Assessment of the Effect of Water Supply on Child Morbidity in Communities of Bié Province in Angola – April, 2017

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Abstract. To decrease the morbidity and mortality of children under-5 related to diarrheal and other enteric diseases, it is hypothesized that by installing a safe water supply in a rural community with no current access to safe water that the morbidity and mortality of under-5 children due to enteric disease will decline significantly. In June 2015, we conducted a household survey to determine the current level of morbidity and mortality of children under-5 years of age due to diarrhea and enteric disease and current sources of drinking water, among other health, social and economic variables in six rural villages of the municipalities of Kuito and Catabola: Wongo, Chipuli, Chitete, Chimbassi, Chiteque and Kaliongo. During the baseline survey, data was collected from a random sample of 589 heads of household from the six villages, which were later divided into intervention and control groups (receiving water wells and not receiving water walls respectively). A year later, in July 2016, data was collected from 573 heads of household during the endline survey and results were analyzed. There were no differences between communities in terms of size, geography, socio-economic status, and education level. After endline, reduction in diarrhea cases, from 44% in 2015 to 30% in 2016 was found to be statistically significant in the communities that indicated that water wells were their first source of water. Other variables such as good hand hygiene practices or good water management were not found to be statistically significant in reducing diarrhea cases in children under 5.

INTRODUCTION

Although, the maternal mortality ratio in Angola has dramatically decreased from 1,400 per 100,000 live births in 1990 to 460 in 2013 (UNICEF, 2015), slightly under the regional average, only 69% of women have at least one antenatal care (ANC) visit and only 49% delivered in a health facility (MOH, 2014). Under-five mortality (167/1,000 live births) in 2013 in Angola was also above the Millennium Development Goal targets and the regional average for these indicators (UNICEF, 2015). Diarrheal diseases continue to be the leading cause of death since 2000, claiming the lives of 37,500 people in 2012. For children under-5, diarrheal diseases accounts for 15% of the deaths, being the third greatest cause of death after acute respiratory infection (17%) and other causes (19%), (UNICEF, 2015).

According to UNICEF and WHO's 2014, Joint Monitoring Program for Water and Sanitation (JMP), Angola has made tremendous gains with regards to improved coverage and quality of water and sanitation. Angola is in the top 10 countries that have achieved the highest reduction of open defecation since 1990, changing from 57% to 24% in 2012, and putting it on track to meet the Millennium Development Goal for rate of utilization of sanitary facilities. However, the improvements in coverage and quality have not been equal between urban and rural areas. In fact, the report shows that coverage of safe drinking water decreased in rural areas from 42% in

1990 to 34% in 2012. Quality and coverage in informal, peri-urban settlements are also not improving and in some areas, even getting worse. In rural Angola, water supply is primarily provided by more than 3,000 boreholes across the country, however, as reported by the Ministry of Energy and Water, maintenance and upkeep is a major challenge as boreholes become covered with branches and natural debris during the year, and spare parts for pumps are often hard to find.

Evaluations of the health impact of water supply, sanitation and hygiene interventions have shown that the incidence rate of diarrheal disease can be significantly reduced through access to and effective use of an appropriate sanitation facility, hand washing with soap and safe storage and treatment of water at the household level (Esrey, 1991). Treatment of water is especially important in rural settings where limited access to improved water sources[1] requires the collection, transportation, and storage of water (Ondu, 2012), as is the case in rural Angola.

The RISE Water Initiative. RISE International, a non-governmental organization working in partnership with the Angolan Ministry of Education, builds primary schools in rural Angola to educate children, empower communities and contribute to the rebuilding of the country. Since 2003, RISE has built 159 schools and over 106,000 students have gained the opportunity for education. Since 2009, RISE has also funded the drilling of 24 wells and distributed 33,520 pairs of new TOMS Shoes to students and teachers. The RISE school network has facilitated school feeding, jobs and stimulated the local economy. In 2016 and 2017, libraries have been established in 5 RISE-built schools, giving students access to books and resources, and improving the quality of education.

OBJECTIVES

The principle objective of the study is to determine the short-term health effects of installing a safe water supply in villages, with attention focused on under-five children, and the enteric diseases prevalent in those communities. If safe water wells are constructed near a public gathering place such as a school, it is hypothesized that morbidity and mortality of children under-five years of age living in the area, due to diarrhea and other enteric diseases will decline.

Additionally, another purpose of the study is to design and test an approach for assessing the health impact of projects of this kind, thereby encouraging more studies with larger sample sizes, and perhaps the ability to assess the possible impact of other infrastructure and behaviour development such as sanitation facilities and refuse disposal.

Finally, the research team hopes to demonstrate the feasibility and benefit to decision-making at the municipal and provincial level of extracting and analysing data of child health and cases due to common illnesses. Additional objectives are to demonstrate to the MOH, and local health authorities, the value of the data and the feasibility of its measurement, in order to attract MOH and municipality attention for more water supply construction and monitoring of the impact on health and hygiene

[1] Improved water sources defined by WHO/UNICEF Joint Monitoring Program included piped water, borehole, protected well or spring, and rainwater. While improved water sources are more likely to be safe water, this is not necessarily true. Additionally, contamination occurs during collection, storage, and use.

METHODS

The dependent variables of the study are under-five cases and deaths related to diarrhea in the intervention and control villages. The independent variables were defined to include important factors, which help reflect aspects likely to influence under-five cases and deaths due to diarrhea including access to and use of safe water.

The specific types of information sought were:

1. Deaths of under-five children in the family, and if possible, the cause of death
2. Occurrence of diarrhea in under-five children in the two weeks preceding the survey
3. Sources of water for drinking, cooking, washing, and laundry used by the family
4. Family's (mother's) knowledge and practice of hygiene (food and water safety and protection (use of chlorine), hand washing, defecation sites and practices)
5. Care-seeking for and management of child health problems, especially diarrhea
6. Mother's level of education
7. Family income and level of living
8. Number of children under 18 years of age who currently attend a RISE school or other school in their village

This baseline measurement through household interviews was conducted in six villages before building the wells, and was repeated at the end of the study, one year after the water supplies were installed in three villages randomly selected as intervention villages. The wells were built in the intervention villages 3 months after the baseline survey was applied. They were well maintained during the study period by RISE International and a team from the local community. During this study, RISE International also sought to establish a partnership with UNICEF Angola so that UNICEF could implement the WASH program in the three villages that received the wells initially, and could distribute education and communication material (IEC) on water and sanitation to both intervention and control communities during the period of the study.

During baseline, a sample of the water from the rivers and streams accessed by the communities was taken using a water test kit by the Provincial Office of the Ministry of Energy and Water in Bie. However, despite numerous attempts at getting the results, these were never provided. Due to similar coordination challenges, no data collection of water samples was conducted during the second year, thus constituting an unmeasured risk, as ground water may sometimes seep into wells thus polluting the water inside the wells.

Data collected. The evaluation included two types of data: 1) a cross-sectional household survey of a random sample of families in the six villages, 2) abstraction of data from 2014, 2015 and 2016 Child Health facility registries that heads of household indicated using in the surrounding areas.

Evaluation population. The six villages selected for this study are all located in the outskirts of Kuito city, the capital of Bie province. These communities were selected because RISE International already has schools in operation in four of the communities: Wongo, Chipuli, Chimbassi and Chitete. According to local records, it is estimated that the combined total population in the six villages is 4,174 residents (RISE, 2014). Health services in these

communities are offered mainly by public health facilities level I (health posts). All families with children under-five in the six villages were eligible to participate.

Sample size calculation. To determine the household survey sample size, we assumed 20% of children under-five would have diarrhea within the last two weeks at the time of the baseline survey. We also assumed a confidence level of 95%, and power of 80%. Due to the expected proximity of the households, as well as to account for non-responsive households, design effects of 20% and of 5% respectively were applied resulting in a sample of 557 heads of household in the six villages. The sample size chosen effectively sampled 13.3% of the overall population.

Survey enrollment. For the cross-sectional survey, households with children under-five were randomly selected by using a random number table to avoid any subconscious selection bias. Given that a current list of households could not be obtained from the communities, the research team followed Annex M of WHO's Immunization Coverage Cluster Survey – Reference Manual: How to use a Random Number Table, which consists of selecting a central location of the community, such as a market or the school, as the starting point and then through the use of a random number table, choose a direction in which to select houses, and a starting house in that direction.

Exclusion Criteria. Any households that did not have children <5 residing in the home or where the head of household (mother, grandmother or father) was not available after 2 attempts, were excluded from the study.

Household survey implementation. Trained surveyors fluent in local languages used a standardized questionnaire to interview heads of household about demographic and socio-economic characteristics, diarrhea history in their children under-five, use of health services, water and sanitation practices, knowledge about safe water and sanitation, and receipt and use of chlorine pills or powder to treat water in the household. Observations of home environmental characteristics were also made. Surveyors were retrained in July 2016, a few days before the data collection for the endline.

Event Definition. Using the World Health Organization's (WHO) definitions, simple diarrhea was defined as the passage of three or more loose or liquid stools (as opposed to formed stools) per day. Severe diarrhea was defined as acute watery diarrhea, which lasts several days, and can include cholera. A diarrheal outbreak was defined as three or more cases of simple diarrhea in one community.

MCH registry data abstraction. Data abstracted from health facility Child Health registries included monthly totals for cases of enteric diseases in children under-five for the past year. Diseases included in this extraction were: Cholera, Dysentery, Acute Diarrheal Infection (ADI), Viral Hemorrhagic Fever, Typhoid Fever, Acute Malnutrition, Schistosomiasis and Hepatitis A. When monthly case data was not available, yearly totals were obtained from the Provincial Health Office (DPS) of Bie province.

Health facility and worker survey. To improve our understanding of water and sanitation interventions, during year 1 we interviewed the directors of two of the health posts more

commonly mentioned by heads of households during the baseline survey to 1) confirm the responsibility areas of each health facility, 2) record the method and frequency by which the health facility reports health education is provided about water and sanitation to the communities in its responsibility area and 3) record the method and frequency by which the health facility provides chlorine or bleaching powder for the water supplies in the communities in its responsibility area.

Data analysis. For the baseline assessment, data from the household survey were entered into Epi Info 7 at the point of the interview using Android Tablets and then transferred to a computer for analysis using Epi Info 7's Classic Analysis program (CDC). During the endline survey, 3 of the Android Tablets did not work properly and thus interviews were conducted using a paper survey questionnaire and later manually entered the data into the Epi Info 7 files by one of the research team members. Frequency analysis was performed on the data. Health facility registry data were entered and analyzed in Microsoft Excel (Redmond, WA). In order to compare baseline and endline data, a simple logistical regression analysis was conducted using the chi-square test to determine whether there was a statically significant change in the rate of diarrhea among the case and control groups. Results of this analysis have been stratified by community, age, household size, education level and income level among others to determine any effect modification factors.

Ethical review and considerations. The research protocol for this study was approved by the Angolan Institutional Review Board, the Comité de Ética Nacional, Ministério da Saúde, República de Angola (letter signed and dated April 9, 2015). Verbal informed consent was obtained from all heads of household before participating in the household survey.

Surveyors were also trained on how to explain the purpose of the study and the content of the informed consent to the head of household, including assurance of confidentiality and the respondent's liberty to skip questions, stop the interview or decline to answer all together. Surveyors conducted the survey in Portuguese and local languages as necessary.

Another important ethical consideration of this study is that in order to maintain equity among the study population, RISE International has committed to building a well in the comparison communities after the completion of the study.

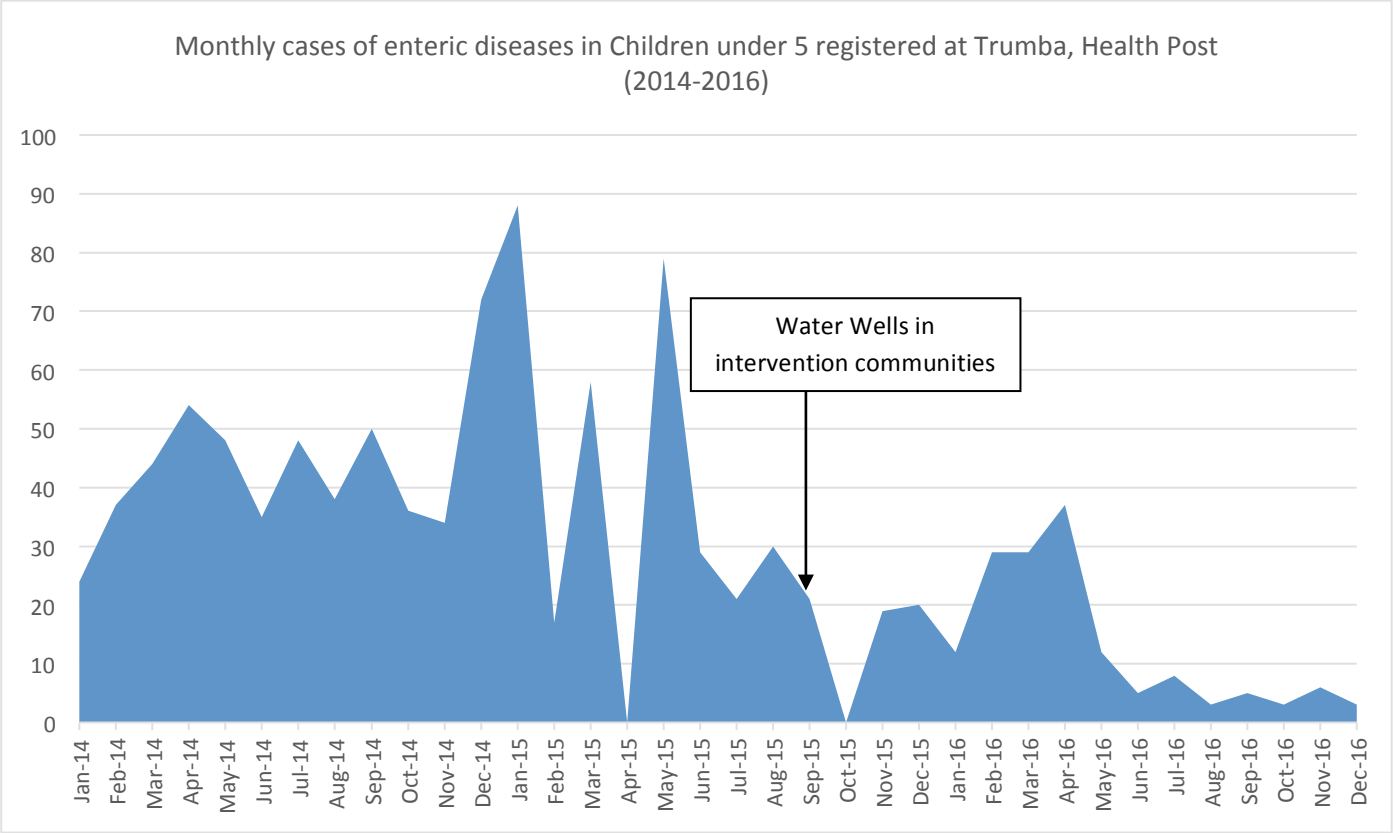
In order to not bias the responses, participants were not told during the interview that safe water wells will be built before or after the study.

RESULTS

Health facilities. Data from three health facilities was analyzed. These are health posts level I within the Angolan health system (GEPE, 2011)[2] and were chosen because they were the three

[2] The Regulamento Geral das Unidades Sanitárias (REGUSAP), or regulatory document for health facilities in Angola, establishes the characteristics (in terms of infrastructure and resources), and operation (in terms of services to be provided by type of health facility), for the lower-level facilities dependent on the Ministry of Health. According to REGUSAP, health posts are the most basic structures of the system and should provide the full range

facilities most utilized by survey respondents. At endline, these facilities were: Health Post (HP) Trumba (59%, n=239); HP Kuquema (17%, n=97); HP 7 Casas (16%, n=90) and 6 Other HPs (25%, n=147). Data was available for 7 diarrheal and vector-borne diseases: Cholera, Typhoid Fever, Amoebiasis, Acute Diarrheal Infection, Intestinal Parasitosis and Schistosomiasis. Data from January 2014 to November 2016 was available only for HP Trumba and for cases of enteric diseases. It is important to note that HP 7 Casas opened in February 2015 and replaced HP Chipeta in third place of being most used by heads of household. As has been reported elsewhere, the health information system in Angola is very weak, and is based on paper registries recorded in a clinical log book that are then transferred to a monthly summary sheet. It is a challenge for many health facilities and especially those in rural areas, to record data appropriately and keep past records archived. Graph 1 shows monthly case data for HP Trumba.



The graph suggests that there is a relationship between when the wells were opened and a reduction in the reported cases of diarrhea in children under-five. However, this reduction cannot be fully attributed to the construction of the wells as other factors such as out migration, access to other health facilities and water and sanitation education could be a factor. The study team is not aware of any water and sanitation infrastructure improvement projects that occurred in the

of services that make up the Primary Health Care Strategy (i.e., basic consultations, vaccinations, monitoring of child growth, prenatal care, family planning and distribution of essential medicines). Level I and II health posts are to provide these services except for child births. The difference between a Health Post Level I and II is that the latter must have laboratory due to the fact that they are meant to cover a geographic area of higher population density.

area during this period. This is information that the Provincial office of water and sanitation confirmed. However, an education initiative, implemented by the organization People in Need (PIN) did take place in the village of Chitete. PIN's schedule has prevented them from delivering WASH training in the other villages as requested, though the commitment for 2017 is to implement the training in Chiteque, Chimbassi, Chipuli, Kaliongo and Wongo.

Household survey

*Enrollment***.** We enrolled 589 households across the six communities at the baseline and 573 households at the endline that passed the eligibility criteria: 1) to have children under-five years of age living in the household and 2) to have the head of household available for interview, ideally the mother. When the mother was reported to be away, surveyors asked to interview the grandmother or father. If none were available, surveyors made an additional attempt the following day. Table 1 below shows the distribution of households surveyed per village. The desired sample size was surpassed each year. However, during endline in the communities of Wongo and Chiteque, many houses were found abandoned due to out-migration of families.

Village	Total No. of Households interviewed in 2015	Percentage of Total Sample	Total No. of Households interviewed in 2016	Percentage of Total Sample
Chimbassi	105	17,83%	102	17,80%
Chitete	82	13,92%	93	16,23%
Chiteque	102	17,32%	97	16,93%
Kaliongo	62	10,53%	61	10,65%
Wongo	113	19,19%	83	14,49%
Chipuli	125	21,22%	137	23,91%
Total	589	100%	573	100%

The proportion of households where the respondent was the mother remained consistent from year to year at 70%. Only one intervention and one control village changed much (Chitete increasing 2% points and Wongo decreasing 4.5%.)

Demographics. The median age of respondents was 30 years (range 15–82) with roughly 50% of respondents in both years reporting having ever attended school at all, while roughly 40% had completed only some primary level education (grades 1 through 7). However, surveyors asked respondents to read out loud a simple sentence in Portuguese, of which 418 of the respondents during baseline (70%) could not read compared to 68% of respondents during endline (n=388). The median family size was 7 (range 2–15) and median number of children under-five years of age living in the household was 2 (range 1-8) for both years. The majority of the households (97%) indicated farming as the main source of income for the family in both years. The percentage of households that reported having at least 1 child that attended a RISE school went up from 29% to 31% between 2015 and 2016. The percentage of households that reported having at least 1 child in that age group that does not go to school at all also went up from 77% to 85% within the 1 year period.

Use of Child Health services. When asked what respondents did if their child had simple diarrhea, the proportion of heads of household that said they would bring the child to the nearest health center decreased from 51% to 35% between baseline and endline. The proportions remained the same when asked what they did if the child had severe diarrhea. Around 93% of

households reported bringing them to a health facility. In both cases (simple and severe diarrhea), the remainder of households indicated using home remedies or doing nothing.

Recall of Diarrheal cases and deaths for children under five years of age. During baseline, 44% of households indicated that at least one child under-five years of age had an episode of diarrhea in the 2 weeks prior to the survey compared to 30% of the households surveyed during endline. There was also a decrease in the number of households that reported their child under-five having had diarrhea accompanied their last disease from 41% at baseline to 26% at endline. 22% of respondents indicated being aware of an outbreak of diarrhea in their village in the last year compared to 17% of respondents during endline. The proportion of households that indicated being aware of deaths of children under-five years of age in the community remained unchanged at 15% for both years.

Water source and treatment. During the month of September, 2015, the intervention communities of Chimbassi, Chitete and Chiteque each received a water well. Wells varied in depth ranging from 28 to 45 meters. At baseline in June 2015 and before the installation of the wells, improved water sources, primarily boreholes, were already used by 52% of households while 47% reported open sources of water as their main source of water for drinking and cooking such as rivers, lakes, ponds or natural springs. These proportions changed at endline with 53% preferring to use water wells to 39% that reported using open water sources. If respondents responded that they "boiled water and covered water containers with a lid", the household was considered to apply safe water management practices. The proportion both at baseline and endline of households with safe water practices remained low at 34 and 32% respectively. It should also be noted that wells were drilled in the three control villages, at Chipuli in November 2016, and at Kaliongo and Wongo in March 2017, after data for the endline was collected.

Hygiene and sanitation practices. Upon observation of household water storage conditions by the surveyors, buckets were the most frequently observed item to store the water both years at 86%. Researchers categorized a household as having "good hygiene practices" if respondents indicated that: 1) they washed their hands after using the bathroom, 2) changing a diaper and if there was an observation recorded by the surveyor of having seen soap in the house. If these 3 criteria were not met, a household was classified as having "poor hygiene practices". At baseline, the proportion of households that met the criteria of good hygiene practices was low at 10% and it reduced even further to 4% at endline. Also upon observation, the proportion of homes with traditional latrines remained the same during both years at 88% with the remainder 12% of households reporting to practicing open defecation.

Year 2015

	Well / No Well in the community	Diarrhea in children under 5-2 weeks prior to survey	Good Hand Hygene Practices	Good Water Management	Water Well / Bore Hole usage
Chimbassi	No Well	42%	0%	0%	10%
Chitete	No Well	49%	1%	12%	66%
Chiteque	No Well	47%	7%	0%	75%
Kaliongo	No Well	32%	0%	0%	73%
Wongo	No Well	60%	4%	19%	53%
Chipuli	No Well	32%	2%	10%	47%

Year 2016

	Well / No Well	Diarrhea in children under-5 2 weeks prior to survey	Good Hand Hygene Practices	Good Water Management	Bore Hole usage
Chimbassi	Well	37%	5%	4%	50%
Chitete	Well	23%	1%	8%	71%
Chiteque	Well	5%	0%	0%	77%
Kaliongo	No Well	37%	2%	10%	54%
Wongo	No Well	33%	0%	7%	52%
Chipuli	No Well	45%	0%	9%	35%

Definitions**:** Hand Hygene practices were defined as respondents who indicated washing hands after using the bathroom, changing a diaper and when the surveyor observed soap in the house**.** Good Water Management was defined as cases where the respondent indicated boiling water and covering water containers with a lid.

The research team had assumed that at least 20% of the children under-five years of age were going to be found to have had diarrhea in the 2 weeks prior to the survey. Results of this evaluation suggest that this number is much larger as 44% of families reported this to be the case at baseline and 30% at endline.

Although it is known that factors such as the construction of the wells, good hand hygiene practices and good water management practices impact morbidity and mortality of diarrheal diseases, the purpose of this intervention was only safe water well construction. Nonetheless, the research team ran various logistic regression analysis, controlling for good hand hygiene practices and good water management practices, using Chi square tests to determine whether the reduction in diarrhea cases, from 44% in 2015 to 30% in 2016 was statistically significant. An odds ratio test indicated that the difference was statistically significant for the communities which had a well constructed. The other variables such as good hand hygiene practices or good water management were not found to be statistically significant in reducing diarrhea cases in children under-five.

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Logistic regression                                     Number of obs   =       1143
                                                        LR chi2(1)      =       5.86
                                                        Prob > chi2     =     0.0155
Log likelihood = -752.40168                             Pseudo R2       =     0.0039
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Diarrhea	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Well	.7433182	.0911616	-2.42	0.016	.5844968	.945295
_cons	.6962025	.0611312	-4.12	0.000	.5861306	.8269453

Limitations. Household survey data showed that the only statistically significant predictor to a reduction of diarrhea cases was having a water well or borehole as your main source of water. However, some limitations of this study affect the reliability of the data. In addition to the small number of villages participating in the study, the short time period of 1 year in which to register an impact was a challenge for this study. Poor quality of health facility data or lack of health data was also a limiting factor in this study. Additionally, since household data was collected through observations, the study considers observation bias as a possible limitation. Another factor is the possibility of cross contamination as a limitation. Because the households in the case and control groups are close in proximity, it is possible household members from the control groups traveled to the communities in the intervention groups to access the water wells.

Other factors that also affect diarrheal cases and that were not included in this study are: The hygiene and cleanliness of local food markets, the natural variability in the susceptibility of children to contract diarrhea, the natural variability in the tendency of mothers to detect and worry about loose stools as a symptom of an illness, and the obvious concern that we should have about the reliability of the responses received from mothers to the questionnaire, and about the consistency in the manner in which the surveyors express the questions and note the answers.

Despite these limitations, it is the hope of the research team that at the very least, local and national authorities as well as international NGOs and donors are encouraged to implement more studies with larger sample sizes, and more complex interventions that integrate education, infrastructure development and sanitation.

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