patil et al., 2014; Tyndale-Biscoe et al., 2013; Spears, 2012).

Water, sanitation, and hygiene programs vary in implementation and are conducted in heterogeneous social systems that influence adoption and sustainability in different ways. This paper looks at the impact of programs designed by Living Water International-Uganda (LWIU) in rural Uganda, with three contributions to the literature on water access, hygiene, and sanitation. First, I use a methodology where I create a retrospective health panel from a single survey. I ask mothers to rank children from having the most to least diarrhea when under the age of two. This allows me to compare siblings who were born before and after the program in treated and untreated households. I am the first, to my knowledge, to use such an approach in this body of literature.

Second, I estimate the effect of borehole wells on diarrhea for children under the age of two. I use a difference-in-difference estimation with a household fixed effect to compare siblings in a household born before and after a well was installed in the village, in households within 500 meters of a well to households farther than 500 meters. Third, I evaluate a hygiene and sanitation program that borrows from PHAST and CLTS using a triple difference estimation with a household fixed effect. I compare siblings in a household born before and after the program, in households within 500 meters of a well to those farther than 500 meters, in villages that received the program to villages that did not.

I do not find a statistically significant impact for either borehole wells or the hygiene and sanitation program. I test the reliability of my methodology by resurveying 27 households

and find that mothers did not consistently rank children across both surveys. The likely explanation is salience bias. I find a strong significant correlation between the child in the household under the age of two having diarrhea at the time of the survey and mother's reporting that child having the most diarrhea when under the age of two as compared to their siblings. In light of these findings, I explore if and how households use the well and if households build latrines. I find that LWIU's change in program design increases water access and well use. However, most households use more than one water source, which increases the probability that clean water is contaminated. I also find that the hygiene and sanitation program did not increase latrine ownership, which can potentially be attributed to villages being statistically poorer than control villages, or a bias results because it is possible that the parallel trends assumption does not hold.

The remainder of this paper is organized as follows: Section 2 presents the programs implemented by LWIU. Section 3 reviews the literature on the effectiveness of the programs used by LWIU. Section 4 describes the empirical strategy and empirical specification in 4.5. Section 5 reviews the findings. Section 6 discusses the limitations of the study and Section 7 concludes with recommendations.

2 Empirical Context

In response to the problem of poor water, sanitation, and hygiene, the first lady of Uganda, Janet Museveni, asked LWIU to focus on Ruhaama County in the Ntungamo District in southwest Uganda. In 2010 LWIU installed 46 borehole wells at or near local schools in Ruhaama County, and in 2011, LWIU installed 48 borehole wells at or near local schools in Ruhaama County. The program also included a hygiene promotion program in each school, where six teachers and six community leaders were trained on hand washing, disease transmission and blocking, teeth cleaning practices, safe water practices, nutrition, and diarrhea prevention.

LWIU reported that the communities around the schools excessively used the wells, which caused frequent breakdowns and disrupted classes. This fact, along with a new strategic plan outlined by CEO Mike Mantel, led LWIU to a new program approach. In January 2012 LWIU implemented a comprehensive approach that went beyond water access and hygiene training at schools, to providing full water, sanitation, and hygiene programs (WaSH) in strategic concentrated geographical areas known as WaSH Program Areas (WPAs) in Ruhaama County. The first program goal was to increase water access. LWIU defined 'access' as living within 500 meters of a well. LWIU installed a well in each village, even if the village received a 2010 or 2011 well.

Second, LWIU followed CLTS and PHAST to mobilize villages to become open defecation free; build latrines, hand washing stations, dish drying racks, and; to adopt improved hygiene behaviors such as boiling or treating drinking water, using a clean transport container, and washing hands with soap. This was accomplished through a 'triggering' event in each village. The event used a series of demonstrations, such as mapping where village members defecate; calculating the amount of feces produced by the village each year; and calculating the financial burden to sanitation related diseases. The goal was to stimulate a collective sense of shame and disgust and for village members to create a plan to improve hygiene and

sanitation conditions. LWIU hygiene officers led the triggering events and trained volunteers to assist in community action and education. In most villages, volunteers were assigned 15-20 households to encourage and education on changing sanitation and hygiene behaviors. The goal of the program was to address each fecal-oral pathway in Figure 1.

Third, LWIU developed a program to train and support the Water User Committee (WUC) for each well. WUCs are responsible for the sustainability of the well by creating rules related to the use of the well and setting and collecting fees for maintenance and repairs. The goal was to help reduce well damage and decrease repair time. Fourth, LWIU developed a Christian witness program, utilizing pastors and church leaders, with a goal of triggering spiritually healthy community-led sustainable development.

Twenty-one villages were clustered into 5 WPAs in two concentrated areas of Ruhaama County. Half the villages received a borehole well at or near their local school in 2010 or 2011. Twenty borehole wells were installed across WaSH villages, either at a local school or near the village center. Villages selected into WPAs demonstrated a capacity and willingness to manage additional water points and use CLTS and PHAST.

3 Literature Review

How effective are wells and hygiene and sanitation programs at reducing diarrhea? The literature indicates that any intervention that breaks the fecal-oral transmission pathways has potential to reduce diarrhea. However, effects diminish with problems of contamination, compliance, or after pathogens ingested is below a certain threshold. Table 1 outlines the literature on the impact of water, hygiene, and sanitation programs on child diarrhea and height for age.

3.1 Point-of-Source Interventions

The primary focus of LWIU's 2010-2011 program was providing community wells at local schools, which protects ground water from contamination. Wells and other point-of-source interventions are often the only clean water solution in rural areas where there is no infrastructure for piped water. Unfortunately, the literature indicates that while these sources provide cleaner water than an unimproved source, such as rivers, ponds, unprotected dug wells and unprotected springs, the water is liable to be contaminated between the source and use.

A randomized controlled trial of spring projection reduced E. coli by 66% at the water source but only 24% in home (Kremer et al., 2011). In a program in rural Benin, 30% to 40% of water storage containers used at a clean water source were contaminated with E. coli (Ruben & Zintl, 2011). Contamination of clean water occurs when households use the same transport and storage container for clean and unclean water sources; during collection or transport due to water handling; or by unsafe practices in the home, such as dipping cups or bowls in the storage container to access water instead of pouring (Kremer et al., 2011; Ruben & Zintl, 2011). Contamination between source and use diminishes the expected positive effect of point of source interventions.

3.2 Point-of-Use Interventions

Water treatment technologies at point-of-use, such as improved transportation and storage containers and in home treatment methods, such as boiling or using bleach, are designed to address the contamination problem between source and home use. When used correctly, improved transport and storage containers keep clean water clean and in home treatments improve water quality. LWIU does not provide new transport or storage containers, but trains volunteers on the importance of using clean containers and treating the water in the home. The literature indicates that compliance and long-term use is the primary concern for sustainability.

3.3 Sanitation Programs

Community Led Total Sanitation, the primary component to LWIU's hygiene and sanitation program, aims to eliminate open defecation, increase latrine use, and promote safe waste disposal to break the fecal-oral transmission pathway. CLTS invests in community mobilization instead of hardware to trigger the village's desire for collective change. The underlining motivation for behavior change is shame, disgust, and social pressure. Studies in India and Indonesia found that CLTS had a small effect on improving latrine coverage and decreasing open defecation in treatment villages (Patil et al., 2014; Cameron et al., 2013; Hammer & Spears, 2013). However, in areas with high compliance, population density, or open defecation, CLTS increased child height-for-age (Kov et al. 2013; Spears 2013).

3.4 Hygiene Programs

The second component to LWIU's hygiene and sanitation program, Participatory Hygiene and Sanitation Transformation (PHAST), mobilizes communities for collective behavior change. Gungoren et al. (2007) found after one year of PHAST in rural Uzbekistan, the children had a 30% lower relative risk of intestinal parasites. The researchers believe that the effect size may be larger given more time between the start of PHAST and final survey. A major challenge to the program was changing beliefs about parasitic impact on health, which indicate the results depend on social context.

3.5 Are Water, Hygiene, and Sanitation Programs Substitutes or Complements?

Are the treatments discussed above substitutes or complements? It is difficult to disentangle the impacts of multiple interventions and compare outcomes across different contexts. Randomized controlled trials find that single and combined interventions have similar results (Esrey, 1996; Fetwrell et al., 2005; Waddington et al., 2009). However, improved sanitation appears to have a larger effect on reducing diarrhea than improved water programs, likely due to the problem of contamination as mentioned above.

A large comprehensive study of more than 70 developing countries from 1989 to 2008 found that on average, advanced water technologies reduce diarrhea for children under five by 7.3%, and sanitation technologies reduce diarrhea by 12.9% (Gunther & Fink, 2010).

Similarly, in a multi-country analysis with data from the late 1980s, Esrey (1996) found that marginal improvements in sanitation resulted in less diarrhea than marginal improvements in water.

Luby et al. (2006) used a randomized controlled trial to address the impact of multiple treatment arms in Karachi, Pakistan, a squatter settlement where diarrhea was the leading cause of child death. Treatment arms included: (1) bleach water treatment and improved water containers, (2) soap and hand washing education, (3) flocculant-disinfectant and improved water containers, (4) flocculant-disinfectant, soap, and hand washing education. Households who received any form of treatment had less diarrhea compared to control. Luby et al. (2006) concludes that any substantial reduction in fecal contamination in locations where 65-75% of diarrhea is caused by pathogens will reduce diarrhea. However, once the amount of pathogens ingested is below a certain threshold, interventions may not lead to large reductions in diarrhea.

4   Empirical Strategy

Do LWIU's programs change behavior and decrease diarrhea? I develop an empirical strategy to measure the effect of LWIU's program on diarrhea, taking advantage of the program change between 2011 and 2012, exploiting household's distance to the well, and comparing siblings within a household. LWIU's programs can be understood as generating exogenous variation in diarrhea for children exposed to the well or hygiene and sanitation program during the first 24 months of life.

4.1   Village Selection

I surveyed 48 villages in Ruhaama County. All 21 villages in WPAs were surveyed and 27 villages that received a well in 2010 or 2011 but not the hygiene and sanitation program in 2012 were randomly selected using Excel random number generator. All villages have similar characteristics and are subject to the same weather, political or economic shocks. The Ntungamo district director of Water and Environment reported that since LWIU started working in Ruhaama County, the government ceased water projects in the county. In other words, there were no other water interventions that would have changed a village's potential outcome trajectory.

4.2   Household Selection

I utilized the Village Health Team (VHT) in each village to obtain a list of mothers. VHT's are community members recruited and trained by the government of Uganda to keep records of disease, births, deaths, immunizations, and hygiene and sanitation behavior for all pregnant women and children under age five. VHTs were asked to compile a list of all mothers who had given birth in the last two years and to indicate if the mother had given birth previously.

Fifteen to eighteen mothers from each village were randomly selected from the list provided by the VHT to be surveyed. If the list was obtained before surveying, Excel random

number generator was used to select mothers. If the list was obtained in the field, enumerators were trained to use MTN airtime codes as a random number generator.

Only mothers who met the eligibility requirement of giving birth at least once in the last two years and once prior were surveyed. On average, 4 selected mothers in a village were not eligible to be surveyed, often because their youngest child was slightly older than two or they had only given birth to one child. In non-WaSH villages, 235 mothers were surveyed and in WaSH villages, 219 mothers were surveyed, with a response rate of 91%.

4.3   The Survey Instrument

Data was collected from June 17, 2014 to August 6, 2014. The survey was conducted on tablets and lasted approximately 40 minutes. Mothers were asked about water sources, hygiene and sanitation behavior, individual child characteristics, and household income. GPS coordinates were obtained at the household, each water source used by the household, and the local LWIU borehole well. This allowed me to accurately calculate the household's distance to all water sources to compare households within 500 meters of the well to those farther than 500 meters. Table 2 displays summary statistics of household characteristics by non-WaSH and WaSH-villages and by households who live near and far from the well. An outline of the survey can be found in Section 9

4.4   Panel Construction

For the main analyses I used one survey question to create a panel of diarrhea for children when under the age of two. The survey asked the following: Think about when all of your children were under the age of two. Who had the most diarrhea? Who had the next most diarrhea? The question was repeated until all children were ranked from having the most to least diarrhea.

To create the outcome variable, children reported having the most diarrhea when under the age of two are assigned 1. The remaining children are assigned a zero. This method allows me to estimate the probability of being the child with the most diarrhea when under the age of two. Section 6 discusses the advantages and limitations of this methodology.

4.5   Empirical Specification For Borehole Wells

To estimate the impact of LWIU's wells on diarrhea, I begin with a difference-in-difference specification with a household fixed effect to compares change in diarrhea in a household, between children born before and after a well was installed, in households that live within 500 meters of a well to those farther away. The intuition driving the empirical strategy is the intended treated group, households who live within 500 meters of a well, have a noticeable reduction in diarrhea. The outcome variable is a binary variable equal to one if child i had the most diarrhea when under two. I run the following regression

$$Diarrhea_{it} = \alpha \ + \ \beta_1(Well_t \times PostChild_i) \ + \ \beta_2(PostChild_i) \ + \ \pi_h \ + \ \epsilon_{it} \qquad (1)$$

where *PostChild* is an indicator variable taking the value of one if child i was born in 2010 or later; *Well* is an indicator variable taking the value of one if the household lives within 500 meters of a 2010 or 2011 borehole well; π_h is a household fixed effect that controls household's unobserved time-invariant characteristics that may influence the dependent variable; and ϵ_{it} is a child-specific error term that satisfies $E(\epsilon_{it}|\mathbf{X}) = 0$. I cluster standard errors at the household level because outcomes are likely to be correlated across siblings within the household.

In addition to the primary definition of *Well*, I use an alternative *Well* variable that is distance to the well in 1 and 20 meter increments, for households up to 1500 meters of the well. This alternative definition addresses concerns with households who live farther than 500 meters using the well.

To capture only the effect of wells, I drop all children treated with the hygiene and sanitation programs, which are children born after 2012 in 21 WaSH villages. I reorder the birth order and ranking question to correctly reflect the panel as if the survey was conducted before those children were born.

I run the model with and without the following controls which are unique to each child: age of child at time of survey, age-squared, gender, birth order, an indicator variable if the child was born outside the village, and an index representing individual child health using the methods outlined by Anderson (2008). The child index was created based on vaccines, where 88.5% of the children had health cards with vaccine records; used oral rehydration salts and zinc during infancy, which reduces the risk of diarrhea; and if the child was delivered at home, in a health center, or hospital. Breastfeeding also reduces the risk of diarrhea, however all mother's reported breastfeeding, therefore it not used in the index.

The coefficient of interest β_1 is the intention to treat (ITT), measuring the effect of the borehole wells irrespective of usage and compliance. I expect $\beta_1 < 0$, indicating that borehole wells decrease the probability of a child having the most diarrhea within a household. The results can be found in Table 3.

4.6 Empirical Specification for the Hygiene and Sanitation Program

To estimate the impact of the hygiene and sanitation program, I use a triple difference specification with a household fixed effect, where the three differences are households that live near and far from the well, in WaSH villages that received the hygiene and sanitation programs and villages that did not, and siblings born before and after 2012 when the hygiene and sanitation programs started. The outcome variable is a binary variable equal to one if child i had the most diarrhea when under two. I run the following regression

$$
\begin{aligned}
Diarrhea_{itv} = {} & \alpha \ + \ \beta_1(Well_t \times PostChild_i \times WaSH_v) \ + \ \beta_2(Well_t \times PostChild_i) \\
& + \ \beta_3(WaSH_v \times PostChild_i) \ + \ \beta_4(PostChild_i) \ + \ \pi_h \ + \ \epsilon_{it}
\end{aligned} \tag{2}
$$

where *WaSH* is an indicator variable receiving a one if child i lives in a WaSH village that received hygiene and sanitation programs. *PostChild* is an indicator variable if child i was born in 2012 or later. *Well* is an indicator variable if the household is within 500 meters

of any borehole well. π_h is a household fixed effect that controls for household's unobserved time-invariant characteristics that may influence the dependent variable. ϵ_{it} is a child-specific error term that satisfies $E(\epsilon_{it}|\mathbf{X}) = 0$. I cluster standard errors at the household level, since outcomes are likely to be correlated at the household level.

The coefficient of interest β_1 captures the change in diarrhea for children who live within 500 meters of the borehole well in WaSH villages after the 2012 programs relative to the change in diarrhea for children who live within 500 meters of a borehole well in non-WaSH villages after 2012. Using a household fixed effect, β_1 is identified through changes within the households in diarrhea in households within 500 meters of a borehole well in WaSH villages before and after the 2012 programs. Like (1), β_1 estimates the ITT. I expect $\beta_1<0$, indicating that the additional programs in WaSH decrease the probability of being the child with the most diarrhea within a household.

As in (1) I also use *Well* as continuous measure of distance to the borehole well in meters. I run this model with and without the same controls as used in (1). The results can be found in Table 4.

The identifying assumption is that the outcomes for households who live far from the well are parallel to what would have happened for those who live near the well if the well was not installed in the village. In assessing the validity of this identification strategy, one concern is that households move to be close to either the well or the school. I find a statistical difference in tenure between households who live within 500 meters of a well and those who live far. However, the mean tenure in households close to the well is 6.8 years and 8 years for those who live far, which is a long tenure compared to the program. Anecdotal evidence from the field suggests households move after acquiring new land or to set up a small shop. Regardless, I address this concern with a control for children born outside of the village. This addresses the concern about the type of water source the child was exposed to, since the survey only asked about water sources used in the past five years.

A limitation of this empirical strategy is that I do not have reliably data on when a well broke down and for how long it was not functioning. At the time of the survey, 5 wells were not functioning and several were not used for drinking water. Due to this issue, it is possible that children in the sample are indicated as treated, when they did not have a functioning well. This would bias the results upward, underestimating the effect of wells.

5   Results

5.1   Borehole Wells on Diarrhea

Table 3 displays the results for the impact of wells on diarrhea. The estimates in Table 3, columns (1) and (2) suggest wells decrease diarrhea by 0.066 and 0.057 percentage points over a baseline mean of 0.272 and 0.243. I fail to reject the null hypothesis $H_0: \beta_1 = 0$ against the two-sided alternative $H_1: \beta_1 \neq 0$ at the 10% significance level. The one-sided p-value = 0.408 and indicates that if the null hypothesis is true, I would observe an absolute value of the t-statistic as large as -0.83 about 40 percent of the time ($t_{\beta_1} = -0.83$).

Borehole wells were installed at different times, treating children across three to four years, compared to children up to age 20. A potential concern is unobservable shocks, such

as drought, typhoid, or government programs, may affect outcome within each year. To test this I run the specification (1) with a birth year fixed effect to control for unobservable heterogeneity across each year. The results in Table 3 columns (3) and (4) suggest that the wells decrease diarrhea by 0.054 and 0.046 percentage points over a baseline mean of 0.0182 and -0.166. The birth year fixed effect does not increase precision and I fail to reject the null hypothesis against the two-sided alternative (p-value = 0.49).

Column (5) and (8) of Table 3 display the results using *Well* as a continuous measure of distance, where (5) and (6) are in one meter increments and (7) and (8) in 20 meter increments. The interaction in (7) and (8) indicate that diarrhea increases by 0.0168 and 0.0138 percentage points over a baseline mean of 0.298 and 0.631. I fail to reject the null hypothesis H_0: $\beta_1 = 0$ against the two-sided alternative H_1: $\beta_1 \neq 0$ at the 10% significance level ($t_{\beta_1} = 1.584$).

There are several potential explanations for the results. Kremer et al. (2011) find that spring protection reduces diarrhea incidences for children under age three by 4.7 percentage points over a baseline mean of 0.39, where the outcome variable is an indicator for diarrhea in the past week. While I find similar effect size in (1) and (2) of Table 3, the differences in sample size may be one explanation for my lack of precision. In Kremer et al. (2011), 183 springs were randomly selected to be protected over four years, surveying with 7-8 households who use the spring. This is not only a significantly larger sample size than this study, but also only included a random sample of households who used the spring as the ITT, where my sample included households near or far from the well regardless of well use[1].

One concern of point-of-source interventions is that clean water is contaminated between the source and home because of water handling practices or using the same transport or storage containers for clean and unclean sources. The survey did not ask if different transport or storage containers were used for different water sources. However, evidence from the field suggests that contamination is a potential problem. 47% of households who live near a borehole well reported using two or more water sources. For households who currently used the well at the time of the survey, only 14% of the households reported treating water all of the time, where boiling was the most common method. 19% reported treating water most of the time, 41% some of the time, and 26% hardly ever. Additionally, children were responsible for fetching water in most households, which potentially raises the risk of contamination through unsafe water handling practices.

Another explanation for the results could be due to households not using the water source. In the sample, 42 households once used a well, but no longer do, because the well broke down (35 households) or because the water tasted or looked bad (7 households). In some locations, households do not use the well for drinking or cooking due to water quality. Figure 2 is a picture taken a few hours after water was collected from one of the wells. In several locations, water turns a rust color within 30 minutes to an hour after pumped from the well. The Ministry of Water and Environment reported that areas of Ruhaama county's ground water has iron, sulphate, total dissolved solids, or is hard. The water is safe to drink, but these issues affect the taste and look of the water and can discolor food and dishes. LWIU Monitoring and Evaluation Officers noted this as one of their challenges in a 2013 report (Owani & Abdulla, 2013, p. 6).

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[1]The reason well use was not a criteria for survey selection is because well use is likely endogenous.

5.2 Hygiene and Sanitation Program on Diarrhea

Table 4 displays the results of the triple difference specification, which estimates the effect of the hygiene and sanitation program on diarrhea. Columns (1) and (2) suggest that wells increase diarrhea by 0.0519 and 0.009 percentage points over a baseline mean of 0.239 and 0.185. I fail to reject the null hypothesis that the coefficients are statistically different from zero. The large difference between coefficients with and without controls, the large standard errors, and the direction of the coefficients indicate a problem with the model or the data. From the literature, I expected to find either similar effects between the estimation on borehole wells and the hygiene and sanitation program, or for the hygiene and sanitation program to have a larger impact on diarrhea. Adding birth year fixed effect to specification (2) in columns (3) and (4) of Table 4 slightly decreases the coefficients and increases the standard errors.

Columns (5) and (8) of Table 4 display the results using *Well* as a continuous measure of distance with columns (5) and (6) in one meter increments and (7) and (8) in 20 meter increments. In all four estimates, the coefficients is negative, which is not the expected direction. I fail to reject the null hypothesis the coefficient is statistically different from zero.

What could be driving the results? In Section 6, I show the outcome variable is biased, which explains the positive, statistically insignificant coefficients in Table 4. In light of this bias, I explore the mechanisms by which the program works to reduce diarrhea.

One of the primary goals of the hygiene and sanitation program was to end open defecation and increase latrine ownership. I estimate the change in latrine ownership in households in WaSH and non-WaSH villages, before and after the hygiene and sanitation programs. I define latrine ownership has owning a pit latrine, pit latrine with slab, or ventilated pit latrine. I regress a binary variable for latrine in household i in village v at time t

$$Latrine_{it} = \alpha + \beta_1(WasH_t \times Post_i) + \beta_2(Post_i) + \pi_v + \epsilon_{it} \qquad (3)$$

Where *WaSH* is an indicator for household i living in a WaSH village, *Post* is an indicator for post 2012, and ϵ_{it} is a household-specific error term that satisfies $E(\epsilon_{it}|\mathbf{X}) = 0$. I use a village fixed effect to control for unobserved time invariant characteristics in the village since the effectiveness of the program is a function of village leadership and volunteers. I run the regression with and without a set of household controls: a wealth index, hygiene index, tenure, the mother's highest level of education, and income type. I cluster standard errors at the village level since outcomes are likely correlated at the village level.

I expected $\beta_1 > 0$, indicating the hygiene and sanitation program increases latrine adoption. As reported in Table 5 the coefficient on improved latrine is -0.0197 and -0.0230 percentage points over a baseline mean of 0.418 and 0.383, indicating that the program decreased latrine ownership, which is not the sign expected. I fail to reject the null hypothesis H_0: $\beta_1 = 0$ against the two-sided alternative H_1: $\beta_1 \neq 0$ at the 10% significance level.

There are five possible explanations results for the of the hygiene and sanitation program on latrine adoption, which may explain the null results in the triple difference. First, a t-test shows that Non-WaSH villages have statistically significant higher mean wealth index score than WaSH villages. The difference in means for the hygiene index score between Non-WaSH and WaSH villages is not statistically different, which is not what I expected. The differences in wealth may explain the similarities in hygiene. Tyndale-Biscoe (2013) found

the cost to build and maintain a latrine was the main reason why households in villages that had CLTS and had been declared open defecation free never built or no longer had a latrine. Financial constraints could explain the difference in latrine ownership, as well as the number of households who have hand washing stations, 10% in non-WaSH villages compared to 3% in WaSH villages, and soap, 27% in non-WaSH villages and 16% in WaSH villages.

Second, the LWIU Monitoring and Evaluation Officer stated in a midterm report on the WaSH Program Areas: "some challenges recognized mid-way through the initial two year pilot program cycle has been the impact of staff turnover, the transition from LWI Uganda being the maintenance service provider for each WPA community to the CBOs contracting local private sector service providers and perceived poor quality of water in specific WPA communities" (Owani & Abdulla, 2013, p. 6). These challenges may have impacted the effectiveness of the program, resulting in little or no changes in behavior. This could also explain why none of the WaSH villages have been declared 'open defecation free.' [2]

Third, it is possible that not enough time has passed to see program results. Patil et al (2014) conducted a follow up survey 21 months after CLTS was launched. The researchers believe that this was not enough time and was the reason why they did not find an increase in latrine ownership. I do not have dates on when WaSH villages were 'triggered', and therefore it is plausible that two years or less had passed between the time of triggering and the survey. Given the financial constraints, it may take a household a significant amount of time to save for the materials to build or improve a latrine.

Fourth, the survey did not ask about the prior latrine, only about the current latrine. I assume that the household moved from no latrine or open pit to a pit latrine, pit latrine with slab, or ventilated pit latrine. I indicate an open pit as a zero in the analysis, even if the household recently dug an open pit. However, moving from no latrine to an open pit may indicate the success of CLTS. Every household reported having at least one of the four types of latrine, where 24% of households in non-WaSH villages had an open pit and 25% in WaSH villages had an open pit. The fact that all households have some kind of latrine could be a positive indicator for the program, however, owning a latrine does not guarantee latrine use.

Last, it is difficult to estimate the impact of the basic hygiene program associated with the 2010-2011 borehole wells. LWIU does not have a record of how teachers and village leaders used the information from the basic training. This leads to concerns about the identifying assumption of parallel trends. It could be possible that after receiving a 2010 or 2011 well, the school teachers and village leaders started training and educating households on hygiene and sanitation. If true, this would change the outcome trajectory for these villages compared to those that did not receive a 2010-2011 well, which is half of the WaSH villages. This may explain why I find that non-WaSH villages have a faster rate of latrine adoption than WaSH villages, which explains why β_1 in (3) is negative. On the other hand, the villages that did not receive a 2010 or 2011 well are neighboring those that did. If the 2010 and 2011 program had an impact on hygiene and sanitation, it would have likely effected these villages as well. Without data on baseline sanitation and hygiene behavior, it is impossible to make a clear

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[2]The 'open defecation free' status indicates that a village has passed a variety of hygiene and sanitation checks by LWIU and government officials. This is done by randomly selecting households in the village and checking for hand-washing stations, drying racks, the presence of soap or ash, a latrine, and for the presence of human feces.

argument. Therefore I believe the estimations on latrine adoption should be taken lightly.

I do find that WaSH is successful at increasing the number of households who have access and use a well. Of the 137 households who live near a well in WaSH villages, 95 reported currently using a well as one of their drinking water sources, where 86 of the 95 use the well as their only source of drinking water. 32 households farther than 500 meters in WaSH villages use the well for drinking, traveling an average of 636 meters. Only 12 of the 91 households near a well in non-WaSH villages report using it for drinking, and 7 households who live farther than 500 meters report using the well for drinking.

While a large number of households are using the well as their drinking water source, 66% of the household in WaSH village villages who live near the well use two or three other water sources. The water from these sources are used for bathing, cleaning, and washing clothes. As stated earlier, the concern is that households do not use separate transport containers for each water source, contaminating clean water.

6   Limitations

I present a methodology creating a retrospective panel based on one survey. In using this methodology, I assumed mothers could identify which child had the most or least diarrhea when under the age of two, which child was the healthiest and sickest, and mothers could recall the year a child died. Only the data related to the child with the most diarrhea was used in the analysis, for reasons explained below.

There are several advantages to this methodology. The practical advantage is that it allowed me to obtain pretreatment and post-treatment data for all villages in the sample, which was a time and cost saving advantage. Specifically to this study, this methodology potentially addresses the challenges measuring health related outcomes for water and sanitation interventions. Individuals suffering from environmental enteropathy, caused by poor water, hygiene and sanitation, may not experience excessive diarrhea, and therefore it is possible for programs to show no impact on diarrhea while improving health by reducing fecal exposure (Korpe & Petri, 2012). Lin et al. (2013) show a joint association between poor water, hygiene, and sanitation, and markers of environmental enteropathy by analyzing stool samples and stunting. Under budget constraints, the health ranking question may capture overall health improvements caused by water, hygiene, and sanitation programs.

I found several limitations of this method, including a bias in the dependent variable. Mothers had a difficult time answering all questions. Out of the 39 reported deaths in the sample, death dates were reported for only 3 children, and only 7 had health cards reporting birth date and immunizations. This made it impossible to study the program's impact on infant morality.

I also found that mothers had a difficult time ranking children. Evidence from the field suggests that it was easier to rank the extreme, such as the child with the most diarrhea, but became more difficult to rank the children in the middle, especially as the number of children increased. To test the reliability of this method, I resurveyed 27 households across 7 villages, asking only the ranking questions. I matched the first survey with the second survey to test if the mother gave consistent answers across surveys. On average, the second survey was conducted 27 days after the first survey. Ten households were in non-WaSH villages and

17 were in WaSH villages. The results are displayed in Figure 3. I found that mothers were most consistent on ranking children with the most diarrhea, where 67% of mothers ranked the same child as having the most diarrhea on both surveys. Less than half to a third of mothers ranked the same child as the child with either the least diarrhea, healthiest, and sickest. This is the primary reason I used most diarrhea as the outcome variable of choice.

One might believe mothers could only recall severe cases of diarrhea? Das et al. (2012) find weekly and monthly recall periods on reported health give very different results, using both experimental and observational data in Delhi, India. Both rich and poor people under report information related to acute health in monthly recall surveys, but the poor have a higher rate of under reporting compared to the rich, where "monthly reporting 'erases' almost half the morbidity burden of acute illnesses, over a third of doctor visits for both acute and chronic illnesses, and almost half of all self-medicated episodes" (Das et al, 2012, p 77). In the experimental data, the authors find that "forgetting" acute health-related doctors visits and sick days is higher among those with larger health burdens. They conclude that illness among the poor is part of every day life, which explains why doctors' visits and sick days for acute diseases are easily forgettable and under reported in monthly recall surveys. This could explain why mothers could not rank children and recall death dates. The change in diarrhea or health would have had to be dramatic between children for it to be memorable to the mother.

For children under two, I compare diarrhea rank to reported instances of diarrhea and find a strong significant correlation between a child having diarrhea at the time of the survey and being ranked as the child with the most diarrhea (Table 6). This indicates salience bias. If the child in the household under two was experiencing diarrhea, the mother was more likely to assign that child as having the most diarrhea as compared to the older siblings. I look at this correlation across the entire sample and by WaSH and non-WaSH villages and households near and far from the well. Few children in the sample had more than 3 days of diarrhea, which explains why the correlation between three days and most diarrhea is only significant in households far from the well in non-WaSH villages, and why the correlation becomes negative in WaSH villages.

The correlation between 3 day diarrhea for children under two and the dependent variable explains the positive coefficients in Table 4 for specification (2). Every household had a child under two, where 26% had diarrhea at the time of the survey, 31% were ranked having the most diarrhea, and 14% had diarrhea and were ranked the child with the most diarrhea. In specification (1) I drop all children under two in WaSH villages to capture only the effect of the 2010-2011 wells, which reduced the bias by dropping 221 children. In these households, I reorder the diarrhea ranking, assigning the child ranked second most diarrhea as the child with the most diarrhea. In order to trust the results found in Table 3, one would have to believe mothers could accurately the children between most to least diarrhea, which I found to be untrue in resurveying mothers (Figure 3). Therefore, given bias, the results for the impact of wells and the hygiene and sanitation program on diarrhea are not a reliable estimation of the ITT.

7   Conclusion

In this paper I study the impact of borehole wells and a hygiene and sanitation program by creating a retrospective panel. I do not find a statistically significant impact of wells and the hygiene and sanitation program on diarrhea. My results are not reliable due to the bias in the outcome variable. Even though this is the case, this is an important contribution to the literature. Researchers and development practitioners have to balance research quality and cost. Though I find this methodology is not a reliable way to measure diarrhea and health outcomes, there is potential for it to be modified and used.

Given the bias created by the methodology, I provide additional evidence to evaluate LWIU's programs. I find that a number of wells are no longer used in non-WaSH villages, either because they broke down or because of poor water quality. On the other hand, WaSH has successfully increased water access and well functioning. It is difficult to speculate the impact of this success on diarrhea since most households use more than two water sources, do not consistently treat water, and may contaminate water by using the same transport container for multiple sources (Kremer et al., 2011; Ruben & Zintle, 2011). I do not find that WaSH increases latrine adoption. However, this result should be taken lightly, since non-WaSH villages may not be an appropriate counterfactual to WaSH villages and because latrine adoption does not guarantee latrine use.

The literature on water, sanitation, and hygiene programs leads me to believe that even under a different research methodology, I might not find a detectable effect on diarrhea. Diarrhea is only one symptom of environmental enteropathy and is not always present (Humphrey, 2009; Korpe & Petri, 2012). This is why some researchers use height-for-age as an outcome variable, which has been shown to be a good indicator for health and nutrition in the first few years of life. The literature also demonstrates that in locations where diarrhea is the leading cause of death, programs saw large reductions in diarrhea, even with imperfect compliance (Spears, 2012; Reller et al., 2003). But as the amount of pathogens digested decreases and other measures to prevent and control diarrhea increases, the effect size of water, sanitation, and hygiene programs on diarrhea diminishes (Luby et al., 2006). In Uganda, not only have large improvements been made in eliminating open defecation, 92-97% of children have received the vaccines for tuberculosis, polio, hepatitis B, diphtheria, tetanus, pertussis, and haemophilus influenza; 87% have received the vaccine for measles; less than 20% reported taking deworming vaccines, though natural remedies are common. The use of zinc and rehydration salts to treat diarrhea has increased, where 31% of children born in 2014 and 52% of children born in 2013 received oral rehydration salts, zinc, or both. The high vaccination rate, the use of oral rehydration salts and zinc, and the improvements in water and sanitation since 1990, are great gains for children's health, but also indicate that diarrhea may not be the best measure to analyze the effectiveness of water, hygiene, and sanitation.

Regardless of the flawed methodology, there are a two policy recommendations that can be made. First, this study echoes the findings in Kolb deWilde et al. (2008): household preferences, water source choices, and constraints largely determined if a water source is used. Kolb deWilde et al. (2008) found households in rural Mexico understood the benefits of drinking clean water, preferred the taste of the safe drinking water system studied (ultraviolet light disinfection water system) over water treated with chlorine or boiled, yet used the most convenient source. In 10 of the 21 villages surveyed, households preferred buying water

at \$0.72-1.81 per 19-liter garrafon over fetching free clean water. While this may appear irrational, Kremer et al. (2008) compared stated preferences to revealed preferences and found household's valuation for a clean water source is much smaller than stated. I found that if water looks or taste bad, it is perceived as unhealthy and not used. In areas with poor ground water quality, spring protection would be a cost effective approach to increasing water access. The survey was piloted in villages that received a gravity flow system, which also appeared to be an effective alternative to wells.

CLTS is a relatively young methodology, and though widely used, has mixed results on latrine adoption and decreasing open defecation. I find all households report owning or sharing either an open pit or another form of latrine, however none of the villages were declared open defecation free. As stated in section 5.2 this may be due to challenges related to the WaSH program being a pilot program and staff turnover. As of August 2014, villages in five of the eleven 2013 WPA's were in process of receiving the open defecation status, an indicator of the program's effectiveness. The fact that none of the 2012 WPA's and half of the 2013 WPA's have not been declared open defecation free are proof that behavior change is difficult. More research is needed to evaluate which aspects of CLTS leads to behavior change in a given context. Other programs, such as the "No Toilet, No Bride" sanitation campaign in India may be more effective in increasing latrine adoption (Stopnitzky, 2012). In addition, finding the correlation between latrine type and latrine use may help determine if LWIU should promote a certain type of latrine, for example, open pit versus pit latrine, and when to subsidized latrine construction.

Though this research suffers from methodology flaws, it provides valuable insights on how to measure the impact of water, sanitation, and hygiene programs. It also reiterates findings in the literature. Designing programs that either require little behavior change or significantly induce sustainable behavior change is paramount in water, sanitation, and hygiene policy.

8   Tables and Figures

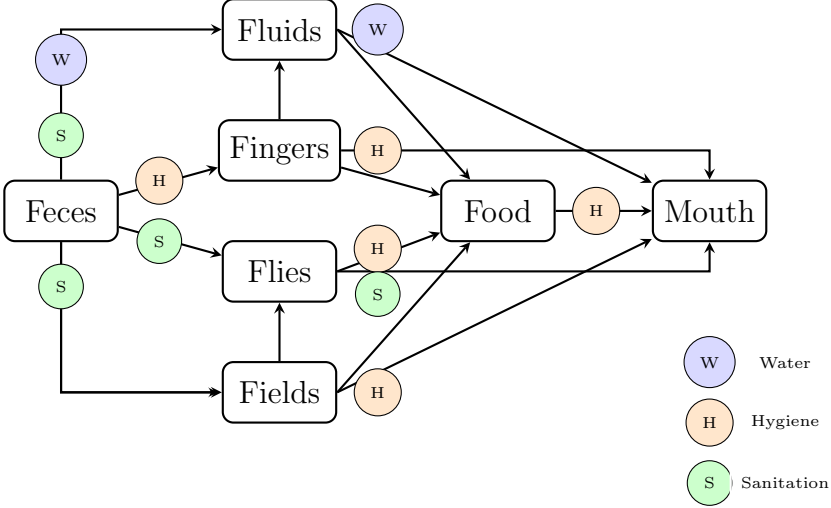Figure 1: Fecal-Oral Transmission Diagram

Table 1: Literature Review

Author	POS	POU	H/S	Combined	Intervention	Methodology	Location	Diarrhea Children<3	Diarrhea Children<5	E.coli	Height-for-age	Result
Arnold et al. (2010)				✓	Water & CLTS	Matching	India	✓				×
											✓	×
Chase & Do (2012)			✓		Hand washing	RCT	Vietnam	✓				×
Clasen et al. (2004)		✓			Ceramic water filters	RCT	Bolivia	✓				-83%
Galiani et al. (2012)			✓		Hand washing	RCT	Peru	✓				×
Gunther & Fink (2010)				✓	Water & sanitation	OLS/Logit	70 Countries	✓				-7-17%
Gunther & Schipper (2013)		✓			Transport & storage	RCT	Benin	✓				×
										✓		-70%
Hammer & Spears (2013)			✓		CLTS	RCT	India				✓	0.2-0.3 std
Kremer et al. (2011)	✓				Spring protection	RCT	Kenya		✓			-25%
										✓		-66%
Kolb deWilde et al. (2008)	✓				Community water treatment	GEE	Mexico	✓				×
Luby et al. (2004)			✓		Hand washing & soap	RCT	Pakistan	✓				-42%
Patil et al. (2014)			✓		CLTS	RCT	India		✓			×
								✓				×
											✓	×
Reller et al. (2003)		✓			Disinfectant & container	RCT	Guatemala	✓				-30%
Ruben & Zintl (2011)				✓	Water & sanitation	DD/Pipeline	Benin	✓				×

Table 2: Summary Statistics

	Non-WaSH Villages		WaSH Villages	
Villages	27		21	
	500<BH	500>BH	500<BH	500>BH
Households	91	137	137	68
Children	326	530	541	265
Number of living children	3.59	3.87	3.96	3.96
	(1.64)	(1.69)	(1.83)	(1.73)
Number of births	3.64	3.90	4.12	3.97
	(1.67)	(1.71)	(2.06)	(1.78)
Mother's Education	6.63	6.65	5.74	4.68
(5 = primary 4, 6 = primary 5)	(3.41)	(3.18)	(3.76)	(3.54)
Primary Income	1.25	1.23	1.24	1.04
(1 = farming, 2 = small business)	(0.55)	(0.59)	(0.55)	(1.04)
Wealth Index	-0.01	.06	0.01	-0.13
	(0.42)	(0.42)	(0.37)	(0.35)
Hygiene Index	0.07	-0.02	-0.003	-0.05
	(0.33)	(0.41)	(0.50)	(0.32)
Tenure	5.27	8.27	6.3	7.16
	(10.27)	(6.36)	(9.18)	(4.68)

Standard errors in parentheses. I use the method outlined in Anderson (2008) to create the wealth and hygiene index. This method uses inverse covariance weighting to capture unique information in a set of variables, opposed to weighting all variables equally. The wealth index is based on the household's ownership of a motorcycle, bicycle, electricity, television, radio, cell phone, goats, cows, type of floor in the home, if the household bought clothes in the last three months and the number of days over the last 30 days the household had not had enough to eat. The hygiene index is based on the mother's response to hand washing, reported use of soap or ash, presence of soap or ash, infant stool disposal, hand-washing station and drying rack.

Table 3: Borehole Wells on Diarrhea (Diff-in-Diff Estimates)

Diarrhea	Well<500m				Distance			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Well x PostChild	-0.066	-0.057	-0.0517	-0.0455	0.001	0.001	0.0168	0.0138
	(0.080)	(0.079)	(0.0797)	(0.0802)	(0.001)	(0.001)	(0.0106)	(0.0104)
Post Child	0.021	0.0136			-0.326*	-0.362*	-0.326*	-0.361*
	(0.047)	(0.079)			(0.179)	(0.191)	(0.179)	(0.190)
Constant	0.272***	0.243	0.0182	-0.166	0.298***	0.701**	0.298***	0.631**
	(0.015)	(0.204)	(0.0529)	(2.427)	(0.025)	(0.302)	(0.0245)	(0.304)
Controls	N	Y	N	Y	N	Y	N	Y
Birth Year Fixed Effect	N	N	Y	Y	N	N	N	N
R^2	0.074	0.079	0.104	0.107	0.086	0.121	0.086	0.115
N	1,371	1,371	1,371	1,371	523	523	523	523

Most diarrhea is a binary variable for the children with most diarrhea. Column (1)-(4) uses *Well* as an indicator variable households within 500 meters of a well. Column (3)-(4) adds a birth year fixed effect. Column (5)-(6) uses *Well* as a continuous measure in meters for all households within 1500 meters of a well and in (7)-(8) uses *Well* as a continuous measure in 20 meter increments. Columns (2), (4), (6), (8) adds the following controls: age, age-squared, gender, birth order, a variable indicating a child was born outside the village, and child health index explained in section 4.5. Cluster standard errors at the household level in parentheses. Significance levels: ***p<0.01, **p<0.05, *p<0.1

Table 4: Hygiene and Sanitation on Diarrhea (Triple Difference Estimates)

Diarrhea	Well<500m				Distance			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Well x PostChild x WaSH	0.0519	0.00985	0.0414	0.0102	-0.000740	-0.000619	-0.0148	-0.0124
	(0.150)	(0.150)	(0.151)	(0.152)	(0.000940)	(0.000910)	(0.0188)	(0.0182)
PostChild x WaSH	0.00693	0.0260	0.00601	0.0206	0.301	0.237	0.301	0.237
	(0.108)	(0.110)	(0.109)	(0.112)	(0.319)	(0.310)	(0.319)	(0.310)
PostChild x Well	0.0200	0.0314	0.0199	0.0321	0.000688	0.000543	0.0138	0.0109
	(0.106)	(0.105)	(0.106)	(0.106)	(0.000815)	(0.000796)	(0.0163)	(0.0159)
Post Child	0.00723	0.0277	0.109	-0.703	-0.202	-0.0515	-0.202	-0.0515
	(0.0646)	(0.0869)	(0.0954)	(2.156)	(0.283)	(0.281)	(0.283)	(0.281)
Constant	0.239***	0.185	0.0442	0.840	0.229***	0.154	0.229***	0.154
	(0.0109)	(0.158)	(0.0518)	(2.165)	(0.0155)	(0.202)	(0.0155)	(0.202)
Controls	N	Y	N	Y	N	Y	N	Y
Birth Year Fixed Effect	N	N	Y	Y	N	N	N	N
R^2	0.091	0.094	0.109	0.109	0.097	0.118	0.097	0.118
N	1,662	1,638	1,662	1,638	867	854	867	854

Most diarrhea is a binary variable for the children with most diarrhea. Column (1)-(4) uses *Well* as an indicator variable for households within 500 meters of a well. Column (3)-(4) adds a birth year fixed effect. Column (5)-(6) uses *Well* as a continuous measure in meters for households within 1500 meters of a well and in (7)-(8) uses *Well* as a continuous measure in 20 meter increments. Columns (2), (4), (6), (8) adds the following controls: age, age-squared, gender, birth order, a variable indicating born outside the village, and child health index explained in section 4.5. Cluster standard errors at the household level in parentheses. Significance levels: ***p<0.01, **p<0.05, *p<0.1

Figure 2: Water from Well with High Iron

Table 5: Latrine Adoption (Diff-in-Diff Estimates)

Latrine	(1)	(2)
WaSH x Post	-0.0197	-0.0230
	(0.0653)	(0.0646)
Post	0.346***	0.346***
	(0.0455)	(0.0456)
Constant	0.418***	0.360***
	(0.0163)	(0.0587)
Controls	N	Y
R^2	0.380	0.383
N	866	864

The dependent variable is a dummy for whether household i owns a latrine. Column (2) includes the following controls: The wealth index, hygiene index, tenure, mother's education, and household's income source. Cluster standard errors at the village level in parentheses. Significance levels: ***p<0.01, **p<0.05, *p<0.1

Figure 3: Health and Diarrhea Ranking Revisit Results
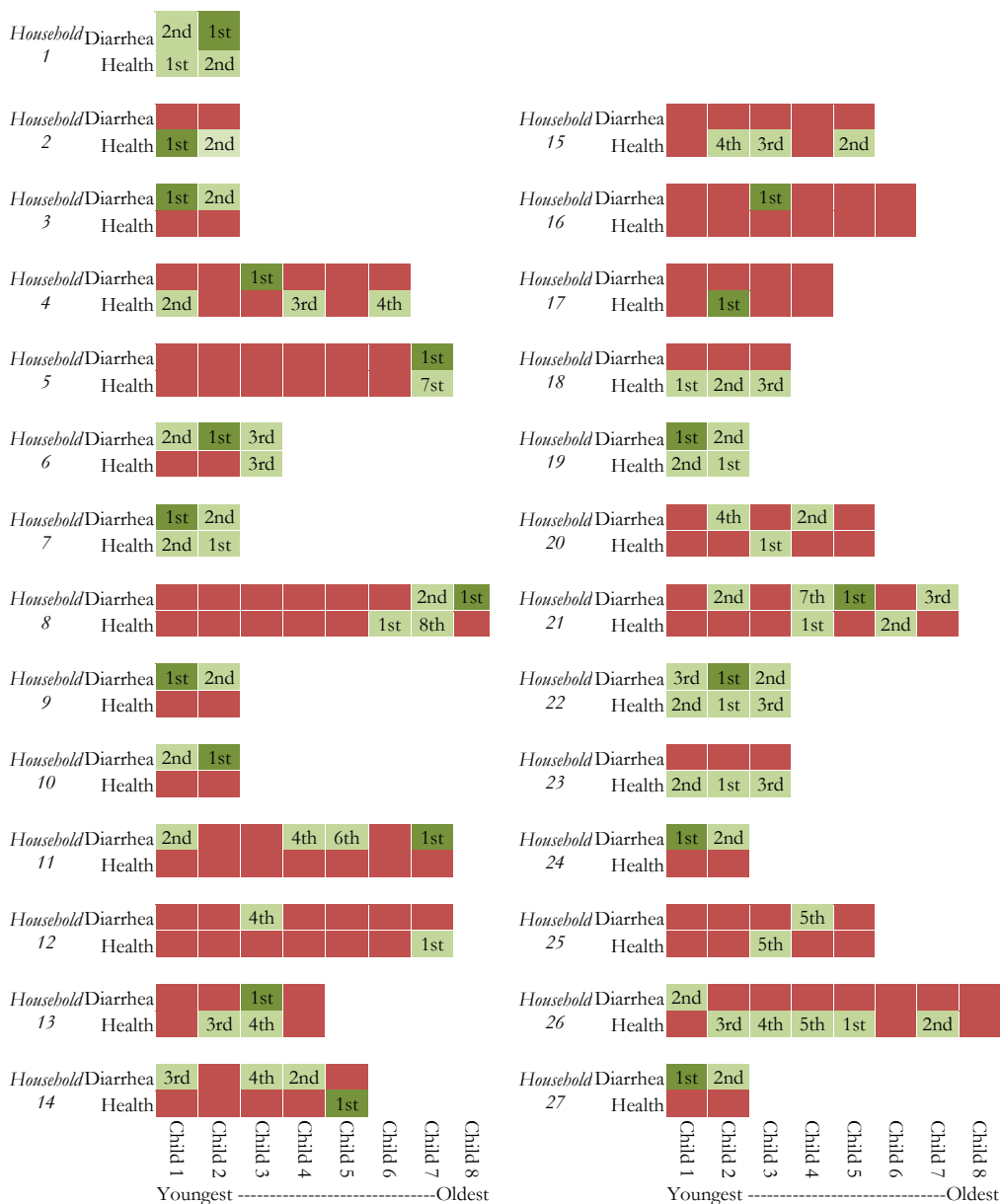
Each box indicates a child in the household. Moving left to right, the boxes indicate the youngest to oldest child. A green box indicates the mother ranked the child the same on both surveys. The number in the box indicates the child rank.

Table 6: Correlation Between Most Diarrhea and Reported Diarrhea

Diarrhea	All Households	Non-WaSH 500>Well	Non-WaSH 500<Well	WaSH 500>Well	WaSH 500<Well
0 Days	-0.283***	-0.354***	-0.400***	-0.149	-0.200**
1 Day	0.231***	0.289***	0.335***	0.034	0.212***
2 Days	0.153***	0.089	0.265***	0.272**	0.089
3 Days	0.150	0.144*	-0.032	-0.118	-0.025
N	466	145	101	72	148

Significance levels: ***p<0.01, **p<0.05, *p<0.1

9 Survey Instrument

Eligibility

1. Is there a child under two years old?

2. Is there a child over two years old?

3. Did mother sign consent?

Child Questions

1. How many children have you given birth to?

2. What are the child's names?

3. Is the child still alive? If deceased, when did the child die?

4. When is the child's birthday?

5. How old is he or she?

6. What is the child's gender?

7. Does the child go to school or nursery?

8. What year and month was he or she born?

9. Has this child had diarrhea in the past two days?

10. Has this child had diarrhea in the past week?

11. Did you breastfeed the child? Until what age?

12. When did you introduce complementary food?

13. Do you have the child's health card?

14. What vaccines does the child have?

Child Ranking

1. Rank children from most healthy to least healthy.

2. Rank children from most diarrhea to least diarrhea

Water Questions

1. Name the water source you have used in the past five years

2. What type of source is it?

3. Who built the water source?

4. Do you still use the water source?

5. Is/was this used for drinking?

6. Who delivers/delivered water from this source to your home?

7. How long does it take you to go there, get water, and come back?

8. What takes up the most time in collecting water?

9. Is there a fee?

10. How much is the fee?

11. How satisfied are you with your drinking water?

12. How do you treat your drinking water

13. How long ago did you begin using the source?

14. If no longer use the source: Why did you stop using the water source?

15. When did you stop using the source?

Hygiene and Sanitation Questions

1. Where did you learn about your hygiene practice?

2. Has a health care worker visited your home to talk about safe hygiene practices?

3. How often do you wash your hands with soap?

4. List all of the times you may wash your hands with soap (open-ended)

5. What are the reasons why you wash your hands with soap (open-ended)

6. Where do you wash your hands at?

7. Is there soap present?

8. Is there ash present?

9. What kind of toilet facility does your household usually use?

10. How long ago did you build the latrine?

11. If bush or field: How far away do you go from the house?

12. Do you share a facility with other households?

13. How many households use this toilet facility?

14. The last time your child passed stools, what was done to dispose of the stools?

Household Characteristics

1. What is the main source of income in this household?

2. Does anyone in this household own a motorcycle?

3. Does anyone in this household own a bicycle?

4. Do you have electricity?

5. Do you own a television?

6. Do you own a radio?

7. Do you own a mobile phone?

8. What is main material of the floor?

9. What is your religion?

10. How long have you lived in this house?

11. What is your highest level of education?

12. How many times in the last thirty days have you not had enough to eat?

13. Have you purchased clothing or shoes in the past three months?

14. How many cows does this household own?

15. How many goats does this household own?

16. Are there flowers around the home?

Geocodes

1. Enumerator takes geopoint at entrance of household.

2. Enumerator takes geopoint at each water source.

3. Enumerator takes picture of each water source.

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