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Executive Summary

The Safe Water Systems Project is a randomized controlled study comparing the effectiveness of drinking water and hygiene improvements to determine which improvement(s) reduce diarrheal disease rates, acute respiratory infections (ARI) and eye infections in a rural population in Wardak Province, Afghanistan. The specific objectives of the project include the following:

1. Describe knowledge, attitudes and practices concerning drinking water and related hygiene in rural Afghanistan
2. Identify household practices which impact diarrheal disease rates
3. Compare effectiveness of leading interventions for improving water and related hygiene, alone and in combination, on reducing the risk of diarrhea rates in rural Afghanistan
4. Compare costs of each intervention per case of diarrhea averted
5. Compare the effectiveness of improving water on reducing the risk of ARI and eye infection
6. Develop evidence base for national drinking water strategy and related policies

The four intervention groups studied during the course of this project included: liquid sodium hypochlorite point-of-use product ("Clorin") distributed with an improved water vessel; hygiene education; improved tubewells; and a multi-barrier approach inclusive of all three of these interventions. Each was provided at no cost to intervention households. Households receiving no active intervention were simultaneously studied as controls. Primary data were collected through two methods: two household surveys conducted one year apart and disease surveillance collected twice-weekly over 16 months. Cost-effectiveness analyses were conducted on interventions which demonstrated a significant impact on decreasing diarrheal disease incidence. Conducted as a joint project between the Islamic Republic of Afghanistan's Ministry of Public Health (MoPH) and the Johns Hopkins University (JHU), the project's results are intended to provide an evidence base for further development of Afghanistan's national drinking water policy. An advisory committee was created with key stakeholders to regularly discuss and oversee the project development and implementation.

One thousand, five hundred and fourteen households with 11,115 individuals were enrolled into the study in May 2005. Baseline two-week prevalence [95%CI] of diarrheal diseases was 22.1% [20.2%-24.0%] for children under five years of age and 6.4% [6.0%-6.9%] across all age groups. Analysis of longitudinal disease surveillance data found that the All intervention group demonstrated the greatest reduction in diarrheal disease incidence across age groups, reducing the relative risk of new cases during peak summer diarrhea season by 39% [47% - 81%]. Additionally, household survey data found significant results only in the All intervention group, with a 47% reduction in the likelihood of diarrhea in the total population (AOR [95% CI] = 0.53 [0.30%-0.93%]). Inconclusive results were found for any of the interventions on ARI and eye infections. Factors associated with preventing diarrhea in children under the age of five included use of soap for washing the body (OR [95% CI] = 0.77 (0.60 – 0.98), p = 0.03) and washing hands with soap in or near the kitchen/food preparation area (OR [95% CI] = 0.58 [0.34, 1.00], p=0.05). Washing hands in the food preparation area was also associated with decreased diarrhea in the total population (OR [95% CI] = 0.66 [0.44, 0.99], p=0.04). Analysis of asset ownership indicates that children in the households with the least assets benefit less than those in households with greater assets when interventions are introduced to improve household drinking water. Children under five years of age in the lowest 40% of asset ownership showed a 92% increased likelihood of diarrhea compared to children under five in households in the top 20% when households received all three interventions. Fecal coliform contamination of drinking water supplies remained quite high with 67% of household drinking

water testing positive for fecal coliforms pre-intervention and 49% testing positive post-intervention in convenience sampling.

Cost-effectiveness analysis of longitudinal surveillance data demonstrates that annual costs per intervention range from $0.99 per case averted in households receiving hygiene education alone to $5.35 per case of diarrhea averted in households receiving Clorin and a protective water vessel.

Annual cost per case of diarrhea averted across age groups
by intervention and varying projected lifespans of tubewells

Intervention	*15 year well lifespan*	*20 year well lifespan*	*25 year well lifespan*
Hygiene	$0.99	$0.99	$0.99
Wells	$1.48	$1.21	$1.01
All	$2.88	$2.70	$2.58
Clorin -- Not significant	$5.35	$5.35	$5.35

Analyses of both survey and surveillance data for children less than five years of age did not find statistically significant decreases in diarrheal disease rates after any of the interventions were implemented. Only the All intervention group approached statistical significance in reducing diarrheal disease in children. The extremely poor environmental hygiene conditions observed during the study period provided abundant sources of contaminants, especially for vulnerable children, which likely contributed to high infection rates of diarrheal diseases and the difficulty in breaking transmission of diarrheal diseases. The combined intervention inclusive of all three interventions together provided the best protection against diarrhea for the total population but was unable to surpass the high threshold level of contamination in order to effect change in diarrheal disease rates for children under five. It is recommended that a multi-barrier approach which includes all three interventions be used to address high levels of diarrhea in Afghanistan as individual interventions did not consistently demonstrate effectiveness. Further study is required to investigate the impact of interventions aimed at improving sanitation, especially in conjunction with the multi-barrier approach described above.

Several other study questions arose during the course of the project which were examined as well. Among these were the following research areas: association between latrine condition and diarrhea; association between existing wells, their condition and diarrhea; seasonal patterns of diarrhea, bloody diarrhea, ARI and eye infection; correlation between ambient temperature, precipitation and disease occurrence; and the effectiveness of Community Health Workers as disease surveillance data collectors in an insecure setting.

Key Findings:

1. Diarrhea is widespread throughout the year, especially among children less than five years of age with two-week prevalence in this age group ranging from 13% in the winter to 40% in the summer.
2. Dysentery is also widespread, comprising 16-32% of all diarrhea cases and is more likely in adults with diarrhea than children.
3. Drinking water is often contaminated with fecal coliforms. Even after interventions were implemented, 49% of household drinking water was found to be contaminated with fecal coliforms in convenience sampling. Numerous sources of fecal contamination were frequently observed near water supplies and households in the study site. Contamination sources included poorly maintained latrines, defecation in open areas, open waste canals and inadequate burial of wastes.
4. Clorin along with an improved water vessel was not found to be effective in reducing diarrhea in the study population.
5. Cost-effectiveness analysis of the three intervention groups based on longitudinal data gave the following annual cost per case of diarrhea averted: $5.35 for Clorin and improved water vessel; $2.58 for the inclusion of all three interventions; $1.01 for improved tubewells alone; and $0.99 for hygiene education alone.
6. The combination of all three interventions was the only intervention group which was significantly associated with decreased diarrhea and bloody diarrhea in both the longitudinal and survey-based data.
7. After interventions were implemented, diarrheal disease levels were statistically higher in poorer households when compared to households with greater relative wealth, even though there were no economic barriers as all interventions were provided free of cost.
8. Handwashing with or without soap in or near the kitchen was found to be associated with decreased diarrhea prevalence.
9. Latrines were not found to provide protection against diarrhea at baseline survey but were protective one year later at follow-on. Further study is required to better understand these findings.
10. Interventions to improve drinking water and hygiene did not decrease levels of acute respiratory infection (ARI) or eye infection.
11. ARI was inversely related to ambient temperature; as temperatures dropped below 15˚C, ARI incidence rose dramatically and decreased again when daily temperatures rose above 15˚C.
12. Community Health Workers (CHWs) were effective disease surveillance data collectors.

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List of Acronyms

AIMS	Afghanistan Information Management System
AOR	Adjusted Odds Ratio
ARCS	Afghan Red Crescent Society
ARI	Acute Respiratory Infection
BHC	Basic Health Center
BPHS	Basic Package of Health Services
CDC	Centers for Disease Control and Prevention
CEA	Cost-Effectiveness Analysis
CHC	Comprehensive Health Center
CHW	Committee Health Worker
CI	Confidence Interval
CSO	Central Statistics Office
DACAAR	Danish Committee for Aid to Afghan Refugees
DALY	Disability-Adjusted Life Year
DID	Difference in Difference Analysis
FGD	Focus Group Discussion
HMIS	Health Management Information System
JHU	Johns Hopkins University
KAP	Knowledge, Attitudes and Practices Study
MOE	Ministry of Education, Afghanistan
MOPH	Ministry of Public Health, Afghanistan
MRRD	Ministry of Rural Rehabilitation and Development, Afghanistan
NCHFA	National Community Health Feedback Assessment
NGO	Non-Governmental Organization
NHSPA	National Health Services Performance Assessment
NSP	National Solidarity Programme
OR	Odds Ratio
ORT	Oral Rehydration Therapy
PAHO	Pan American Health Organization
PSI	Population Services International
RR	Relative Risk
SCA	Swedish Committee for Afghanistan
SES	Socio-Economic Status
SWSP	Safe Water Systems Project
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WatSan	Water and Sanitation
WHO	World Health Organization
WSG	Water and Sanitation Group
WSP	Water and Sanitation Programme
ZOA	ZOA Refugee Care, Dutch non-governmental organization

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Water collection in rural Afghanistan

1. Introduction

Afghanistan's health system has begun the comprehensive task of rebuilding after several decades of war, increasing isolation and the demise of its infrastructure. In examining the health indicators, clear evidence emerges that diarrhea remains a significant threat to the health of the population. As a leading cause of morbidity and mortality, the high prevalence of diarrhea among all age groups is critical to overcome if the country's health is to be improved. A 2001 study in Faryab Province found that diarrhea caused the most deaths across all ages at 25% followed by respiratory infections at 19.4%. The study also found that diarrhea caused 30.5% of deaths in children under five years of age and 40% of deaths in children 5-9 years.[1] Other studies have placed the prevalence of diarrhea within the country between 20-50% for children under five.[2] The result of this high diarrheal disease prevalence is an estimated 85,000 deaths annually among Afghan children.[3]

Use of unsafe water, poor hygiene and uncontrolled feces disposal are all associated with increased risk of diarrhea and contribute to about 1.5 to 1.8 million deaths of children globally each year.[4, 5] these conditions are all common in Afghanistan so it is not surprising that diarrhea plays such a significant role in the country's health. Current estimates by United Nations Children's Fund (UNICEF) place Afghanistan among the lowest in the world for using improved drinking water at only 39% of the total population.[6] Improved drinking water includes public standpipes, boreholes, protected dug wells and protected springs but does not include unprotected wells springs or surface water. When the rural population (where the majority of the population lives) is considered separately, the estimate of the population using improved water drops further to just 31%. To put this in a global perspective, UNICEF estimates that Afghanistan's population is ranked the third worst in the world in terms of the percentage of the total population using improved drinking water.

Of further concern is the influence diarrheal disease can have on the general health of a child. Diarrhea undermines the nutritional status and overall development of children by diminishing the nutrient uptake. Repeated bouts of diarrhea can lead to nutritional declines as evidenced by stunting and wasting.[5] Recent studies indicate that 49% of children under five in Afghanistan are considered underweight while 50% of children under five are chronically malnourished and an additional 10% suffer acute malnutrition.[3] In a vicious cycle, this comprised nutritional status leaves the child more vulnerable to diarrhea.

Historical evidence demonstrates that piped water systems dramatically reduced morbidity and mortality rates due to diarrhea in industrialized countries in the 19th century.[7] Based on this evidence, many countries focused on installing community-based improved water supplies during the last few decades in an attempt to duplicate this dramatic health improvement is less developed countries. In rural areas where populations are less dense and households are spread apart, improved water meant protected wells or protected springs generally shared among many households. However, the effect of providing water improvements other than piped schemes where piped schemes were too expensive has had mixed results. A recent review of interventions to decrease diarrhea concludes that interventions are strongly affected by current practices, field conditions and household compliance with interventions.[8] Findings such as these have lead the United National Environment Programme (UNEP) to suggest that water systems must be studied within their national context before assumptions can be made about the expected effectiveness.[9] In order to determine the best practices for a particular setting, the impact of those practices within the cultural setting must be understood through vigorous study.

The primary purpose of this study is to provide an evidence base for the most cost-effective method to reduce current rates of diarrhea in rural Afghanistan, particularly in young children, through improved water and hygiene. Effects of improved water and hygiene on eye infection and ARI are also included in this study. The General Directorate of Preventive Medicine's Office of Water, Sanitation and Hygiene Education in MoPH worked jointly with JHU to conduct this research with support from the World Bank. Leading drinking water improvements and hygiene education currently available in Afghanistan were studied to determine their individual and combined effects on diarrheal disease rates.

2. Background

2.1 Diarrhea Transmission

Diarrheal diseases are primarily transmitted through the fecal-oral route. This route is described when diseases enter a susceptible person through ingestion of fecal matter which is contaminated with pathogens. Transmission of disease-causing pathogens may occur through direct contact with contaminated fingers; or ingesting contaminated food, water or soil.[10] The pathogens which commonly cause diarrhea are bacteria (S*almonella, Escherichia coli, Camplobacter, Shigella dysenteria,* and *Vibrio cholera*), protozoa (G*iardia, Cryptosporidiam*), and viruses (*enteroviruses, Hepatitis A virus, rotavirus, norovirus*) which are then carried through fecal matter to contaminate food or water.[11]

Prevention of diarrheal diseases depends on breaking the routes of transmission. This can be accomplished through four general methods: by using source water of good quality and protecting the quality of the water until it is ingested; treating water to destroy pathogens prior to ingestion; protecting food from contamination through proper hygiene, cooking and temperature control; and avoidance of placing contaminated hands or other objects into mouths.

Where water supplies are limited and water quality is poor, water often becomes a major determinant of high diarrheal disease rates through unsafe drinking water and reduced water for hygiene. The use of surface water as a drinking water source dramatically increases the risk of fecal contamination as surface water is prone to runoff from livestock, poor sanitation and various other surface sources. Groundwater sources of water tend to be better protected as they originate below the surface which acts as a filter of contaminants. In general, water percolating through soil and rock becomes cleansed over time. Deep groundwater is usually considered to be higher quality and more desirable as a drinking water source.

Drinking from a hand-dug well, Wardak Province

In Afghanistan, the country is particularly subject to harsh water conditions due to periodic drought and low ground cover.[3] It is categorized along with the most water scarce countries in the world. While water is often scarce in this drought-prone country, potable (or

drinkable) water can be challenging to find.[12] Most of the population uses shallow hand-dug wells which are more prone to surface contaminants or surface water that is often highly contaminated with fecal material. The use of springs and kareze, however, may provide improved drinking water if the outlet it protected as these waters usually originate deep within the ground. A kareze is a traditional, constructed water source mainly used for irrigation which requires digging a horizontal channel underground to tap a source of water through gravity flow.

2.2 ARI and Eye Infection

A review of water-related diseases also suggests possible links between acute respiratory infections (ARI) and eye infections with drinking water supplies.[13,14,15] ARI prevalence in Afghanistan is estimated at 20% for children less than five years of age and, along with diarrhea, is a leading cause of morbidity and mortality in the country.[1,2,16] While increased risk for ARI has been found to be associated with some recreational waters, no conclusive evidence has yet to be found between ARI and drinking water.[12,17,18] Researchers have also found an association between access to water and the prevalence of trachoma.[19.20] The prevalence of eye infections in Afghanistan is unknown as it is not included in the current data collected by the Health Management Information System (HMIS). SWSP provided a good opportunity to examine potential associations between improved water and ARI and/or eye infection.

2.3 Study Site

Wardak Province to the west of Kabul was chosen as the study site due to its large rural population, high prevalence of diarrhea, the need for improved drinking water, accessibility to Kabul-based field staff and relative stability at the start of the project. Wardak has an estimated population of 413,000 of which 99% is rural, based on 2003 Central Statistics Office reports. The province is ranked near the national median in terms of provincial population at 18th out of 34 provinces.[21]

According to UNICEF, Wardak tends to be better off than many other provinces, having a generally improved status in multiple indicators when compared with national averages. The cumulative score of statistics covering health, environment, education and women's indicators ranks the province at the 7th highest out of 32 provinces.[2] Scores relating specifically to access to water, sanitation, vitamin A, iodized salt and the coverage of immunizations set Wardak above the national median while scores for access to education are only marginally above the national median. Women's health indicators place Wardak well below the national median.

While national population-based health statistics are not yet available, surveys of health facility catchment areas demonstrate that Wardak shows improved diarrheal disease rates over the rest of the country, although these rates are still quite high. In a 2004 survey, Wardak had diarrheal disease prevalence over the preceding 30 days of 34% for children under five and 12% for all ages combined while nationally the prevalence rates were 43% and 25% respectively.[22]

Based on an assessment of the existing improved water sources conducted in 2004, the District of Saydabad in Wardak was selected as the center of the project since 76% of the villages in Saydabad were found to be underserved by improved water points.[23] Existing water sources in the district were primarily hand-dug wells. The varying terrain of this district also provides a good cross-section of terrain found across the country. Saydabad varies from lush river valleys to dry, rocky mountains and flat, open, arid plateaus. Furthermore, much of Saydabad is accessible by road which would enable project interventions to be implemented in a timely manner as road access for well drilling equipment was considered good. The improved road through the district also meant the project would be less impacted by weather conditions. The site is approximately two to three hours from Kabul.

Saydabad District, Wardak Province

3. Study Design

3.1 Objectives

The Safe Water Systems Project (SWSP) was initiated to examine the effectiveness of leading interventions to improve drinking water and hygiene on diarrheal disease, ARI and eye infection. The specific objectives of the project include the following:

7. Describe knowledge, attitudes and practices concerning drinking water and related hygiene in rural Afghanistan
8. Identify household practices which impact diarrheal disease rates
9. Compare effectiveness of leading interventions for improving water and related hygiene, alone and in combination, on reducing the risk of diarrhea rates in rural Afghanistan
10. Compare costs of each intervention per case of diarrhea averted
11. Compare the effectiveness of improving water on reducing the risk of ARI and eye infection
12. Develop evidence base for national drinking water strategy and related policies

3.2 SWSP Interventions

The four interventions chosen for this study are the most readily available for rural households in Afghanistan and are currently in use in the country. The study design called for 400 households per each intervention and a control group to be able to detect a 20% change in the incidence of diarrhea given the following assumptions: a 5% per week incidence (new cases of diarrhea) for children less than five years; a design effect of two associated with the cluster design; and an average size of six people per household.

The project measured the effects on household diarrhea prevalence and incidence of: (1) liquid sodium hypochlorite ("Clorin") as commercially formulated and promoted along with an improved water vessel (2) hygiene education (3) improved tubewells and (4) liquid sodium hypochlorite and improved water vessel together with hygiene education and improved tubewells. Disease occurrence in a control population which received no active intervention was simultaneously measured. Past studies in locations around the world have demonstrated the effectiveness of each of these interventions in decreasing morbidity and mortality due to diarrheal disease. [24,25,26,27,28]

Note that throughout this report the following abbreviations are used to denote villages randomized to intervention groups: "Clorin" refers to the group of villages receiving Clorin and a safe water vessel for each household; "Hygiene" refers to villages where each household received hygiene education; "Wells" refers to villages where tubewells were installed or repaired; "All" refers to those villages receiving all three interventions together and "Control" refers to villages receiving no intervention.

3.2.1 Clorin

Clorin

Clorin is a point-of-use disinfectant developed by the Pan American Health Organization (PAHO) and the Centers for Disease Control and Prevention (CDC) in the 1990s. It is comprised of a 0.05% sodium hypochlorite solution that can be locally produced with water and salt through an electrolytic cell. As a social marketing approach to improving health, Clorin is currently made available in Afghanistan at the subsidized price retail price of 17 Afghanis (approximately US$0.34) by the United States Agency for International Development-funded organization known as COMPRI-A. COMPRI-A is responsible for overseeing production in Kabul, including monitoring and maintaining the quality of Clorin. Quality assurance testing on samples collected in Kabul is conducted by CDC in Atlanta, Georgia (personal communication with COMPRI-A in Kabul).

Clorin is easy to use and is intended to leave a chlorine residual in the treated water that is available for further disinfecting after the initial treatment. The residual, when present, adds value through its potential to continue treating potentially harmful microbes in drinking water.[29,30] Contamination of drinking water after collection leads to a significant amount of diarrhea prevalence making residual treatment important to breaking disease transmission.[31]

To further protect drinking water supplies during storage and dispensing, a specially designed 20L plastic vessel was distributed with Clorin. These improved water vessels have a narrow mouth, tight-fitting lid and spigot to decrease the likelihood of hands or other unhygienic items from coming into contact with the water. Previous studies have suggested that Clorin along with an improved water vessel may reduce diarrhea prevalence by 15- 48%.[30,32] Both the Clorin and water vessels were produced in Kabul and were provided at no cost to the project households.

Improved
Water Vessel

3.2.2 Hygiene Education

Hygiene plays an important role in diarrheal disease transmission with numerous studies demonstrating the association between poor hygiene practices and increased risk of diarrhea.[33,34] The extremely low levels of hygienic conditions across Afghanistan contribute greatly to the contamination of drinking water sources. Hence, hygiene education has become a regular feature

of many Afghan health projects. MoPH, Ministry of Rural Rehabilitation and Development (MRRD), Ministry of Education (MoE), US Agency for International Development (USAID), UNICEF, World Health Organization (WHO) and many Non-Governmental Organizations (NGOs) have all been involved with developing materials for hygiene education programs in Afghanistan but there is little data on the effectiveness of these programs. There is much ongoing debate within Afghanistan as to how to present hygiene messages, how often they need to be repeated and how best to change national hygiene norms. [2, 35,36,37,38]

The essential messages contained in most programs focus on the following five points:

1. Use protected drinking water
2. Improve environmental sanitation, especially the use and maintenance of latrines
3. Improve personal hygiene, especially handwashing practices
4. Protect food from contamination
5. Use oral rehydration therapy (ORT) when diarrhea occurs to prevent dehydration

Handwashing Items

3.2.3 Improved Water Sources -- New or Repaired Tubewells

The use and distribution of tubewells topped with handpumps is increasing across Afghanistan. Hand dug wells traditionally have been the primary type of wells found in the country, especially in rural areas, as they are less expensive than tubewells and can be installed and easily maintained by the community. However, they are more prone to surface contamination, drought and seasonal water variations due to their reliance on shallower water supplies. As a result, government and NGO providers are increasingly installing deeper drilled wells to ensure a better, more sustainable water supply.[39] According to study design, wells installed for the project would consist of new tubewells drilled by percussion rigs. These rigs are easy to transport, can access more remote areas, and are often locally owned.

New Tubewell

The new tubewells would be installed following the national standard of an average of one new well for each 25 families.[36] Each site for well drilling would be determined through community consensus in consultation with an engineer. Conditions for appropriate well siting included choosing a location that would ensure community ownership, accessibility to women and no obvious sources of contamination close to the site. If the location was on private property, the land must be donated to the community to ensure access to all.[40] Where possible, existing tubewells which were inoperable due to mechanical failure were repaired.

At the conclusion of the disease surveillance phase of the project, all villages that did not receive new tubewells as part of their intervention group were to have new wells installed.

3.2.4 All Three Interventions

The effect of combining all three interventions was sought to find if the added benefits would provide protection from diarrheal disease, ARI and eye infections beyond the sum of the individual components. This intervention was designed to follow the methods of each single intervention above but with the three occurring simultaneously in selected villages.

3.3 Intention-To-Treat Analysis

Research and analysis in SWSP was designed to provide results based on field conditions (effectiveness) rather than attempt to reproduce laboratory conditions (efficacy). Each village meeting the inclusion criteria was equally likely to be assigned to any one of the four intervention groups or control. By design, all households randomized into an intervention group are kept within their originally assigned group, regardless of whether or not they adhered to the intervention. This method allows for "real-life" results aimed at best understanding the practical impact of interventions while maintaining the validity of the study by reducing the possibility of biases. If, for example, an intervention has been shown to be quite effective in reducing diarrhea under ideal circumstances but is not likely to be culturally acceptable in rural Afghanistan, the study would demonstrate this reduced effectiveness in the field.

Randomization is an important component of the project protocols that aims at controlling for unknown variables that may influence or bias the outcomes. If a variable other than the intervention itself could influence an outcome, randomization helps insure that households with this variable are equally distributed among intervention groups. Intention-to-treat analysis retains the original randomization for all analysis.[41]

3.4 Ethical Approval

The study protocol was approved by both the Ethical Review Board of Afghanistan's Ministry of Public Health and Johns Hopkins Bloomberg School of Public Health's Committee on Human Research.

4. Methods

4.1 Project Partners

An advisory committee was created with key stakeholders to regularly discuss and oversee the project development and implementation. Meetings began in April 2005 and continued approximately every two weeks through the initial study design and implementation period. While membership was open to all interested parties, regular contributors to the advisory committee included representatives of MoPH, MRRD Rural Water and Sanitation Office, Wardak provincial health department, Danish Committee for Aid to Afghan Refugees (DACAAR), Population Services International (PSI), UNICEF, Swedish Committee for Afghanistan (SCA), ZOA Refugee Care (ZOA) and JHU. Furthermore, SWSP staff participated in the Secretariat of the Supreme Council of Water Affairs Management, the Water and Sanitation Working Group of MRRD and many other national level water policy discussion sessions.

Community input was gathered through meetings with the District Commander of Saydabad, a district-wide National Solidarity Programme community shura meeting, and ongoing discussions with village leaders and elders. Field staff also provided ongoing feedback from households and village representatives. Four health facilities provided meeting space and

support during the disease surveillance portion of the project: Shah Qalander, Afghan Red Crescent Society (ARCS) Sheikhabad, Tangi and Onkhai Clinics. Additional space and support was provided by the SCA's training center in Saydabad.

SWSP partnered with two NGOs to implement the interventions. DACAAR was chosen to oversee the installation of tubewells. DACAAR has been working in Afghanistan since 1988 and is known for its leadership in developing improved water for rural communities. DACAAR also works to ensure community ownership and responsibility for the wells.

The other leading partner was PSI who provided support for SWSP interventions through supplying Clorin and improved water vessels at cost as well as trained Clorin and hygiene educators. Clorin was first introduced to the Afghan market by PSI in June 2003.[42] PSI established an extensive network of sales and marketing of Clorin. It was the sole producer of Clorin under a contract with the Center for Disease Control and Prevention through USAID. Management Sciences for Health (MSH) and subsequently COMRI-A took over the production and marketing of Clorin after PSI's Afghanistan office was closed in October 2005.

4.2 Sample Selection

Initial village site selections within Wardak were based on a village-level water availability survey conducted by DACAAR. Completed in December 2004, the "Water and Sanitation Programme Survey Report of Saydabad Wardak," in Saydabad District provided detailed description of water sources utilized by district households.[23] At the time of the survey, DACAAR found that 37.2% of the District families used "safe" or improved water sources and 62.8% used "unsafe" water sources. Improved drinking water includes public standpipes, boreholes, protected dug wells and protected springs but does not include unprotected wells, springs or surface water.

Permission to operate the project within the region was requested and received from the Wardak Provincial Governor and Saydabad District Commander. Prior to visiting households, meetings were held at the district level and within each village to communicate project objectives and methods to community leaders including (but not limited to) village elders, mullahs and teachers. Permission was received from village elders before the project approached individual households. No village refused to become involved in the study.

Interventions were allocated across numerous villages and district regions to decrease the likelihood of any one intervention being adversely affected by a localized disease outbreak which would distort the findings. Only one intervention group was initiated in any one village or geographically separated portion of a village in order to limit cross-over between interventions.

The project aim was to have a broad representation of villages while still maintaining similar village profiles across intervention groups. Villages were classified by two characteristics to ensure comparability between intervention groups: size (as measured by the total number of households reported by village elders) and location. The range of households included from any one village was from 11-120. Locations within the project area were divided into four regions according to the closest health clinic: Shah Qalander Basic Health Center (BHC), ARCS Sheikhabad BHC, Tangi Comprehensive Health Center (CHC) and Onkhai BHC. These regions represented a variety of environmental conditions including lush river valleys, barren hillsides, and flatlands. While some villages were along the main "ring" road that runs through Saydabad, others were more remote and difficult to access by car.

4.2.1 Eligibility for Villages

Villages were selected using the following criteria:

1. Security assured for local survey teams and project personnel

2. Permission was granted by relevant authorities
3. Water access and utilization patterns met study criteria of less than one improved water source per 50 households (or less than half the availability of improved water sources recommended by national policy)
4. In villages eligible for new tubewells, the community agreed to support post-construction maintenance. The community must also have been willing to appoint a maintenance person and this person must have been willing to attend maintenance classes. Furthermore, the community was willing to pay for any maintenance cost occurring in the future.
5. Access to the village was likely during the study period
6. Local advice by development organizations and local leadership supported the selection of the village.

4.2.2 Eligibility for Households

Households within the selected villages were chosen on the following basis:

1. Permission was granted by relevant authorities
2. Prevalence of diarrhea in the area made this a suitable potential study household
3. Household provided informed consent to participate
4. Household agreed to cooperate with conditions of the study, such as obtain water from specific sources, chlorinate domestic water, supply the survey team with information on household diarrhea on a periodic basis, and not to resell supplies provided to the household.

4.2.3 Informed Consent

Informed consent was obtained from all participating households. Each household was read a consent form by one of the survey team members prior to being enrolled in the study. The other surveyor witnessed whether or not consent was given and signed the form attesting to the response. A copy of the consent form was left with each household which contained SWSP contact information should the household have any questions or wish to rescind their consent at a later time. As individuals in project households spoke Pashto, interactions with villages and households were conducted primarily in Pashto. All survey instruments and consent forms were translated from English to Pashto.

4.2.4 Randomization to Five Study Groups

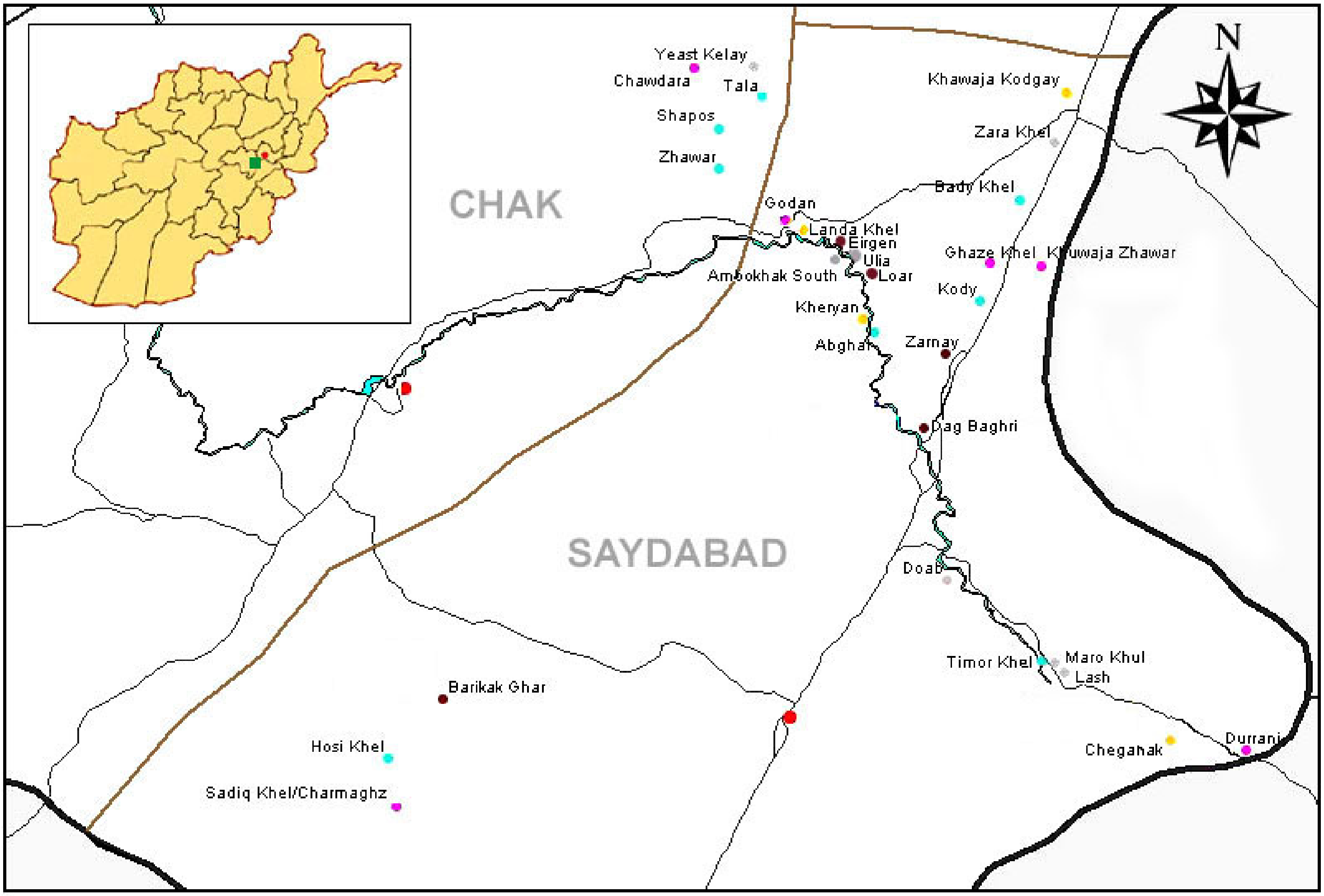
Once permission was received from villages identified for inclusion in the project, the villages were systematically randomized into one of five study groups. To randomize, villages were ranked from largest to smallest according to population estimates obtained from village leaders. Each of the five intervention groups was then assigned a number from one to five. A random starting number from one to five was generated. This random number was assigned to the village at the top of the list while the next village on the list was assigned the next sequential number. The assignment of intervention groups followed in numerical order, cycling through the five numbers corresponding to the five intervention groups until all villages were assigned an intervention.

Village site selection was coordinated with the National Solidarity Programme of MRRD and ZOA as both had projects operating in the district of Saydabad. The final list of 32 villages selected for participation in the project included sites in both Saydabad and Chak districts of Wardak Province. The project was intended to be entirely located in Saydabad District of

Wardak; however several Chak District villages near the border of Saydabad were included due to errors in current maps. (For complete list of study villages see Annex 5).

Below is a map showing the distribution of interventions by village. The map is based on Afghanistan Information Management System (AIMS) data files and does not match local district demarcation as found in the field.

Figure 1: SWSP Project Map, Wardak



Key:

Intervention Groups
- Clorin & Vessel
- Hygiene Education
- Tubewells
- Tubewells + Clorin/Vessel + Hygiene Education
- Control

Road
River
District Center
Provincial Line
District Line

NOTE: Map based on AIMS data, boundary lines not accurate

4.3 Intervention Implementation

Interventions began in June 2005 in participating villages. It was expected that all interventions would be completed with two months.

4.3.1 Clorin

Implementation of the Clorin intervention proceeded as designed. Households randomized to the Clorin study group each received an initial one month supply of Clorin, a new, plastic 20 liter water vessel and training on appropriate use from a team of Clorin educators. The teams visited each household for 20 to 30 minutes, using illustrated cards to demonstrate proper use (complete translation of messages can be found in Annex 6). A pamphlet outlining the instructions through illustrations and text were distributed to each household. Trainers explained to household members that they would be expected to treat their drinking water supply with Clorin throughout the study. Continuing free supplies of Clorin were distributed throughout 16 months of disease surveillance.

4.3.2 Hygiene Education

Implementation of the Hygiene Education intervention also proceeded as designed. In the Hygiene study group, SWSP utilized the previously developed hygiene education curriculum produced by PSI and USAID as the development of an updated national hygiene education package was not completed at the time of the project commencement. Hygiene education messages were communicated through pictures printed on large cards and accompanied by spoken hygiene messages on safe water practices relating to the five key messages listed above (complete translation of messages can be found in Annex 6). These messages were delivered by teams of PSI and JHU trained educators in house-to-house visits lasting approximately 30 minutes each. Households in the Hygiene group were visited by the teams twice during the summer of 2005 with approximately one month between each visit.

4.3.3 Tubewells

The original study design called for the use of percussion well drilling rigs to develop the new tubewells. In the village of Kody, this also included improving an existing, failed hand dug well by deepening it with percussion rigs. Community outreach and well maintenance programs followed standard Ministry of Rural Rehabilitation and Development (MRRD) policy. Labor and natural materials, such as stones, were often provided by the community but no monetary inputs were required of the villages. Once drilled, each well was completed with 4" PVC casing, a filter, gravel pack and back fill to protect the deeper, generally better quality water from groundwater contamination. To finish the well, it was equipped with an Afridev handpump. Construction of intervention wells was expected to occur over two months, June and July 2005.

Several barriers were encountered which prevented completion of the Wells intervention. The main barrier to successful interventions was the lack of water-bearing rock strata in several villages combined with the lack of sophisticated drilling and pumping technology that limited well development strategies. Additional barriers to new wells included insurgent threats against well-drilling staff and villages along with poor road conditions in outlying villages which prohibited the use of heavier drilling equipment. The conditions described above resulted in slow progress of the implementation of tubewells and necessitated a one-year extension of the project. Actual construction of intervention wells began in June 2005 and was completed where possible by May 2006. No wells were drilled from November 2005 through March 2006 due to weather and road conditions.

To improve the well installation success rate, wells in primarily mountainous or rocky areas were installed using rotary rigs. This more sophisticated equipment is faster and better able to penetrate rock; however it is also less common in Afghanistan, too large and heavy for smaller village roads, much more costly and difficult to maintain and repair.

Well drillers were unable to successfully install any wells in two of the villages that were randomized to well intervention groups. These villages are Ghaze Khel in the All group and Bady Khel in the Wells group. Six failed wells were drilled between these two villages. Other failed wells were encountered in the villages of SadiqKhel/Charmaghz and Hosi Khel; however further efforts eventually succeeded in these villages.

4.3.4 All Three Interventions

The fourth study group received a combination of each of the interventions discussed above. Training in the proper use of Clorin and hygiene education sessions were conducted consecutively at each study household. Well installation followed the methods described above, with drilling attempted unsuccessfully in the village of Ghaze Khel.

4.4 Data Collection

SWSP collected both qualitative and quantitative data. Definitions of several critical study variables were established to provide standards for data collection and used throughout the project. These included the following:

- Household - People who ate from the same meal the night before
- Diarrhea - 3 or more loose, watery stools within a 24 hour period
- Acute Respiratory Infection - Coughing, wheezing, shortness of breath or difficulty breathing
- Eye Infection - Red eye with clear, purulent (pus) or discolored discharge. Patient may or may not complain of pain or change in vision
- Latrine - An enclosed sanitary facility which is intended to hygienically contain feces and prevent stored feces from contaminating the area

4.4.1 Qualitative Research

Qualitative data focused on understanding the knowledge, attitudes and practices of the community concerning drinking water and hygiene through key informant interviews and focus group discussions (FGDs). Key informant interviews were held with community leaders, MOPH and MRRD staff, NGO rural water supply field staff, UNICEF and WHO representatives. Literature reviews drew information from peer-reviewed journals through PubMed and unpublished articles from NGO working in Afghanistan.

Two distinct sets of FGDs were held during the course of the project. In July 2005, eight FGDs were held in Saydabad District within four control group villages. The villages were Doab, Ambokhak South, Lash Timor Khel and Zarakhel. Four of these discussions included only women and four included only men. Between seven and ten individuals participated in each FGD. Subjects were selected who were long term residents in the community, respected by their community, and had a good knowledge of water handling practices. Discussion centered on attitudes toward water and water-borne diseases, water handling practices as well as perceptions of water hygiene. Questions also explored the acceptability of chlorinated water. Each session

lasted one to one and a half hours. At the end of each session, a pen was given to each individual who participated. (Summary of the results can be found in Annex 4, FGD 1)

In October 2006, four FGDs were held in Saydabad with the disease surveillance teams, two for men and two separately for women. The primary focus of these discussions was to better understand the impact of their work as data collectors. No incentive was given to participants; however their travel to the discussion site was paid. Each discussion lasted approximately one and a half hours. (Summary of the results can be found in Annex 4, FGD 2).

4.4.2 Quantitative Research

Quantitative data was collected in all project households through two methods: household-level surveys conducted before and after interventions, one year apart; and twice-weekly disease surveillance. The data collection was designed to run from May 2005 through September 2005. However, delays caused by slow well implementation lead to a one-year extension. Therefore, quantitative data collection was conducted from May 2005 through September 2006.

Surveys

Conducting household survey

There were two main surveys conducted during SWSP, a baseline survey in May 2005 and a follow-on survey one year later in May 2006. A team of 16 surveyors was trained over the course of two days in Kabul for the baseline survey at the beginning of May 2005. The survey instruments were field tested within Kabul (See Annex A for Baseline and Follow-On Survey instruments). The baseline survey collected data on household demographics, hygiene, water collection, water storage and diarrheal disease occurrence.

Households were selected for inclusion in the study during the baseline survey. In villages smaller than 120 households, all households were asked to participate. In villages larger than 120 households, a random start was used to select four groups of 30 households each. No more than 120 households were included from any one village.

The random start was determined as follows: the total village area was surveyed and a mid-point was roughly established. At the mid-point, the village was again divided into half in the perpendicular transect. A coin toss determined which side of the village would be the starting point. Within each quarter, one end of the village was chosen as a starting point for numbering and households were assigned unique numbers, starting at 1 and continuing in numerical order. Subsequently, the last two numbers of the serial number on the paper currency of Afghanistan, the Afghani, were used to determine the starting number. Next, the 30 households closest to that starting point were surveyed.

During the follow-on survey, attempts were made to revisit all households originally surveyed at the baseline. No new households were accepted into the study at this time. The

follow-on survey contained most of the same questions found in the baseline with a few additional questions. These additions included questions on household assets, adult education levels and the prevalence of ARI. The list of household assets was developed from principal component analysis of Wardak provincial data in the 2004 National Community Health Feedback Assessment (NCHFA) which randomly sampled households in health facility catchment areas. The follow-on survey also asked households if they used salt to treat their drinking water in the belief that it would improve the water quality.

Disease Surveillance

Data was collected on an individual level for all household members on the incidence of diarrhea, bloody diarrhea, ARI and eye infection. Attempts were made to visit each household enrolled into the study at baseline twice per week starting in mid-June 2005. With the extension of the project, this data collection continued uninterrupted through September 2006, 15 and 1/2 months in total. Longitudinal data collected during disease surveillance identified changes in disease rates over time in the various intervention groups.

Earlier formative research had shown evidence that the principal female in the household would provide the most reliable data on household disease occurrence.[43] Whenever possible, the wife of the head-of-household was requested to participate in the study. In this rural setting, it was inappropriate to expect a male data collector to speak directly with a female in the household while a female data collector could not travel from household to household without a male counterpart. Therefore, all attempts were made for surveillance teams to be comprised of one male and one female.

After discussions with the MoPH, it was decided that project staff would train Community Health Workers (CHWs) and a partner, both from the project regions, as disease surveillance data collectors. Inviting CHWs to conduct surveillance provided several advantages: they could move easily in the community; they were familiar with local customs and protocols; they would be less hindered by changes in weather; and the project could provide them with added training and experience that would support their work. Contracting with CHWs was coordinated with SCA, implementing partner of the Basic Package of Health Services (BPHS) in Wardak. All CHWs in the region at the time of project commencement were male.

The data collectors were required to work outside their home village in a neighboring village to decrease the likelihood of bias. These disease surveillance teams were trained in Saydabad in early June 2005. All training was conducted separately for males and females. Of the 20 “teams,” 2 were unable to locate females available to work outside their homes. Where CHWs were not available, teachers or clinic staff were contracted as data collectors. Each male/female data collection team had at least one literate person, usually the male.

At each household visit data collectors asked if anyone in the household had diarrhea, bloody diarrhea, ARI or eye infection since the last visit. For any case found, the person’s name, sex and age were recorded along with the type of disease from the four categories. For each case of diarrhea found during the surveillance period, two packets of ORS were given.

Field notebooks were used to record data. This information was transferred to reporting notebooks which were collected every other week for data entry and monitoring. Chlorine residuals were randomly checked throughout the study period using LaMotte Insta-Test3 strips (LaMotte Company, Chestertown, MD).

Additionally, surveillance data collectors conducted a complete household census two times during their field work, once in the summer of 2005 and again at the end of the project in October 2006. These censuses were used to determine the total population at risk for disease.

4.4.3 Additional Information Collected

Bacteriological testing for fecal coliforms was performed on water samples from each village. Two rounds of water sampling in study villages were conducted to assess drinking water quality at the source and within the household. The first round of sampling was conducted in July 2005. Project field staff was trained in water sampling techniques. Between four and twelve samples were collected from each village, depending on the size of the village. Samples were first collected from the household drinking water container and then from the corresponding drinking water source. All samples were checked for chlorine residuals.

Water sampling

Quality control measures were also performed through the use of approximately one blank sample (distilled water) for every 25 samples and one duplicate for every 15 samples collected. These quality control samples were not identified as such to laboratory staff. Samples were transported on ice from the field to a water lab in Kabul within 5 hours of collection, within WHO guidelines.[44] The first round of samples was analyzed in the DACAAR water quality lab in Kabul. The second round of sampling was conducted in April 2006. Similar methods as above were used, however, the water analysis was carried out in the MOPH water quality labs in Kabul. Additionally, DACAAR conducted chemical and microbiological analysis of water from each new well. When necessary, testing was repeated to ensure water safety. All water samples were based on convenience sampling to get an indication of contamination levels in the source and household water supplies. These samples were not random samples and therefore have limited interpretation.

To better understand the impact of latrines, a brief study of latrine conditions in SWSP households was conducted during the month of September 2006 in all study households. CHWs were trained in administering a short questionnaire and given 30m tape measures necessary to evaluate latrine set-back distances (see Annex 1, Survey 3).

The Health Management Information System (HMIS) of MoPH provided data on outpatient clinic visits at health facilities within the project vicinity. The data was collected from March 21, 2005 through September 22, 2006 (the first day of the Afghan calendar year 1384 through the sixth month of 1385). Several HMIS categories were collapsed to better match

SWSP disease surveillance categories. "Cough & cold," "ENT" and "Pneumonia" were combined for ARI while "Acute Water Diarrhea" and "Diarrhea with Dehydration" were combined for Diarrhea. Eye Infection data is not currently collected by Afghanistan's HMIS.

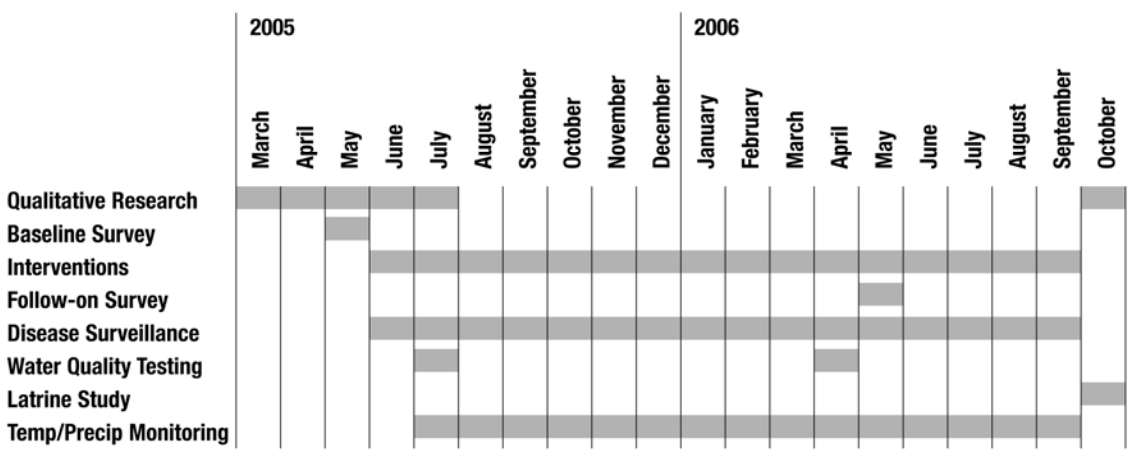
Monitoring of ambient temperature and precipitation at two sites within the SWSP region was conducted from July 2005 through September 2006. Initially the two sites were Sheikhabad ARCS Clinic and Sayadabad SCA Training Center. The Sheikhabad ARCS recording site was closed in early December 2005 and a replacement monitoring site at the Tangi CHC began later in December. Daily readings were recorded throughout the active study phase by local health clinic staff.

4.5 Additional Study Questions

Several other study questions arose during the course of the project which were examined as well. Among these were the following research areas: association between latrine condition and diarrhea; association between existing wells, their condition and diarrhea; seasonal patterns of diarrhea, bloody diarrhea, ARI and eye infection; correlation between ambient temperature, precipitation and disease occurrence; and the effectiveness of Community Health Workers as disease surveillance data collectors in an insecure setting. Throughout this report, "insecure setting" refers to an area with increased concern for safety and well-being due to ongoing conflict or threat of violence.

Figure 2 below provides a summary timeline of all data collection and field activities conducted during SWSP.

Figure 2: SWSP Timeline



4.6 Data Management

Data was checked daily in the field and again in the Kabul office for accuracy and completeness. Supervisors accompanied surveyors to the field during both the baseline and follow-on surveys. Supervisors sat in on survey interviews with each team and reviewed data forms before leaving the field. Errors or omissions on surveys which were found on the day of collection were reviewed with surveyors. Where possible, surveyors corrected data or revisited

households to obtain correct information. Changes to survey data forms were not made if they could not be confirmed.

Kabul-based field staff met with surveillance data collectors on a regular basis to collect data and review any errors found. Errors and data in need of clarification were noted on monitoring forms and returned to data collectors for revision at the next household visit. Initially, meetings were held weekly with data collectors. After several months, this schedule switched to every other week as data collectors became proficient in their work and security concerns were heightened.

Additionally, unannounced monitoring visits by Kabul-based field staff were conducted at least three times in all project villages. During these visits, surveillance data was checked by conducting household interviews to see how well they correlated with surveillance data notebooks. Discrepancies were noted and protocols were reviewed with data collectors as needed. Consistent errors made by one of the data collection teams necessitated the replacement of that team. This was the only team replacement due to data collection errors. Three other data collectors were replaced when they left for other work.

Age groupings were thought to be the most prone to inaccuracy due to the lack of date awareness in rural villages. It was assumed that mothers would know the age of their children up to approximately one year. However, dating past one year became more difficult. Data grouping into the following three age ranges decreased the impact of this difficulty: less than one year, one to less than five years, and five or older.

Missing data that could not be verified or referenced from existing data was left missing. No imputation of missing data was performed. All data entry was entered in Kabul and verified by two separate people. All original data forms were only accessible to data entry operators, project manager or deputy project manager once submitted by field staff.

4.7 Analysis Methods

The following epidemiological and statistical terms were used to describe disease occurrence in the study population:

- Prevalence – Total number with disease in the population during a specified time divided by the total number at risk in the population at that time. Throughout this project, prevalence refers to disease occurring during the two weeks immediately prior to the survey. Also, prevalence can be measured by household or individual. For example, a household diarrheal disease prevalence of 0.25/two weeks means that 25% of all households in the study population had at least one person with diarrhea during the previous two weeks.[45]
- Incidence – Total number of *new* cases of a disease during a specified time divided by the total number at risk in the population at that time. This project examined incidence as new cases in individuals per week. For example, an individual diarrheal disease incidence of 0.25/week means 25% of all individuals in the study population had a new case of diarrhea during that week. [45]

Significance testing of data analysis was based on p-values ≤ 0.05.

4.7.1 Baseline Data Analysis

Baseline data was entered in Kabul into Excel while cleaning and analysis were performed using Stata 9.2 (StataCorp, College Station, TX) by JHU in Kabul and Baltimore. All

data were entered by one operator and each entry was checked for accuracy by another data entry operator. Baseline data analysis included summary statistics of household responses to each question. Diarrheal disease prevalence during the two weeks prior to the survey was measured through cross-sectional analysis. Logistic regression analyses were used with household and individual diarrhea prevalence as the units of analysis; variables found to be associated with diarrhea prevalence were included in modeling.

4.7.2 Longitudinal Data Analysis

All disease surveillance data was entered by one operator and individually verified by another. The data was entered in Excel in Kabul and analyzed at JHU in Baltimore using R software (GNU Project free software).

Overall incidence rates on a per person-week basis were calculated for the period of interest, June - Sept. 2006. Incidence rates were needed to determine the annual number of averted diarrhea cases and cost-effectiveness per case of diarrhea averted (see 4.7.4). For each study visit during that time, a person was considered to have an incident case of illness if 1) he/she was recorded as sick at that time point, and 2) he/she was not sick at the most recent visit preceding the current visit. The number of incident cases was summed over all people and over the entire period of interest to get the total number of incident cases. Person-time was computed by taking the estimated number of individuals in the village (for which were used the mean of the number in the surveillance data and the number in the post-survey), and multiplying this number by the number of weeks of interest, which for this period was 17.3. This gave total person-time under surveillance. To get at-risk person-time (which was required for incidence rates) at each time point if a person was recorded as sick, the length of time immediately following that visit until the next study visit would be subtracted from the total surveillance person-time computed above. That time was subtracted because the person was not considered "at-risk" of having an incident case of illness, since he/she is already recorded as ill, and therefore, according to our definition of an incident case above, cannot have an incident case at the next study visit. This subtraction was done at all time points of interest, and what remained was total at-risk person-time. Finally, the total number of incident cases was divided by the total at-risk person time to obtain the incident rate reported for that village. Incident rates for the entire intervention group were the population-weighted mean of the village level incident rates. Again, the population number used is the mean of the surveillance and post-survey numbers. Therefore, villages with larger populations had greater weight in the mean.

In addition to calculating the overall incidence rate for the period of June – September 2006, the incidences of diarrhea were calculated over time for each twice-weekly assessment in all intervention groups over the entire 16 month surveillance period. These rates were calculated as the number of new cases of diarrhea over the denominator of the number of persons without diarrhea at the previous assessment. Persons with diarrhea at the previous assessment were not counted in this denominator as they were not "disease free" and therefore not at risk.

To determine the number of cases of diarrhea averted in the total population, two time periods were used, the non-peak diarrhea months from October 2005 - May 2006 and the peak diarrhea season from June 2006 - Sept. 2006. Peak diarrhea months were determined by the Office of Water Quality, Sanitation and Hygiene Education at the MoPH (personal communication). Averted cases were calculated separately in each period and then summed together to obtain cases averted during the entire year. In the summer, the risk difference for each intervention group was computed by subtracting the intervention group incidence rate from the control group rate for the summer period. This risk difference may be interpreted as the mean number of cases averted per person-week during the summer period. Therefore, total cases

averted during this period were the risk difference multiplied by the number of person-weeks under consideration. This would be the number of people receiving the intervention, multiplied by the number of weeks in this period (17.3). In the non-peak months, intervention group incidence rates were estimated by first finding the control group incidence during this period and then adjusting this rate by the corresponding percentage difference between that intervention and control found in the summer period. For example, if the intervention group incidence rate found in the summer period was 0.8 of the control group incidence rate found during the summer period, then the estimated non-peak incidence rate for that intervention group would be 0.8 of the incidence rate found for the control group during the non-peak months. Once non-peak incidence rates were estimated, the same procedure used above was applied to the non-peak period: risk difference was computed and multiplied by the number of people that received the intervention and the number of weeks under consideration (34.7).

The annual number of averted diarrhea cases was estimated from incidence rates during the period of June – September 2006 for each intervention compared to the control group. The rest of the year was found by computing the non-summer incidence rate (Oct 2005 - May 2006) in the control group, and then estimating what the incidence rate would be in each intervention group by using the same percentage change between intervention and control found in the summer months. As an alternative analysis, logistic regression models were created using the outcome of the odds of being a new case at each given time *t* conditioned on being disease free at time *t-1*. Cases with diarrhea at time *t-1* were considered as missing in the analyses. In addition, persons with no data at *t-1* were also not included in this analysis. Missing data occurred frequently due to persons leaving the village to look for work elsewhere, and from new births and deaths.

Monthly prevalence rates for each of the four illnesses were stratified by intervention group. Prevalence rates were plotted and shown in the following section, at the intervention group level against time. Twice-weekly incidences of diarrhea for all age groups and for children less than 5 years of age for each intervention group as compared to the controls were also plotted.

4.7.3 Follow-On Data Analysis

The follow-on survey was completed by the end of May 2006. Follow-on data underwent double-entry in CSPro in Kabul and analyses in Stata 9 (StataCorp, College Station, TX).

The difference-in-difference (DID) analytical method is used to estimate the effect of the interventions on the change in diarrhea and bloody diarrhea prevalence over time. This method examines the change in disease from the baseline survey (pre-intervention) to the disease levels at the follow-on (post-intervention) for each treatment group. When this change in prevalence is expressed as on odds ratio, a value greater than 1 indicates that the odds of diarrhea at follow-on is greater than the odds of diarrhea at baseline, while a value less than 1 indicates a lower likelihood of diarrhea at the follow-on survey as compared to the baseline. The intervention-specific ORs for disease prevalence over time are then compared to the corresponding OR for the Control group, controlling for confounders.

To estimate the DID in a logistic regression framework the following model was used:

$$\text{logit}(P_i) = b_0 + b_1\text{time} + b_2\text{Clorin} + b_3\text{hygiene} + b_4\text{wells} + b_5\text{all} + b_6\text{time*Clorin} + b_7\text{hygiene*time} + b_8\text{wells*time} + b_9\text{all*time} + cX_i$$

where 'Pi' is either 1) the probability that the i^{th} household has had at least one member with diarrhea in the past two weeks, or 2) the probability that the i^{th} individual has had diarrhea in the previous two weeks; 'time' equals 1 for follow-on, 0 for baseline; the variable 'Clorin' equals 1 if the i^{th} household (or individual) is in the Clorin treatment group, 0 otherwise; 'hygiene' equals 1 if the i^{th} household is in the Hygiene treatment group, 0 otherwise; 'wells' equals 1 if the i^{th} household is in the Wells group, 0 otherwise; 'all' equals 1 if the i^{th} household is in the All treatment group, 0 otherwise; the treatment variables multiplied by 'time' represent the treatment-by-time interaction terms, and X_i is a vector of demographic and clinical characteristics for the i^{th} household or individual.

The interaction terms associated with the regression coefficients b_6 through b_9 represents how the effect of each intervention modifies the change in odd ratio of disease over time from that seen among the controls. In other words, these terms in the regression model allow the ORs of the change in prevalence to vary by intervention group. For example, from the model above the exponential of b_1 (e.g. $\exp(b_1)$) represents the ratio of the odds of diarrhea at follow-on to the odds at baseline for the Control group. Similarly, the exponential of b_1 plus the interaction coefficient associated with a given treatment group (e.g. $\exp(b_1 + b_6)$ for the Clorin group) gives the odds ratio of diarrhea at follow-on to baseline for that treatment. If the 95% CI associated with the interaction term does not include 1, then the ratio of the odds of diarrhea over time for that intervention group is statistically different than the odds ratio for the Control group. Mathematically, this is equivalent to the ratio of two odds ratios: the numerator being the difference in the likelihood of a person having diarrhea between the follow-on and baseline in the intervention group, while the denominator is the difference in the likelihood of a person having diarrhea between the follow-up and baseline in the control group (e.g. $\exp(b_1+b_6)$ / $\exp(b_1) = \exp(b_6)$ for the Clorin group versus the Control group). If the exponential of the interaction coefficient is greater than one, then the likelihood of a household or individual having diarrhea over time increased more in the intervention group as compared to the control group. This indicates a failure of the intervention to either reduce or at least slow the increase in diarrheal disease levels. If the exponentiated coefficient is less than one, the likelihood of a household or individual having diarrhea declined more over time in the intervention group compared to the control group. This indicates a positive effect of the intervention. A coefficient of one indicates that both intervention and control groups experienced the same change over time.

Analysis of asset-related survey questions added to the follow-on survey provided insights into intervention uptake by relative wealth. Results from the asset questions were used to create an asset index through principle component analysis (PCA). Initially PCA was carried out on the 2004 Wardak NCHFA data to generate household asset scores using the following formula:

Household asset score = [(value of asset variable – unweighted mean of asset variable)/ (unweighted standard deviation of asset variable)] x "raw" asset factor score.[46] See Annex 3, Table 6

Individual standardized scores were generated for each household asset depending on whether the household owned the item or not. The standardized household asset scores were then added up for each household resulting in a total household asset score. Households were ranked and then divided into 5 quintiles. The household asset scores and the quintile cut off points were then applied to the SWSP database to generate a household asset index. The 2004 NCHFA sample in Wardak Province was used as the reference population. The households were then classified into three broad socio-economic groups. The lowest two quintiles were classified as

poor, the next two quintiles were classified as average, and the top quintile was classified as rich.[47]

The difference-in-difference analysis regression models with the time-by-group interaction terms allows for a statistical comparison of the change in the diarrhea prevalence for each intervention groups as compared to Control group. The DID analysis was done with both household and individuals within household as the unit analysis. In addition, clustering was considered by village and by household for the household-as-unit-of-analysis and individual-as-unit-of-analysis, respectively, using the Huber-White sandwich estimators for the variance.[48] Based on exploratory analysis, DID statistical analysis controlled for the following variables: socio-economic status (SES) as measured by the household asset index; age of person being interviewed; whether the principal wife was interviewed or not; total number of people in the household; education of principal female (some versus none); education of principal male (some versus none); presence of sanitary facility (latrine); and usual washing of hands in the kitchen or food preparation area (yes versus no). These models resulted in outcomes of adjusted odds ratios (AOR) for each intervention group as compared to the Control group.

4.7.4 Cost-Effectiveness Analysis

Cost-Effectiveness Analysis (CEA) is a method to compare the net gain in health or reduction in disease from health interventions in relation to the cost of each intervention.[49] Where resources are limited, CEA helps determine how funds can be allocated to provide the greatest benefit. CEA was used to estimate the unit cost of averting a case of diarrhea through each intervention

Financial costs were applied in the CEA. Costs and assumptions used in the cost-effectiveness analysis were determined, wherever possible, from actual field costs found in the study. Otherwise, costs and assumptions were based on discussions with MoPH, MRRD, DACAAR and several other NGO's working in Afghanistan. This CEA does not include benefits beyond the reduction of diarrheal disease in the total population.

Appropriate cost inclusions were determined by following WHO guidelines on estimated cost effectiveness in environmental health. Sensitivity analysis was performed based on varying handpump and well lifespans. Costing was spread over the estimated life of hardware while it was assumed that Clorin and hygiene education would be repeated annually as carried out during the study.

Once the number of diarrheal disease cases averted annually by each intervention was determined from the longitudinal data as outlined above, the corresponding annual rate of diarrheal disease reduction per intervention was applied to a hypothetical population equivalent to the average study village enrolled in SWSP. The result was cases averted standardized to a village population. Costs to implement each intervention in this population were then divided by the cases averted to estimate annual cost per case of diarrhea averted across a total village population.

4.8 Changes in Study Implementation

Two villages that were originally randomized into the study were excluded from the data analysis when they were found to not comply with inclusion criteria due to the existence of adequate improved water points. In both villages, the entire population relied on existing protected wells with handpumps. These two villages were Ranji Khel and Koday Ranji Khel.

In the course of project implementation, several villages did not receive the intended intervention as prescribed by the randomization protocol. As previously mentioned, wells were

not able to be successfully drilled in the villages of Ghaze Khel and Baday Khel. Two other project villages, Sadiqkhel/Charmaghz and Zarnay, were impacted by an unexpected overlap with an intensive sanitation and hygiene project implemented by ZOA. A fifth village, Khwaja Kodgay, mistakenly received new tubewells in addition to their intended intervention of hygiene education. While the original randomization of households to study groups was kept for the primary analyses, sub-analyses were also conducted with the five villages of Bady Khel, Ghaze Khel, Sadiqkhel/Charmaghz, Zarnay and Khwaja Kodgay excluded. Results given below are from the primary analyses using the complete dataset containing all randomized villages meeting inclusion criteria unless otherwise noted.

Prior to the project extension, it was apparent that there was not enough data to compare interventions which required wells. Six additional villages were identified within the project area that had not already been involved in the study and had sufficient improved water sources for their population. These villages were surveyed in an attempt to find villages with wells for comparison with the other intervention groups. However, after analyzing the data, it was found that these villages differed greatly in their household characteristics and are not comparable to SWSP project sites. Results from these "Existing Wells" villages are not included in this report as they were not part of the original design or randomization and do not represent an appropriate comparison.

5. Results

5.1 Field Changes Occurring During Course of Project

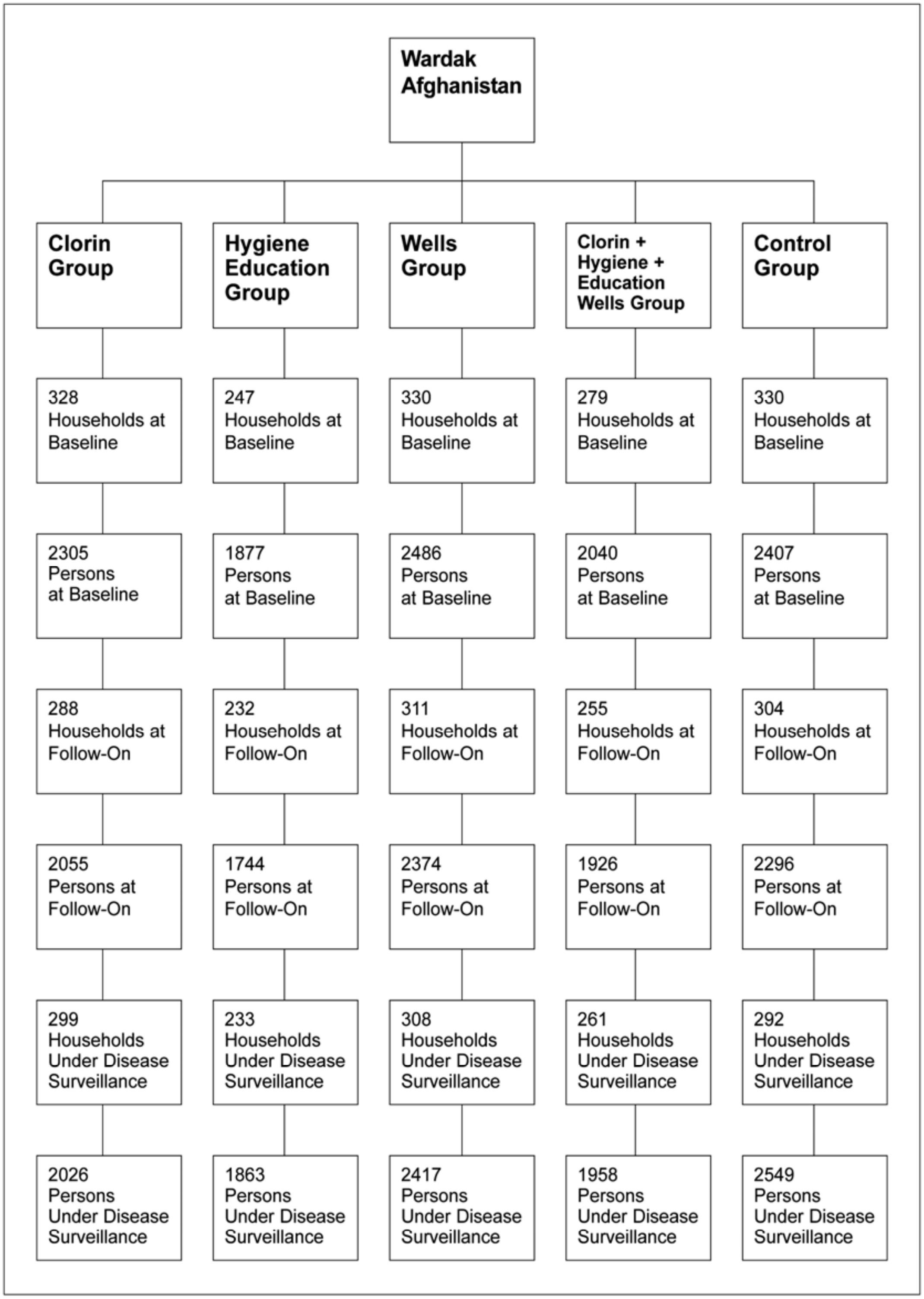
5.1.1 Total Sample Size

It was common to encounter discrepancies between the expected household numbers in a village based on village leader estimates and the actual number of households found upon project commencement. The number of households in each village was consistently over-estimated by village leaders. The result was that fewer households were enrolled in SWSP than expected. Initial project design called for 400 households per study arm to be able to detect a 20% change in the incidence of diarrhea given the conservative assumptions that there would be a 5% per week diarrhea incidence rate for children less than five years an average size of 6 people per household. Actual numbers of households per arm ranged from 279 to 330, with an average of 7.2 people per household and an average annual diarrhea incidence rate of approximately 9% per week for children less than five years. As randomization of villages to study groups had already occurred prior to household enrollment in the study and households had on average higher populations along with higher diarrhea prevalence than expected, increasing households per study arm to 400 was not deemed necessary. No more than 120 households were included from any one village.

5.1.2. Study Population

The distribution among intervention groups can be seen in Figure 3 below. By the follow-on study, approximately 10% of the study population was lost, primarily due to moves and households combining. These combined households are families that were originally counted as separate households as defined at the start of the study ("ate from the same meal the night before") but were sharing meals at the time of the follow-on and therefore became recorded as one household. (Details of households "lost" over the course of the project can be found in Annex 3, Table 2).

Figure 3: SWSP population totals by intervention group



5.1.3 Changes Due to Field Conditions and Security

SWSP was initially designed to have four months of disease surveillance during the peak diarrhea season of summer 2005. All interventions were to be implemented by the start of this surveillance period. As previously mentioned, several factors led to delays in intervention implementation which necessitated an extension of the project for an additional year of surveillance. The leading causes of delays were difficult rock strata with low water yields in numerous project villages and a sharp decrease in regional security levels in the spring of 2005. The additional year's data allowed for extended well-drilling time and the collection of a full year of disease rates to look at seasonal fluctuations. This was the first known collection of year-long community-based disease surveillance within Afghanistan in the past two decades. By extending data collection to the following summer, the project was able to monitor disease post-intervention during the peak diarrhea months of June through September 2006.

Security in the project region remained a concern throughout the project. On several occasions, field visits were postponed or curtailed in response to security incidents. By summer 2006, increased concerns about project field staff safety lead to restricting Kabul-based field staff to main roads and easily accessible clinics for monitoring visits. As a result, village-level monitoring, well assessment and water sampling were halted in June 2006.

5.2 Qualitative Data Results

5.2.1 Key Informant Interviews

Formative research conducted at the start of the study identified a number of key characteristics related to drinking water and hygiene practices. In most provinces in Afghanistan, women and children are the primary water collectors while in general the principal wife in a household controls the drinking water once it is collected. This practice is especially true in Wardak.

Hygiene behaviors are typically poor as adequate containment of feces is often not practiced; handwashing is also not consistently practiced. The typical latrine found in the project area is a vault latrine made of mud, elevated off the ground less than one meter with a hole in the floor and a small opening at the base of the back wall for cleaning out feces. This opening often has a loose fitting cover, allowing fecal matter to drain out. For drinking water, shallow dug wells with little or no protection from surface contamination are common and the majority of households do not treat their drinking water.

5.2.2 Village Focus Group Discussions

Most participants in the FGDs held in Control group villages recognize that diarrhea is linked to water and food contamination, but they are less aware that good tasting water can be contaminated. The majority of the participants were aware of the point-of-use water treatment product, Clorin, and there was strong interest in Clorin usage. No participant reported any concern about the taste of water with Clorin added to it. However, most of participants felt it was inaccessible to them due to the cost even though the average cost is 17Afs (approximately $0.35) per month for a family of 6-7.

All participants in the focus group discussions held in project villages were aware of the high risks of diarrhea to children but fewer knew how to effectively treat diarrhea. Most had heard of ORS but did not consistently use it to treat diarrhea.

Another finding of the FGD was that salt is commonly believed to be an effective water treatment that will decrease the risk of diarrhea. In the past decade, MoPH itself had advocated

this practice, particularly in water used to rinse vegetables. It was found that the Hygiene Education Policy Guidelines for Afghanistan published by MoPH in 2001 contains the recommendation to add salt to water when washing vegetables. Subsequent literature reviews and discussions with JHU microbiologists have shown this to be a mistaken belief as no added benefit to the quality of water can be found with the addition of salt. A number of hypotheses have been discussed as to the origin of this mistaken belief including the thought that the chlorine ion from sodium chloride can become dissociated when common table salt is added to water; confusion between sodium hypochlorite (bleach) and sodium chloride (table salt); or possibly that oral rehydration "salts" are known to help in cases of diarrhea so that perhaps salt alone will improve water enough to avoid diarrhea. Regardless of the origin, further discussions have shown that this belief in the ability of salt to improve water quality is quite wide spread in the country and, as yet, unproven. Complete summary results of these FGDs can be found in Annex 4, FGD1.

5.2.3 Disease Surveillance Data Collectors Focus Group Discussion

Discussions held with disease surveillance data collectors demonstrated an overwhelming willingness to work throughout the year. While many reported initial reluctance and suspicion on the part of villagers to strangers visiting the household, all reported improvements within a few weeks of beginning their work. Male and female data collectors were eager to continue their work, expressing an appreciation to earn money, learn more about household methods to avert disease and serve their greater community. The women in particular mentioned the benefits of interacting with others outside their village, saying it improved their own lives.

Focus group discussion with Community Health Workers
acting as disease surveillance data collectors

Those data collectors who were not already CHWs showed strong interest in training to become CHWs. Many participants mentioned a desire to have further training to increase their skills and overall education level.

Hardships brought on by participation in this project included a negative impact on other work due to the time requirement and difficulty traveling to neighboring village during inclement

weather. The females discussed the difficulty of having their children along as they collected data, especially in poor weather. Several participants mentioned that some villagers were initially suspicious that they were spies coming into their village. Other male participants discussed the villagers opinions of them decreased due to their working with females.

The data collectors unanimously requested that they continue their work. Complete summary results of the data collector FGDs can be found in Annex 4, FGD 2.

5.3 Quantitative Data

5.3.1 Baseline Survey Results

The baseline survey population (n=1514) showed a diarrhea prevalence [95% CI] of 22.1% [20.2%, 24.0%] in children less than five years of age during the two weeks prior to the survey. This figure is particularly high since the survey was conducted before the expected peak annual diarrhea season (June through September). It was also found that bloody diarrhea accounted for more than a quarter of all diarrheal disease. Those over 5 years of age and those between the ages of one and five were approximately at equal risk for bloody diarrhea if they had diarrhea. Children under one year were less likely to have bloody diarrhea if they had diarrhea.

Table 1: Diarrhea two-week prevalence [95% CI] at baseline by population age

Age Group	*n (cases of diarrhea)*	*Diarrhea Prevalence during last 2 weeks*	*% Diarrhea which was bloody during last 2 weeks*
<1 year	270 (56)	20.7% [16.1%, 26.1%]	16.1% [7.6%, 28.3%]
1 to <5 years	1697 (379)	22.3% [20.4%, 24.4%]	27.7% [23.3%, 32.5%]
<5 years	1967 (435)	22.1% [20.2%, 24.0%]	26.2% [22.1%, 30.6%]
≥5 years	9118 (276)	3.0% [2.7%, 3.4%]	32.2% [26.8%, 38.1%]
Total population	11085 (711)	6.4% [6.0%, 6.9%]	28.6% [25.3%, 32.0%]

The strongest protective factor for preventing diarrhea in children under the age of five identified in the baseline survey was the use of soap for washing the body (OR [95% CI] = 0.77 [0.60, 0.98], p = 0.03). Washing hands with soap in or near the kitchen / food preparation area (OR [95% CI] = 0.58 [034, 1.00], p = 0.05), was found to be extremely close to statistical significance in its association with decreased diarrhea prevalence in children less than five years of age. Washing of hands in the food preparation area also statistically decreased the likelihood of diarrhea prevalence in the total population (OR [95% CI] = 0.66 [0.44, 0.99], p = 0.04). Although washing hands in or near the kitchen is protective for diarrhea, only 6% of the households were observed with hand washing available in or near the kitchen.

Unprotected dug wells were the most common source of drinking water with 35% of the population using this types of well. Generally these hand dug wells are located within the compound walls which allows for easy and private access. On average, households collected 25.5 L/person/day, with approximately 31 minutes needed for collection. This is considered the minimum needed per person by internationally recognized standards for the daily amount of

water required for drinking, cooking and personal hygiene in emergencies and by MRRD standards.[36,50] According to local customs, approximately 5 L/person/day are used for ablutions by most rural Afghan people over the age of 12 years (personal communication with. Dr. Saibullah). Ablutions are a ritual cleansing with water which is practiced daily in accordance with Islamic practices. Note that the survey was conducted during the spring when water table levels are expected to be at their highest due to spring snow melts.

The mean (sd) household size was 7.3 (3.7), considerably higher than the six predicted during study design. While the baseline survey was designed to be directed to the principal female in the household, 49% of the time a male answered the questions. It was found that in the project area women's interactions with people outside their households were quite limited. Also, the study population was primarily long-time residents with 97% of households living in the village since before 2002. Schooling was quite low; 36% of males interviewed had attended any school while only 7% of females interviewed had ever attended school.

At baseline, only 7% of households treated their water, with boiling the most common method used. Less than one percent of households treated their water with Clorin prior to SWSP interventions.

Questions aimed at knowledge and practice of appropriate hygiene behaviors showed mixed results. While 77% of those interviewed said they had soap available for handwashing, only 55% were observed with soap readily available. Additionally, 62% self-reported that they had handwashing facilities near their latrine but only 25% were actually observed with handwashing near the latrine. Eighty percent of the households had latrines and half of these were shared with one or more other households. Latrines were cited as a probable source of contamination with 23% having obvious fecal matter outside of containment areas. In discussions with household members, it was reported that many households use a corner within the compound walls for defecation. The feces are then either buried, transported to fields or left to decompose on the compound ground. Analysis of baseline data showed a marked increase in the odds of diarrhea for those under five (OR [95% CI] = 1.60 [1.14, 2.22], $p < 0.01$) and the total population (OR [95% CI] = 1.64 [1.16, 2.32], $p<0.01$) for households with a latrine. The findings on latrines led to the creation of a brief latrine study later in the project.

A summary of results from the baseline and follow-on surveys can be found in Annex 3, Table 1. A total of 27 households from randomized study villages refused to participate in the baseline survey.

5.3.2 Follow-On Survey Results

With a loss of 10% of the baseline survey households by the time of the follow-on survey, comparative analysis was performed with the 1514 households found at baseline and the subset of 1361 households found at follow-on. This analysis was designed to determine whether or not there was a systematic bias to the lost households. Proportions of responses to the baseline survey were generally found to be within less than 5% of each other with no systematic bias detected. See Annex 3, Table 3 for a comparison of survey responses in the baseline and follow-on households.

Table 2: Comparison of diarrhea prevalence [95% CI] between baseline and follow-on by age group

Age Group	*Baseline n (cases of diarrhea)*	*Baseline Diarrhea Prevalence during last 2 weeks*	*Follow-On n (cases of diarrhea)*	*Follow-On Diarrhea Prevalence during last 2 weeks*
<1 year	270 (56)	20.7% [16.1%, 26.1%]	254 (53)	20.9% [16.0%, 26.4%]
1 to <5 years	1697 (379)	22.3% [20.4%, 24.4%]	1496 (384)	25.7% [23.5%, 28.0%]
<5 years	1967 (435)	22.1% [20.2%, 24.0%]	1750 (437)	25.0% [23.0%, 27.1%]
≥5 years	9118 (276)	3.0% [2.7%, 3.4%]	8675 (365)	4.2% [3.8%, 4.7%]
Total population	11085 (711)	6.4% [6.0%, 6.9%]	10425 (802)	7.7% [7.2%, 8.2%]

As seen in Table 2 above, diarrhea prevalence actually increased in all age groups post-interventions by the time of the follow-on survey. When these data are further examined, it is found that intervention groups showed an overall rise in diarrhea prevalence except in the All group (see Figures 4 and 5).

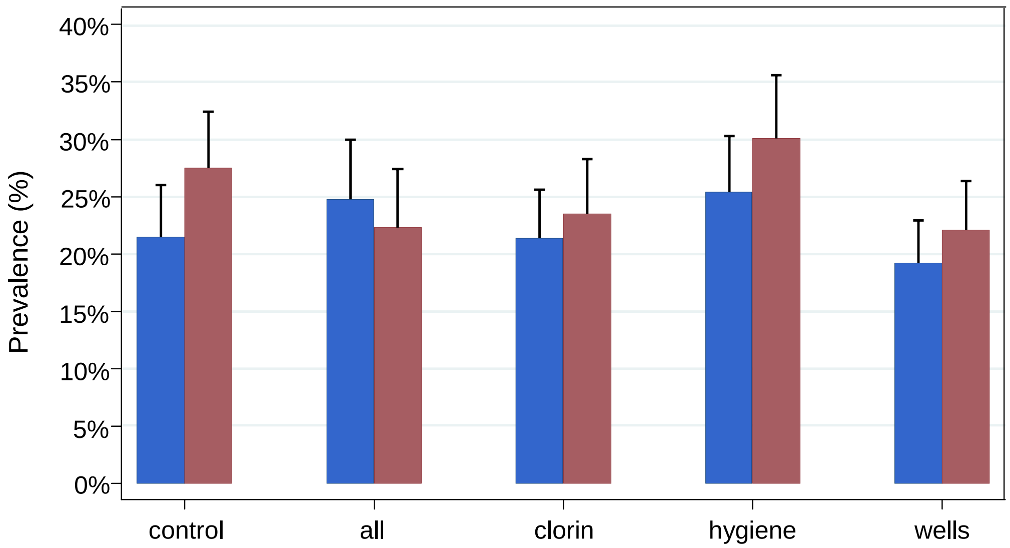


Figure 4: Diarrhea two week prevalence (95% CI) in children < 5 by intervention group, baseline (blue) to follow-on (red)

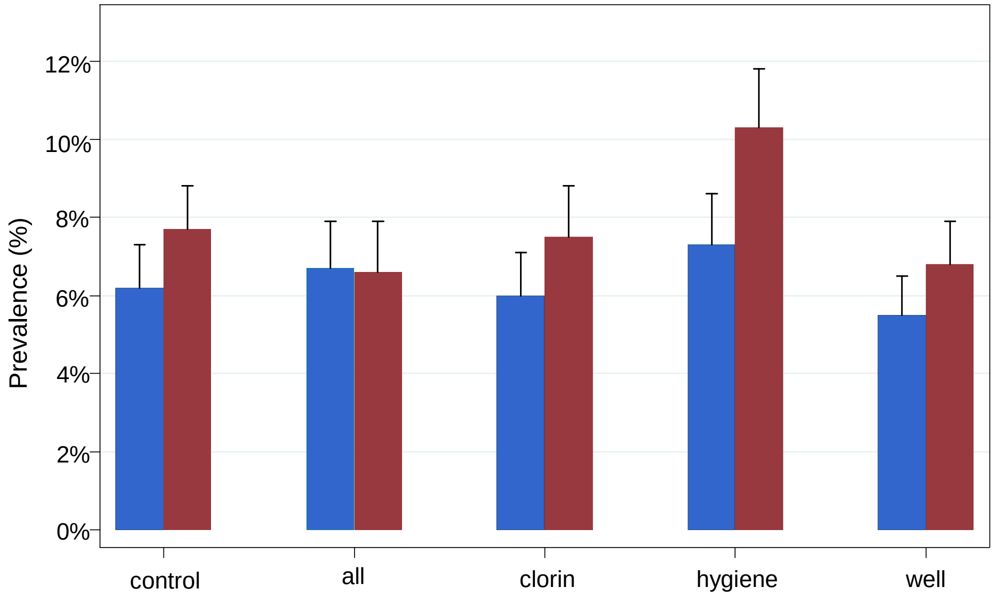


Figure 5: Diarrhea two week prevalence (95% CI) in total population by intervention group, baseline (blue) to follow-on (red)

Self-reported results from the follow-on survey showed a rise in the use of Clorin among all study groups. While groups reported negligible use before the interventions began, by follow-on, the households reported the following proportional usage of this point-of-use treatment: 82% of Clorin group; 78% of All group; 11% of Wells group; 4% of Hygiene group and 5% of Control. Amongst households that reported treating water in the past two weeks, Clorin was the method of treatment for the following proportion of households: 99% of Clorin group; 98% of All group; 76% of Wells group; 52% of Hygiene group and 47% of Control group. These results from the follow-on survey refer to the Clorin liquid, not the improved water vessel. Marketing of Clorin and the improved water vessel by PSI and later Compri-A was ongoing in the region through summer radio campaigns and posters in bazaars.

The new tubewells installed in the Wells and All villages were not consistently utilized as the sole source of drinking water for the intervention households. Thirty-four and seven tenths percent of households in the Wells group used protected tubewells for their drinking water while 47.1% of All households used the tubewells. More than half the population in these villages chose to continue using less protected sources for their drinking water. When a sub-analysis was conducted of only those villages receiving adequate tubewell coverage, the utilization of protected tubewells as the drinking water source increased to 41.2% in the Wells group and 56.5% in the All group. These results indicate that some households probably continued to use nearby unprotected water rather than travel further to a protected source, even if that protected source is within the village. Interestingly, protected tubewell use increased an average of 18.7%

in the Clorin, Hygiene and Control groups indicating that some households did choose to travel outside their home village to collect water from protected sources.

The Hygiene households showed mixed results in sustaining practices learned during the previous summer's house-to-house training. Improvements were seen in the group's usage of protected water sources for drinking water which increased from 12.3% to 34.1%, self-reported use of soap for handwashing in the last 24 hours which increased from 37.9% to 80.9% and self-reported handwashing availability in the kitchen rose from 9.8% of the households to 17.2%. Behaviors which did not improve after the intervention included observed handwashing availability near the latrine which decreased from 31.7% at baseline to only 2.1% at the follow-on as well as a decrease in the maintenance of the latrine which saw a rise in the proportion of households observed to have fecal matter outside the containment area of the latrine from 20.1% to 32.5%. The Hygiene group also had substantial increase over the control group in the proportion of the households reporting the use of salt to treat their drinking water with 22.2% of the households reporting this method as compared to 3.3% of the Control in households that treated their drinking water in the previous two weeks.

The DID analyses demonstrated that the All intervention group was the only intervention group to show either a significant reduction or a trend towards a significant reduction in the odds of diarrhea prevalence over time as compared to the Control group. When considering the household as the unit of analysis, it was determined that children under the age of five in the All group experienced an approximate 11% reduction in diarrhea prevalence follow-on versus baseline, while children under 5 in the Control group experienced an approximate 45% *increase* in diarrhea prevalence over this some time. This results in an approximate 40% reduction in the odds of diarrhea prevalence increasing over time for children in the All group as compared to the Controls (AOR [95% CI] = 0.61 [0.36, 1.04], p=0.07), a finding that approaches statistical significance. Qualitatively similar results were found for children under age 5 when the individuals were used as the unit of analyses. Among children in the All group, an approximate 37% reduction in the odds of diarrhea prevalence increasing over time was found when compared to children in the Control group, (AOR [95% CI] = 0.63 [0.38, 1.06], p=0.08), a deduced odds ratio that also approaches statistical significance. For the total population, a 47% reduction in the odds of a diarrhea prevalence increase over time was found when comparing the All group with the Control (AOR [95% CI] = 0.53 [0.30, 0.93], p=0.03). No trends toward significance or significant results were found in total diarrhea prevalence for any intervention group when the individual was considered as the unit of analysis. Results for the other intervention groups with household as the unit of analyses can be seen in Table 3 and by individual as the unit of analysis in Table 4.

Sensitivity analyses were performed on these findings by dropping the five villages where the intended interventions were not appropriately implemented and the results were similar. Again, the All group was the only group to show statistically significant results with a 61% reduction in likelihood of diarrhea for children less than five (AOR [95% CI] = 0.39 [0.25, 0.61], $p < 0.001$) and a 50% reduction in the total population of all ages (AOR [95% CI] = 0.50 [0.28, 0.89], p = 0.018).

Table 3: The adjusted odds ratios of increases in diarrhea prevalence with the household as the unit of analysis. DID analysis gives the adjusted odds ratio for the change in the prevalence increases by all intervention groups as compared to the Control group.

Intervention	*House holds*	*AOR[95% CI] for change in diarrhea prevalence*	*p*	*AOR[95% CI] for group differences in the change of prevalence*	*p*
Control	282				
< 5		1.45 [1.04, 2.02]	0.03	------	----
all ages		1.54 [0.89, 2.67]	0.12	------	----
Clorin	287				
< 5		1.16 [0.54, 2.53]	0.70	0.81 [0.35, 1.85]	0.61
all ages		1.21 [0.53, 2.75]	0.66	0.78 [0.30, 2.05]	0.62
Hygiene	231				
< 5		1.09 [0.45, 2.62]	0.85	0.75 [0.29, 1.95]	0.56
all ages		1.48 [0.87, 2.52]	0.15	0.96 [0.45, 2.04]	0.92
Wells	304				
< 5		1.22 [0.89, 1.69]	0.22	0.85 [0.54, 1.34]	0.48
all ages		1.41 [0.97, 2.05]	0.07	0.92 [0.47, 1.79]	0.80
All	255				
< 5		0.89 [0.58, 1.36]	0.58	0.61 [0.36, 1.04]	0.07
all ages		0.81 [0.67, 0.98]	0.03	0.53 [0.30, 0.93]	0.03

Table 4: The adjusted odds ratios of increases in diarrhea prevalence with the individual as unit of analysis. The DID analysis gives the adjusted odds ratio for the change in the prevalence increases by all intervention groups as compared to the Control group.

Intervention	*House Holds*	*AOR[95% CI] for change in diarrhea prevalence*	*p*	*AOR[95% CI] for group differences in the change of prevalence*	*p*
Control	282				
< 5		1.35 [0.94, 1.92]	0.10	------	----
all ages		1.23 [0.96, 1.57]	0.10	------	----
Clorin	287				
< 5		1.20 [0.84, 1.69]	0.32	0.89 [0.54, 1.45]	0.64
all ages		1.24 [0.98, 1.59]	0.08	1.01 [0.72, 1.43]	0.95
Hygiene	231				
< 5		1.21 [0.85, 1.73]	0.29	0.90 [0.54, 1.48]	0.68
all ages		1.29 [0.99, 1.68]	0.06	1.05 [0.73, 1.50]	0.80
Wells	304				
< 5		1.22 [0.86, 1.74]	0.26	0.91 [0.56, 1.49]	0.70
all ages		1.27 [0.98, 1.65]	0.07	1.03 [0.73, 1.47]	0.85
All	255				
< 5		0.85 [0.58, 1.25]	0.41	0.63 [0.38, 1.06]	0.08
all ages		1.01 [0.77, 1.31]	0.97	0.82 [0.57, 1.17]	0.27

Results of DID analysis performed with household as the unit of analyses on the prevalence of bloody diarrhea in the follow-on survey compared to the baseline survey once again demonstrated that combining all three interventions was effective at reducing the likelihood of bloody diarrhea in both children under five years, a result that approaches statistical significance (AOR [95% CI] = 0.30 [0.08, 1.08], p=0.07). However, there was a highly significant treatment effect of the All intervention group across all age groups (AOR [95% CI] = 0.15 [0.05, 0.46], p=0.001). Similar results were obtained when the individual was the unit of analysis for children under 5 (AOR = 0.23 [0.05, 1.11], p = 0.07) and for all age groups (AOR [95% CI] = 0.15 [0.04, 0.52], p=0.003). The results are summarized in Tables 5 and 6 below.

Table 5: The adjusted odds ratios of increases in bloody diarrhea prevalence with the household as the unit of analysis. DID analysis gives the adjusted odds ratio for the change in the prevalence increases by all intervention groups as compared to the Control group.

Intervention	*House holds*	*AOR[95% CI] for change in bloody diarrhea prevalence*	*p*	*AOR[95% CI] for group differences in the change of prevalence*	*p*
Control	282				
< 5		0.32 [0.12, 0.83]	0.02	------	----
all ages		0.55 [0.26, 1.12]	0.10	------	----
Clorin	287				
< 5		0.15 [0.04, 0.58]	<0.01	0.48 [0.10, 2.34]	0.36
all ages		0.35 [0.15, 0.84]	0.02	0.65 [0.22, 1.93]	0.44
Hygiene	231				
< 5		0.85 [0.62, 1.18]	0.33	2.65 [1.00, 7.03]	0.05
all ages		0.86 [0.58, 1.28]	0.46	1.58 [0.70, 3.55]	0.27
Wells	304				
< 5		0.13 [0.06, 0.27]	<0.01	0.39 [0.11, 1.32]	0.13
all ages		0.36 [0.21, 0.63]	<0.01	0.67 [0.28, 1.61]	0.37
All	255				
< 5		0.10 [0.04, 0.25]	<0.01	0.30 [0.08, 1.08]	0.07
all ages		0.08 [0.03, 0.21]	<0.01	0.15 [0.05, 0.46]	<0.01

Table 6: The adjusted odds ratios of increases in bloody diarrhea prevalence with the individual as the unit of analysis. DID analysis gives the adjusted odds ratio for the change in the prevalence increases by all intervention groups as compared to the Control group.

Intervention	*House holds*	*AOR[95% CI] for change in bloody diarrhea prevalence*	*p*	*AOR[95% CI] for group differences in the change of prevalence*	*p*
Control	282				
< 5		0.38 [0.14, 1.08]	0.07	------	----
all ages		0.70 [0.35, 1.40]	0.31	------	----
Clorin	287				
< 5		0.21 [0.06, 0.76]	0.02	0.55 [0.10, 2.95]	0.49
all ages		0.47 [0.22, 1.02]	0.06	0.67 [0.23, 1.91]	0.45
Hygiene	231				
< 5		1.07 [0.51, 2.26]	0.86	2.79 [0.81, 9.69]	0.10
all ages		1.09 [0.57, 2.07]	0.79	1.56 [0.61, 3.98]	0.35
Wells	304				
< 5		0.13 [0.04, 0.42]	<0.01	0.35 [0.07, 1.66]	0.19
all ages		0.41 [0.20, 0.84]	<0.01	0.59 [0.22, 1.61]	0.30
All	255				
< 5		0.09 [0.03, 0.30]	<0.01	0.23 [0.05, 1.11]	0.07
all ages		0.10 [0.03, 0.31]	<0.01	0.15 [0.04, 0.52]	<0.01

Sensitivity analyses that excluded the five villages listed above (where intended interventions were not appropriately implemented) supported results demonstrating a reduction in the likelihood of bloody diarrhea in the All group. No cases of bloody diarrhea were found in the All intervention group once these five villages were dropped from the analysis; therefore the likelihood of bloody diarrhea was reduced by 100% in both age categories using the household as the unit of analyses. These sub-analyses also revealed that the Wells intervention significantly reduced the prevalence of bloody diarrhea the total population by nearly 50% (AOR = 0.51 [0.33, 0.79], p = 0.003). In contrast, the Hygiene group significantly *increased* the risk of bloody diarrhea prevalence by household as compared to the Control group by a factor of three (AOR = 2.95 [1.11, 7.87], p = 0.031).

Statistical analysis was also conducted on the disease prevalence rates of children less than one year. However, the number of children in this age group was too small to have statistically significant findings. Annex 3 contains the results for this age group.

5.3.3 Asset Index Results

Results from the household assets index collected at the follow-on study were analyzed to evaluate socio-economic status (SES) variables for each household. The SES variables showed an uneven distribution in the number of households per quintile when standardized to 2004 NCHFA Wardak data, making it difficult to see trends across SES quintiles. However, a clear trend is apparent when comparing the diarrheal disease prevalence rates of the households with the lowest SES to those households with the highest SES to create low/high SES ratios. The households with the lowest SES represented the lowest 40% of the study population while the households with the highest SES represented the top 20%.

The lowest SES households were more likely to have higher diarrheal disease rates in all intervention groups and all ages except for children under 5 in the Clorin group where the lowest SES households had lower diarrhea prevalence than the highest SES. The Clorin group also had the lowest low/high ratio of all the intervention groups when looking at the total population. The largest diarrheal disease prevalence differential between the low and high SES can be found in children less than 5 in households getting all three interventions.

Of particular interest is the finding that there is no difference in diarrheal disease prevalence between SES categories in the Control group for either children under five years or the total population. As interventions were introduced, differences between SES categories became apparent. This suggests that the households with higher assets adopt new interventions more readily with the resulting improvements in health. Results are outlined in Tables 7 and 8 below.

Table 7: Individual two week diarrhea prevalence [95% CI] by SES classification for children <5

Intervention Group	*Lowest SES 40%*	*Highest SES 20%*	*Low/High Ratio*
Control	29.8% [22.4%, 38.1%]	22.9% [15.7%, 31.5%]	1.30
Clorin	24.1% [17.7%, 31.4%]	26.2% [18.0%, 35.8%]	0.92
Hygiene	32.7% [24.1%, 42.3%]	29.2% [20.8%, 38.9%]	1.12
Wells	25.7% [19.4%, 32.9%]	17.9% [12.1%, 25.2%]	1.44
All	25.0% [18.2%, 32.9%]	15.7% [8.1%, 26.4%]	1.59

Table 8: Individual two week diarrhea prevalence [95% CI] by SES classification for all ages

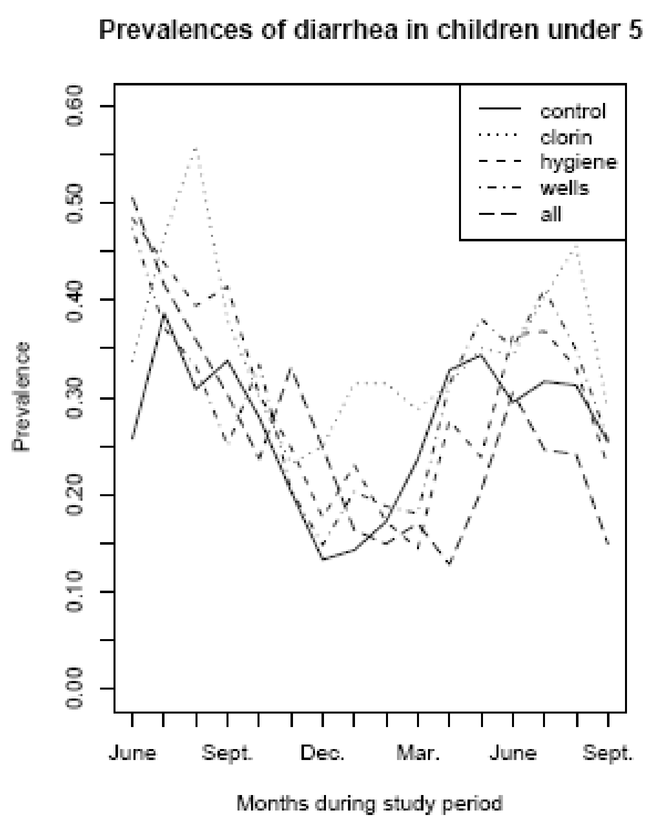
Intervention Group	*Lowest SES 40%*	*Highest SES 20%*	*Low/High Ratio*
Control	9.7% [7.8%, 11.9%]	5.6% [4.1%, 7.5%]	1.73
Clorin	7.9% [6.2%, 9.9%]	8.3% [6.2%, 10.8%]	0.95
Hygiene	12.3% [9.7%, 15.1%]	7.7% [5.7%, 10.2%]	1.60
Wells	7.8% [6.2%, 9.7%]	5.2% [3.8%, 7.0%]	1.50
All	8.2% [6.4%, 10.4%]	5.6% [3.9%, 7.8%]	1.46

5.3.4 Disease Surveillance Results

Disease rates for the total population (all ages) were analyzed as well as a sub-analysis containing only children less than five years of age. The number of children in the study less than one year of age was too low to find statistically significant results when analyzing age groups separately. Results for the children less than five years will be given first; results for the total population follow.

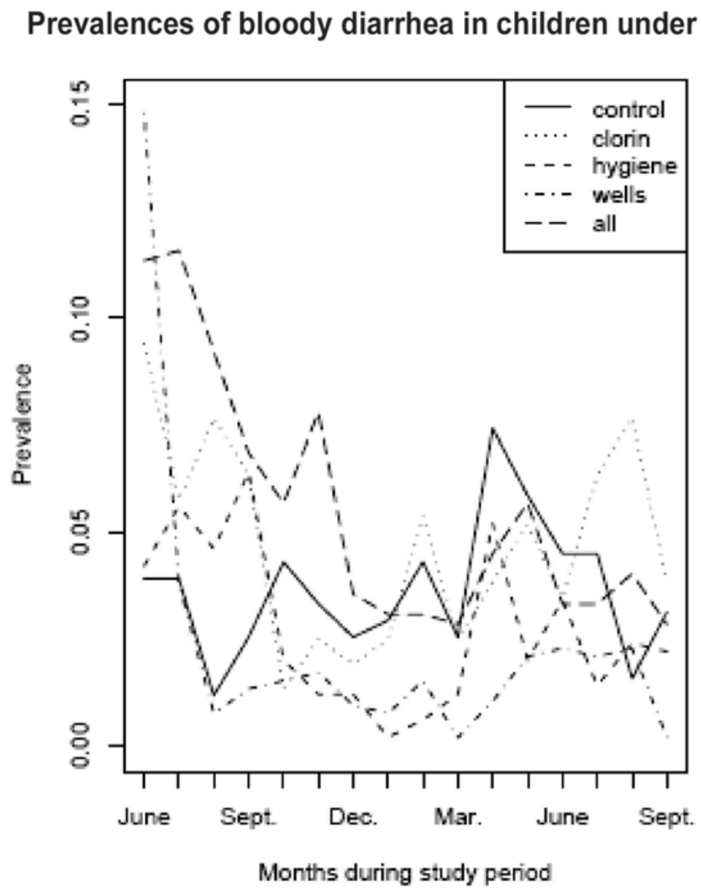
Prevalence of diarrheal diseases in children less than five years of age fluctuated throughout the 16 month study period and was highly influenced by the season. Figure 6 highlights the peak annual diarrheal period during the summer months, with two peaks in monthly prevalence corresponding to the two summer seasons in each intervention group.

Figure 6: Monthly diarrhea prevalence for children less than five years of age, June 2005 through September 2006



Annual fluctuations were also found in bloody diarrhea prevalence (Figure 7). While the prevalence of bloody diarrhea was much lower than total diarrheal diseases in children less than five, peaks also occurred during the summer months.

Figure 7: Monthly bloody diarrhea prevalence for children less than five years of age, June 2005 through September 2006

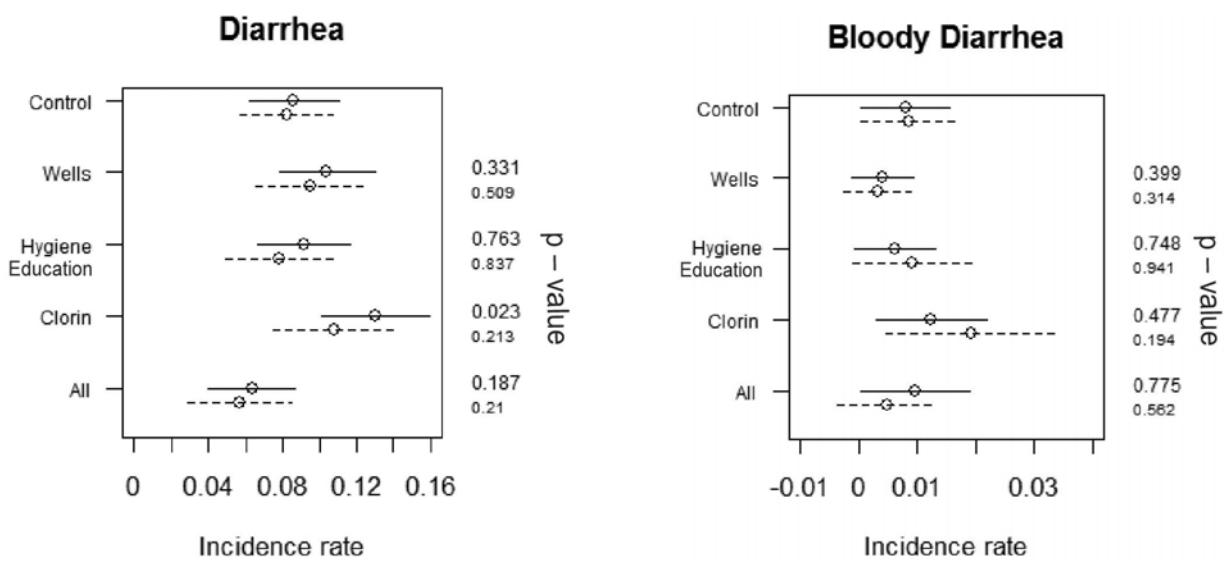


Analyses of disease surveillance data focused on incidence during the months of June 2006 through September 2006 when interventions were in place in all study villages (where it was possible). This period also corresponds with the months expected to have the peak annual diarrheal diseases rates. The entire 15 and a half months of incident disease cases for the control group data were used as a basis for projected intervention impacts.

Analyses performed on data for children less than five years of age from June 2006 through September 2006, indicate a reduction in the weekly diarrheal disease incidence in the All group when compared to the control, but not at a statistically significant level (p-value 0.187). Figure 8 illustrates the comparison of weekly incidence rates for each of the intervention groups. The small circles indicate the incidence point estimates while the horizontal lines demonstrate the 95% confidence intervals around these point estimates. The dotted confidence intervals indicate the analogous results achieved by excluding the five villages where interventions were not appropriately implemented. The numbers to the right of each plot are the p-values resulting from comparing the incidence rate in the corresponding intervention group to the incidence rate of the control group. The upper p-values relate to the entire sample whereas the lower p-values

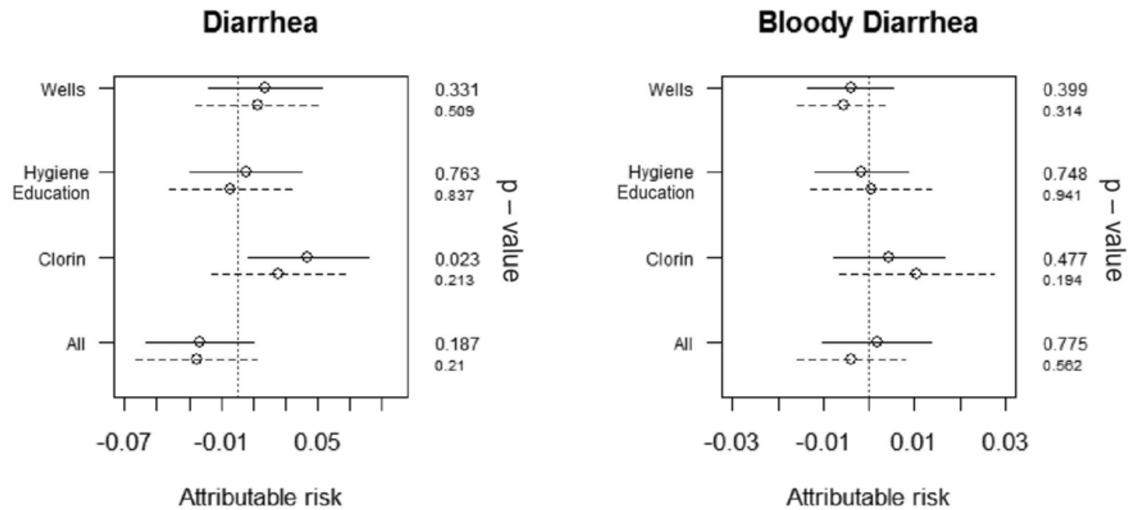
(with smaller font) refer to the results from excluding villages where interventions were not appropriately implemented. For example, the p-value of 0.187 corresponds to the comparison in diarrheal disease incidence between the All group and the control group. Intervention groups other than the All group did not show a reduction in diarrhea incidence rates when compared to the control group. No significant change in the incidence of bloody diarrhea in children less than five years of age was found in any of the intervention groups.

Figure 8: Weekly diarrhea and bloody diarrhea incidence rates from Summer 2006 (June-September) and corresponding 95% confidence intervals by illness and intervention group for children less than five years of age



Attributable risk is defined as the difference in the incidence of an intervention group as compared to the control group. The attributable risk in these results is the proportional change in new cases of diarrheal disease if the population is given an intervention as compared to the control population. If the attributable risk is negative, the intervention was found to decrease new cases of the disease and is therefore protective of the population at risk from diarrheal disease. If the 95% CI (the horizontal dashed line) crosses zero (the vertical dashed line), then a statistically significant association was not found. The p-values to the right of the plots are the same as in the incidence rate plots because the hypothesis test is the same in this case. Figure 9 demonstrates that none of the intervention groups decreased the attributable risk of diarrheal diseases to a statistically significant level since all 95% CIs cross the vertical dashed line marking zero.

Figure 9: Attributable risk from Summer 2006 (June-September) and corresponding 95% confidence intervals by illness and intervention group, children less than 5 years of age



The results of analysis for intervention effect on diarrhea and bloody diarrhea incidence in children less than five years of age did not show a statistically significant reduction when compared to the control group. The Clorin group had a statistically significant increased rate of diarrhea incidence. These results are interesting enough to signal that further investigation is warranted. However, no conclusions can presently be drawn from them.

Analyses performed on the total study population from June 2006 through September 2006 with all ages combined found a statistically significant reduction in the incidence of diarrheal diseases in the Hygiene, Wells and All intervention groups when compared to the control group (see Figure 10 and Table 9). The Clorin group showed a reduction in diarrhea incidence but was only statistically significant when the five villages were dropped that did not have the appropriate interventions implemented. The All group had the largest overall reduction in diarrhea incidence of 2.3% (p-value <0.001) which corresponded to a reduction in relative risk of 39% (see Figure 11 and Table 10). Relative risk is defined to be the ratio of the incidence in an intervention group to the incidence in the control group.

Figure 10. Weekly incidence rates from Summer 2006 (June-September) for total study population and corresponding 95% confidence intervals by illness and intervention

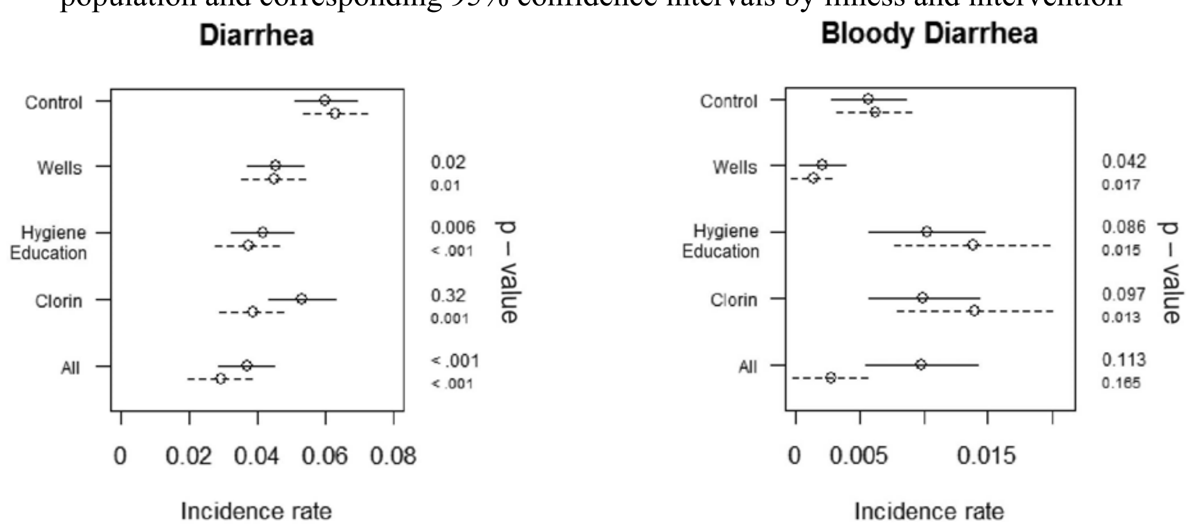


Table 9: Diarrheal disease weekly incidence (cases per person-week) in total study population, Summer 2006 (June-September), with p-values comparing the change in incidence rate in intervention groups to incidence rate in control group.

Intervention Group	*Diarrhea Incidence*	*p-value*	*Bloody Diarrhea Incidence*	*p-value*
Clorin	0.053	0.32	0.001	0.097
Hygiene	0.042	0.006	0.014	0.086
Wells	0.045	0.02	0.002	0.042
All	0.037	<0.001	0.010	0.113
Control	0.060		0.006	

Figure 11: Relative risk of diarrhea for total population, from Summer 2006 (June-September) and corresponding 95% confidence intervals by intervention group

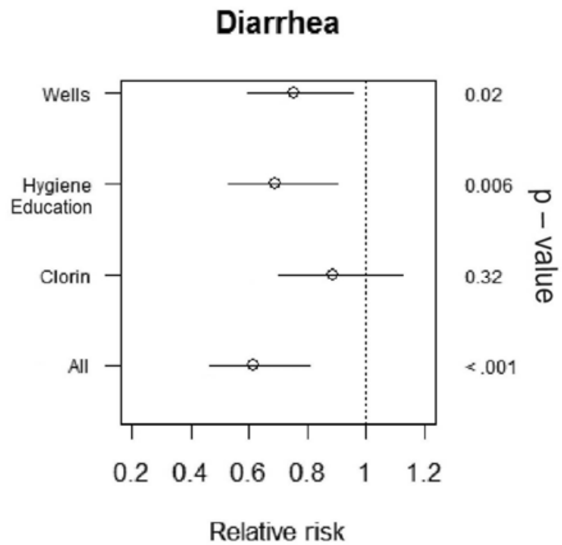


Table 10: Relative risk of diarrhea estimates for all ages, comparing intervention groups to control

Intervention Group	*Diarrhea*	*95% Confidence Interval*
Clorin	0.89	0.70 – 1.13
Hygiene Education	0.69	0.53 – 0.90
Wells	0.75	0.59 – 0.96
All	0.61	0.47 – 0.81

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Further analysis of the interventions' affects on bloody diarrhea incidence showed mixed results (see Figure 12 and Table 11). Wells showed significant association with reduced risk of bloody diarrhea incidence in both analyses with all villages and with the five dropped villages. However, other interventions did not show a statistically significant association with reduced new cases of bloody diarrhea when all villages were analyzed. The All intervention group showed benefits only when five villages were dropped. In both analyses, the Clorin and Hygiene Education interventions were not associated with decreases in bloody diarrhea incidence. While there is no plausible explanation without further statistical modeling, the hygiene education and

Clorin groups were associated with increased bloody diarrhea incidence in the sub-analysis which dropped five villages (where interventions were not appropriately implemented).

Figure 12: Relative risk of bloody diarrhea for total population, from Summer 2006 (June-September) and corresponding 95% confidence intervals by intervention group

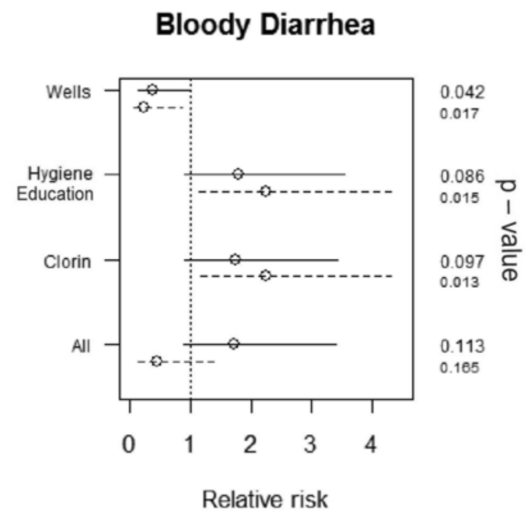


Table 11: Relative risk of bloody diarrhea estimates for all ages, comparing intervention groups to control

Intervention Group	*Bloody Diarrhea*	*95% Confidence Interval*
Clorin	1.75	0.90 – 3.43
Hygiene Education	1.80	0.91 – 3.55
Wells	0.37	0.13 – 1.01
All	1.72	0.87 – 3.39

Again, the attributable risk is defined as the difference in the incidence of an intervention group as compared to the control group; i.e. the portion of the risk that can be attributed to the intervention. If the attributable risk is negative, the intervention was found to decrease new cases of the disease and is considered protective for the population at risk from disease. If the 95% CI (the horizontal dashed line) crosses zero (the vertical dashed line), then a statistically significant association between the intervention and the disease outcome was not found. The p-values to the right of the plots are the same as in the incidence rate plots because the hypothesis test is the same in this case. The attributable risk plots in Figure 13, along with corresponding Table 12, demonstrate that a decrease in diarrheal disease incidence was observed with the Wells, Hygiene and All intervention groups. Furthermore, the Wells intervention was the only intervention that demonstrated a statistically significant reduction in bloody diarrhea.

Figure 13: Attributable risk from Summer 2006 (June-September) and corresponding 95% confidence intervals by illness and intervention group, total study population (all ages)

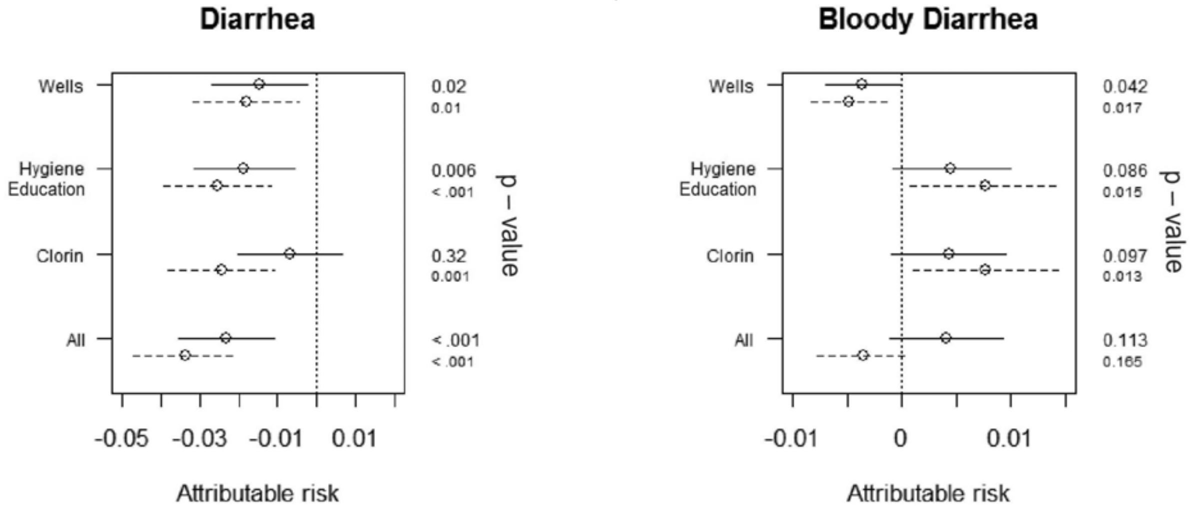


Table 12: Attributable risk estimates and confidence intervals for total population, based on summer 2006 surveillance data

Intervention Group	*Diarrhea*	*95% CI*	*Bloody Diarrhea*	*95% CI*
Clorin	-0.007	-0.020 to 0.007	0.004	-0.001 to 0.010
Hygiene	-0.019	-0.031 to -0.006	0.005	-0.001 to 0.001
Wells	-0.015	-0.027 to -0.002	-0.004	-0.007 to -0.0001
All	-0.023	-0.036 to -0.011	0.004	-0.001 to 0.009

A comparison of estimated cases of disease prevented between intervention groups can be calculated using the attributable risk estimate for each intervention group and applying it to a standard population size. Table 13 demonstrates the results of multiplying the attributable risks for each intervention by the population of a typical village size and population as found in SWSP sites, assuming 100 households with a total population of 700 people. The All intervention averted an estimated 36% - 212% more cases of diarrhea annually than the other interventions.

Table 13: Annual diarrhea cases averted across all ages in hypothetical village, based on SWSP Summer 2006 disease surveillance data

Intervention Group	*Annual diarrhea cases averted*
Clorin	195
Wells	384
Hygiene Education	448
All	608

Logistic regression analyses were conducted on the entire 16 month surveillance period to compare the incidence rates of diarrheal diseases in each intervention groups with the incidence rates in the control group, with the odds of being a new case conditioned on being at risk. These analyses were conducted for both age categories: children less than five years of age and the total population including all ages. The results of these additional analyses were mixed with no clear statistical trend showing any intervention being consistently better or worse than the control group. This was most likely due to a large amount of temporal variation in diarrhea incidences at each twice-weekly assessment. Plots of the incidence rates for each intervention group versus the control group over the entire surveillance period can be found in Annex 4, Figures 1 thru 8.

5.3.5 Cost-effectiveness Results

Cost-effectiveness analysis (CEA) was conducted on each of the interventions. While the All, Wells and Hygiene Education groups were shown to have reduced risk of diarrheal disease in the total population to a statistically significant level compared to the control population, CEA was conducted on the all intervention groups to demonstrate the comparable effectiveness.

CEA incorporates both program costs and health impact as measured by SWSP longitudinal disease surveillance data to allow comparison across interventions. The CEA developed here is based on financial costs, not economic (or opportunity) costs. As the field costs of wells fluctuated widely and somewhat artificially with the introduction of alternative drilling methods to accelerate implementation, a standard percussion-drilled well cost of $2020 was used in this analysis. The rate of diarrhea cases averted per intervention and costs were applied to a hypothetical population of 100 households containing a total of 700 people. Wells are assumed to be installed at the well-to-household ratio recommended by MRRD of one protected tubewell for every 25 households.[36] All costs are in US$. The methods used to calculate CEA were in accordance with those recommended by WHO.[51]

Table 14: Annual cost per case of diarrhea averted across age groups by intervention and varying projected lifespans of tubewells

Intervention	*15 year well lifespan*	*20 year well lifespan*	*25 year well lifespan*
Hygiene	$0.99	$0.99	$0.99
Wells	$1.48	$1.21	$1.01
All	$2.88	$2.70	$2.58
Clorin -- Not significant	$5.35	$5.35	$5.35

Since tubewells have a large upfront cost and relatively long average lifespan compared to Clorin and Hygiene Education, all interventions costs were spread over the expected life of a well with the expectation that Clorin and Hygiene interventions would be repeated annually. Wells last on average 15 to 25 years, depending on groundwater levels, usage and maintenance while handpumps last on average 7.5 to 15 years. Sensitivity analysis was conducted for varying well and handpump lifespans. Table 14 above assumes a 15-year handpump lifespan. Details of the CEA are found in Annex 2, Table 1.

Results of the cost-effectiveness analysis show an increasing similarity in annual cost per case of diarrhea averted across age groups between the wells and hygiene education interventions as the life of a drilled well increases. Of these four interventions, only the All

intervention group demonstrated a consistent reduction in diarrheal disease rates across all SWSP data.

Figures 14 and 15 below provide alternate ways to view the CEA results. In each graph, a line has been drawn from the origin (zero cost and zero effectiveness) through the most cost-effective interventions, Hygiene Education and All Three. In both graphs, the dramatic benefits of All Three interventions is shown, through both reduced risk of diarrheal diseases and increased cases of diarrhea averted. Furthermore, Figure 15 demonstrates that Clorin alone is both more expensive per case of diarrhea averted and less effective in this setting.

Also evident in the CEA graphs is that a percentage risk reduction does not translate into cases avoided by a fixed ratio. Wells are only slightly dominated by hygiene education in the risk reduction vs. cost graph while strongly dominated in the case vs. cost graph. The percentage difference in the risk between hygiene education and wells translates into much larger reduction in actual cases averted when applied to a population. Figure 15 points to wells alone being more expensive and less effective than hygiene education alone in averting diarrhea. It must be noted that these comparisons only examine the effect on diarrheal disease cases and do not take into account the additional benefits of any intervention.

Figure 14: Comparative cost-effectiveness of interventions by risk reduction and annual cost over the projected 25-year lifespan of a well

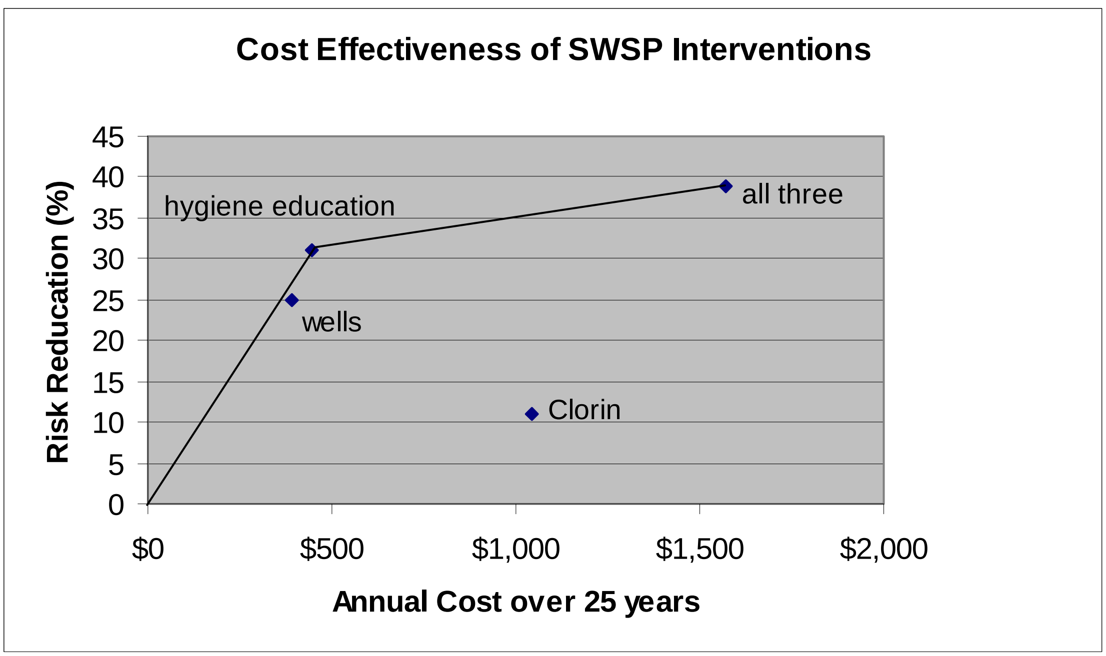
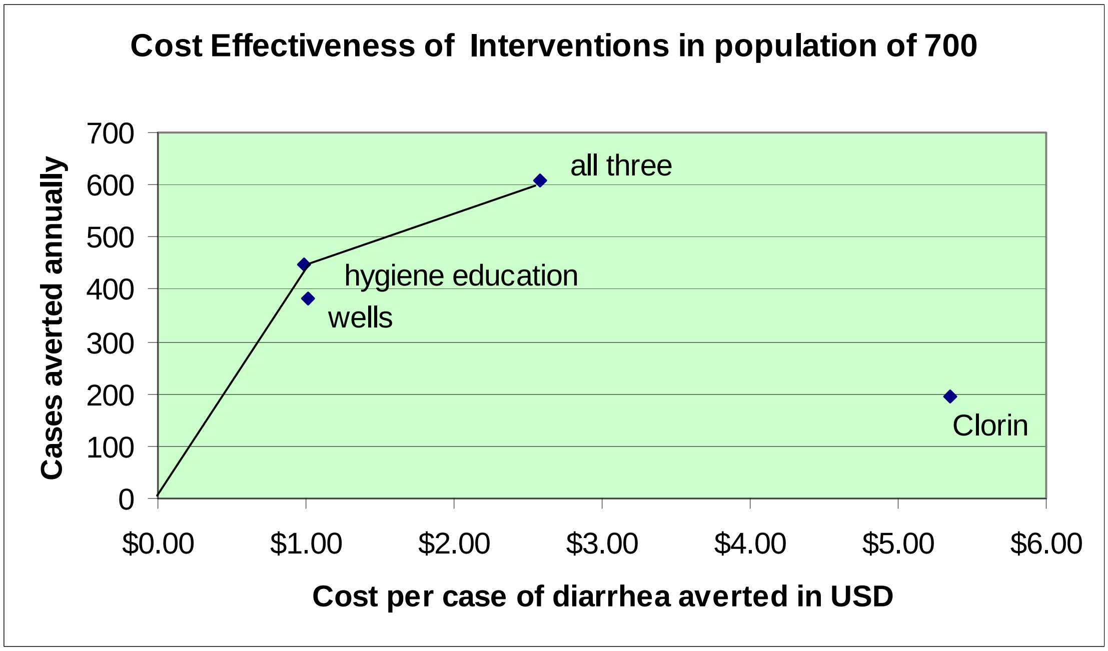


Figure 15: Comparative cost-effectiveness of interventions by annual cases of diarrhea averted and cost per case of diarrhea averted



A number of assumptions were used to develop the cost-effectiveness analysis. Household size of seven was based on the average household size found in field results, rounded to the nearest whole number. While a bottle of Clorin is marketed to be enough for a household of 6 for a month, study results found an actual usage of one bottle per household of 7 people per month. (During the study, households traded in the empty Clorin bottle for a new full bottle whenever the previous one was completely used, so it was possible to receive more than one bottle per month if necessary.) The following costs of Clorin, vessels and transportation of trainers (for Clorin use and hygiene education) were based on actual costs paid by the project in addition to training-the-trainer expenses incurred by PSI: $0.25/Clorin bottle, $3.00/water vessel, $2.00/trainer/day (the current MOPH pay for hygiene educators), $30.00/transportation/day and training-the-trainer for 3 days $6.00/person/day. The costs used here for Clorin are subsidized wholesale costs and do not include full costs of production and distribution. The analysis also assumes one water vessel be distributed to each household annually for those getting Clorin. Two house-to-house visits by teams of trained educators would be conducted for Clorin and hygiene education interventions. Each team would consist of one male and one female trainer. It is expected that each household visit would last 20 minutes for households receiving either Clorin or Hygiene Education and 30 minutes for households receiving both interventions. Cases averted have been rounded to the nearest whole number. Interventions have been annualized by comparing proportional differences with the control group during the summer months and applying this proportional difference to control group disease rates over the rest of the year from October 2005 through May 2006. The following were not included in the analysis: village

contribution to well maintenance person (27 kg of wheat annually), program development, training materials, or advertising costs.

5.3.6 ARI and Eye Infection Results

DID analysis of follow-on data for ARI found no statistically significant association between ARI prevalence in intervention groups compared to the control group. Analysis of the surveillance data on the effects of interventions on ARI and eye infection incidence compared to the control also found no significant reductions in either disease category found by any of the interventions (see Figures 16 and 17). However, there was a significant increase in risk of ARI and eye infection incidence noted in each of the intervention groups compared to control during the months of June through September 2006 when interventions were in place.

Figure 16: Weekly incidence rates of ARI and eye infection from Summer 2006 (June-September) and corresponding 95% confidence intervals by illness and intervention group, all ages

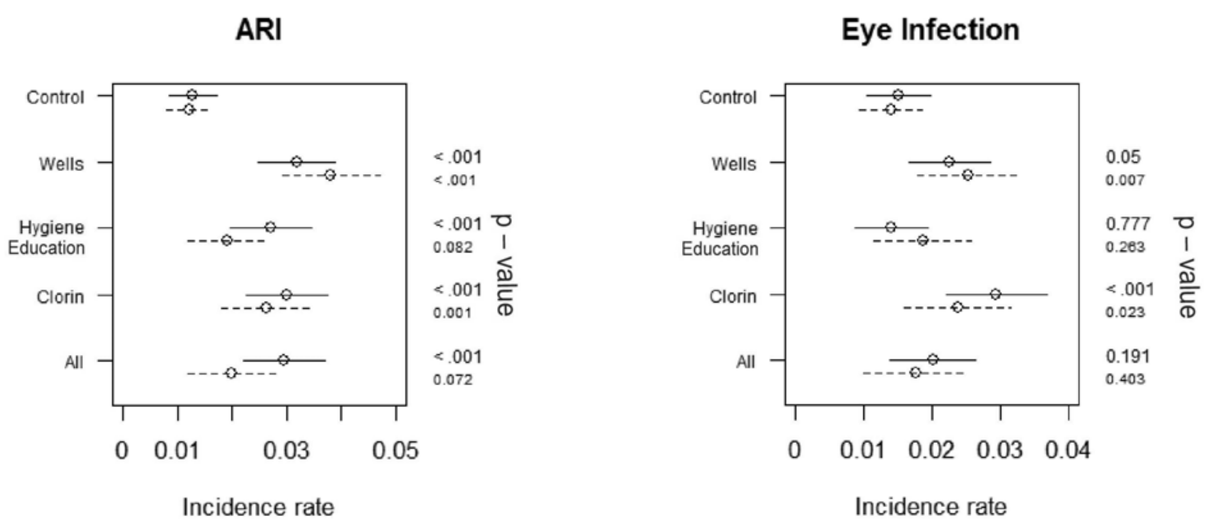
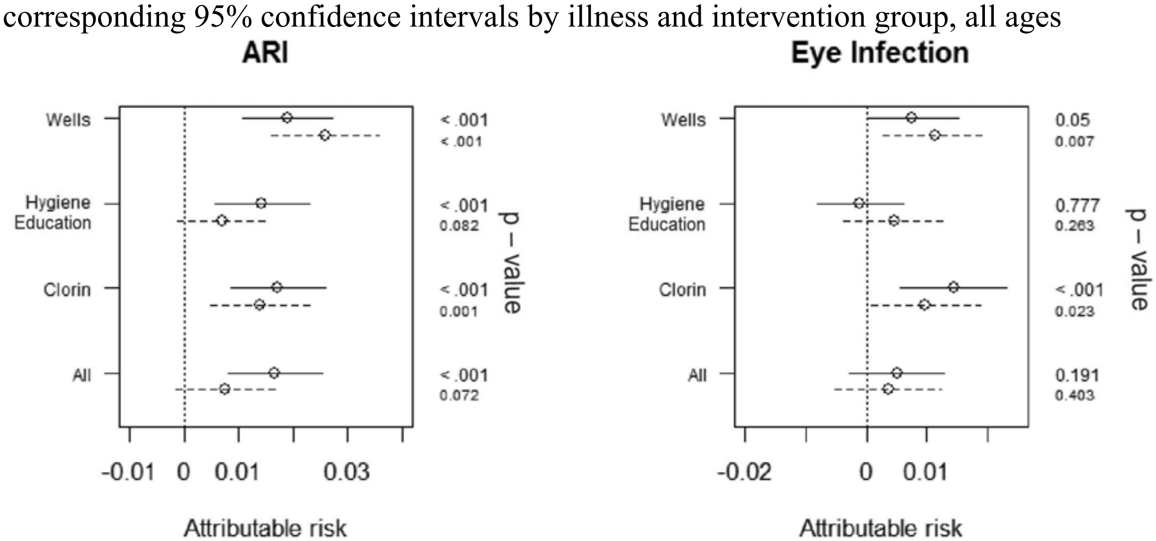


Figure 17: Attributable risk of ARI and eye infection from Summer 2006 (June-September) and corresponding 95% confidence intervals by illness and intervention group, all ages



There are no known plausible pathways to associate the interventions with increased incidence of either ARI or eye infection. The results provide evidence that statistical modeling may be needed to examine potential confounders.

The seasonality of ARI is of particular interest (see Figures 19 and 20). ARI prevalence in children under 5 years of age was found to be highly correlated to ambient temperature; as temperatures decreased below approximately 15˚C across the study area, child ARI prevalence increased significantly in all study groups. The prevalence of ARI in children decreased again when daily temperatures went above 15˚C.

Figure 18: Monthly prevalence of eye infection in children under 5 years, June 2005 – Sept 2006

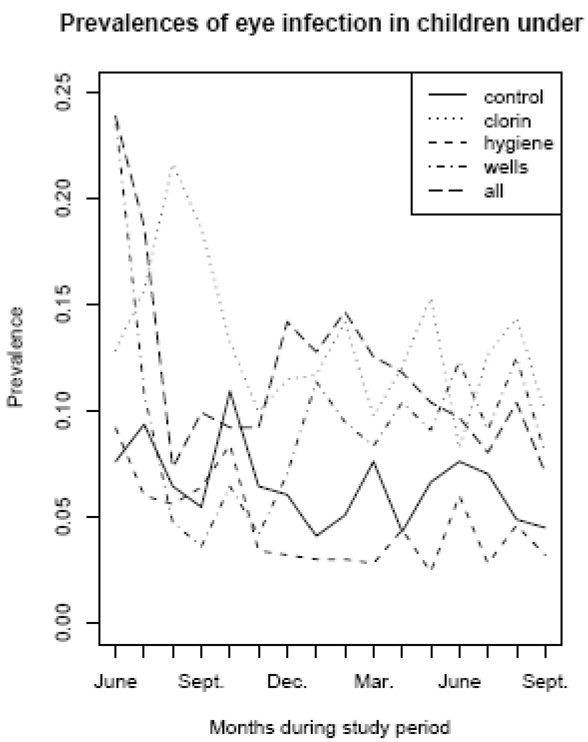


Figure 19: Monthly prevalence of ARI in children under 5 years, June 2005 – Sept 2006

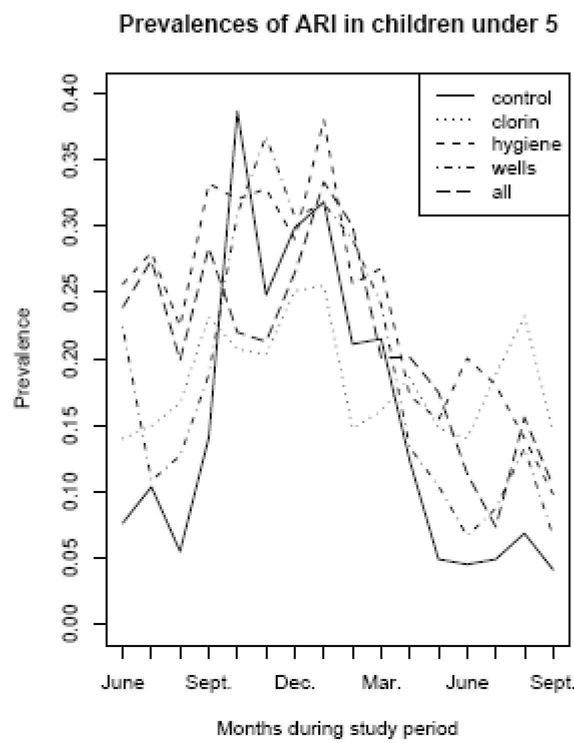
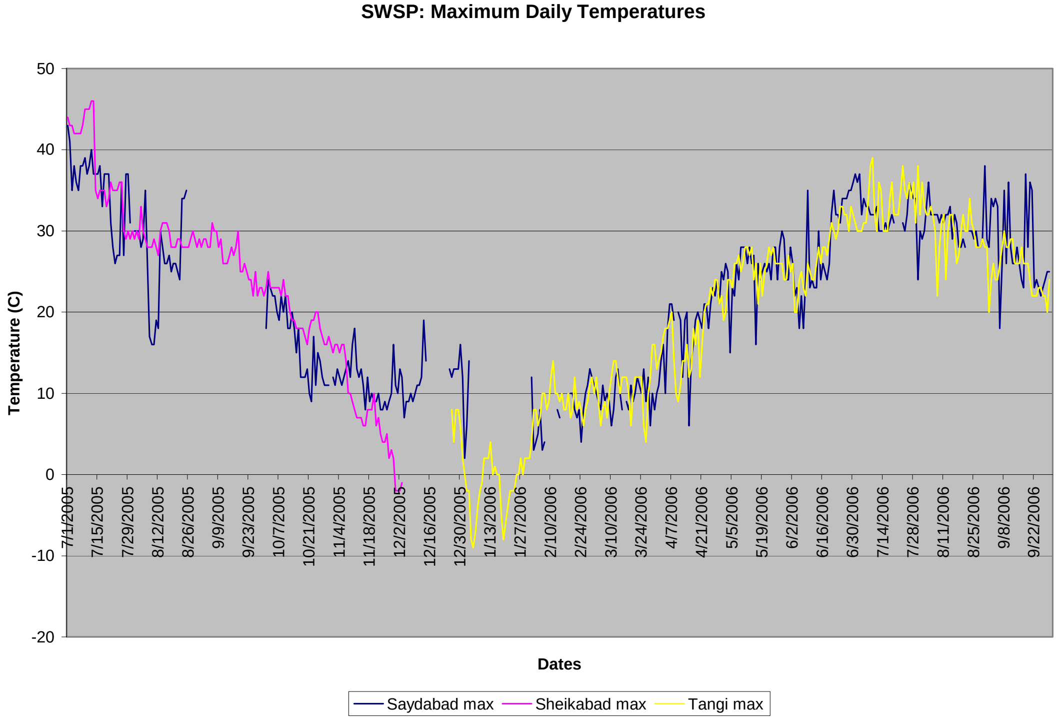


Figure 20: Maximum ambient temperature readings from three health facilities in SWSP project area, July 2005-September 2006



5.3.7 Water Quality Analysis

The results of the water analysis of samples taken across the study site demonstrated a high level of fecal contamination as measured by the presence/absence of fecal coliforms. Fecal coliforms are the most readily available indicators test of potential contamination with diarrheal disease causing agents.

In the first round of testing pre-intervention, household drinking water samples showed 68% had fecal coliforms present while 67% of the source water had fecal coliforms. However, due to a high rate of error (20% of both repeat samples and blank samples were in error) the results can not be assured. Error may have been introduced during sampling, transport, laboratory handling or sterilization of sampling bottles.

The post-intervention round of bacteriological analysis primarily conducted in April 2006 utilized the MoPH water quality lab. Results show a reduction in fecal coliform contamination in all intervention groups except the Hygiene Education group of villages compared to the previous round of sampling (see Table 15). While there is a dramatic changes in fecal coliform contamination between these two rounds of sampling conducted 10 months apart, the samples were taken at different times of the year, analyzed by different labs and can not be directly compared. The error rate has been reduced to 10% for blank samples and 13% for repeats. Of particular interest is the reduction in household drinking water fecal coliform level compared to the source water in both the Clorin (50% reduced to 41%) and All (50% reduced to 33%) villages. Clorin leaves a residual disinfectant which is intended to provide disinfection even after the initial treatment.

These water analysis results are limited in their interpretation as they were based on convenience sampling, not random sampling. Also, the high error rates leave a great deal of

uncertainly to the results, particularly in the pre-intervention water sample analyses. Furthermore, insecurity curtailed visits to villages and halted the planned repetition of sampling. The results do, however, point to two conclusions: first, very high levels of fecal coliform contamination of drinking water occurred throughout the study area; and second, the presence of Clorin appears to decrease fecal coliform contamination.

Table 15: Fecal coliform analysis of drinking water samples

Intervention Group	*Pre-Intervention*		*Post-Intervention*	
	Household June/July 2005	*Source June/July 2005*	*Household April 2006*	*Source April 2006*
All	77%	77%	33%	50%
Wells	64%	61%	57%	36%
Clorin	92%	77%	41%	50%
Hygiene Education	57%	52%	64%	59%
Control	46%	65%	42%	31%
Total	67%	67%	48%	40%

5.3.8 Latrine Study

The separation of fecal matter from drinking water is critical for controlling the transmission of diarrheal diseases. However, the latrines currently in use in the study area provide little protection to the drinking water sources. The results of the latrine study point to many household behaviors and characteristics that suggest that containment of fecal matter is not maintained. (Complete results are found in Annex 4, Table 12).

Using the mean of each descriptive element surveyed, the typical latrine found in the SWSP households was not a pit latrine but rather a vault latrine (98%) with inadequate closure at the back (73%), no separate urine pipe (91%) or vent pipe (95%), on higher ground than the drinking water supply (64%) and rarely cleaned (>60% had 3 months or more between cleanings). When cleaning did occur, the majority of the households dumped the fecal matter outside near the compound (70%). Additionally, 20% of the latrines had obvious fecal matter on the surface of the latrine floor. Clearly there are ample routes of fecal contamination into unprotected water sources, transmission by hands and feet with easy spread throughout the compound and village.

Vault latrine located above hand-dug well

Opening at back of latrine with waste draining toward well

Typically, the vault latrine is designed as a sanitary enclosure, elevated off the ground with a shallow vault under the latrine floor and an opening at the lower back wall which should be sealed with an easily removable cover for cleaning out fecal matter. The fecal matter is then expected to be adequately buried, away from the compound and water sources. Where the vault closure is maintained with a tightly fitting cover, fecal matter is kept within the vault. However, as discussed above, 73% of the time these latrine closures were not tight fitting or were missing altogether. This could allow fecal matter to drain out, which was observed in 20% of the latrines. The presence of a separate urine pipe can minimize the drainage of fecal matter by directing the urine into the ground. These, too, were not present in 91% of the latrines. Vent pipes can increase usage of latrines by controlling offensive odors. The lack of vent pipes in 95% of the latrines could inhibit the population from using the latrines. All of these characteristics contribute greatly to latrines as a potential contamination source rather than a protective element.

6. Discussion

The Safe Water Systems Project collected and analyzed a large data base during 22 months of field work, comparing both diarrheal disease incidence and prevalence through detailed surveys, disease surveillance and qualitative data. The baseline two-week diarrhea prevalence rate for children less than five years of age was 22.1%, confirming that diarrhea is a common risk among rural children. While this high diarrheal disease prevalence in rural Afghan children proved to be difficult to decrease to a statistically significant degree, the project results do demonstrate that household diarrhea is significantly reduced by concurrent interventions inclusive of new tubewells, point-of-use treatment with a protective water vessel and hygiene education. The diverse sources of fecal-oral contamination observed throughout the study area support the strong evidence that only a combination of approaches can significantly decrease diarrhea across the rural population in Afghanistan; no one approach alone demonstrated a sufficient effect to break the chain of disease transmission and consistently decrease diarrhea.

Children less than five years of age are the primary focus in diarrhea reduction efforts as these cases are much more likely to result in or contribute to death. Initial results from the follow-on survey compared to the baseline survey found that the All group showed the only clear trend toward reduction in the likelihood of diarrhea prevalence for children under five, with a decrease of approximately 40% (p=0.07) and a 70% reduction in bloody diarrhea prevalence for this age group (p-value=0.07). The surveillance data again found the All intervention group to have the largest effect on reducing risk in children under five with a point estimate reduction in risk of 27% (p-value = 0.19). While these results for children under five years of age do not reach the statistically significant threshold of a p-value ≤ 0.05, the consistent pattern they project is a strong indicator that the intervention combining all three components is protective against diarrheal disease. The limiting factor may be the overwhelming abundance of diarrhea-causing contaminants in the immediate environment. None of the other interventions alone showed consistent trends across the varying data as statistically significant or even close to statistically significant in reducing diarrheal disease rates.

The results for the total study population (all ages) were much clearer, again indicating that the All intervention was the most effective in reducing diarrhea. The survey data found the All group reduced the likelihood of diarrhea by 47% (p-value = 0.03) and the surveillance data results showed a relative risk reduction of 39% (p-value <0.001) in the All group. The reduction in relative risk in the group receiving new wells was 25% (p-value = 0.02) and Hygiene Education group was 31% (p-value =0.006). Clorin when used with an improved water vessel was not found to be effective in reducing diarrheal disease risk across the study population.

The costs for reducing diarrhea are relatively modest, with an annual rate ranging from \$0.99 to \$2.58 per case of diarrhea averted when spread over 25 year estimated lifespan of a well. Cost-effectiveness analysis conducted over varying field conditions and equipment lifespans concludes that hygiene education and new tubewells are the least expensive means to reduce diarrhea across age groups. These findings are tempered by other study results which indicate limited effectiveness of these two interventions and instead point only to significant diarrheal reductions from combining interventions, which was more expensive but dramatically more effective.

It is not surprising that the combination of interventions reduced risk of diarrheal diseases the most and also cost more than most interventions alone (except Clorin). These results support the underlying economic assumption that as interventions are intensified, benefits increase at a decreasing rate. This can also be stated as marginal costs are lower for an initial, single

intervention but get progressively more expensive as risk reduction is progressively more difficult to achieve (personal communication with C.Griffith, EPA).

Each individual intervention did show some benefits but not sufficient to impact childhood diarrheal levels. Improved tubewells by themselves were shown to be effective in the surveillance data but not in the survey data. However, even the tubewell results were much weaker than the All group results. The decrease in effectiveness of new wells alone was likely due to contamination of drinking water which occurred after water collection. These potential sources of contamination include dirty water-collection and storage vessels, unwashed hands and utensils entering the water vessels and leaving water uncovered allowing flies and airborne contaminates to settle in the drinking water. These sources have all been shown to increase risk of diarrheal disease post-collection.[25,52,53]

Hygiene education alone demonstrated conflicting results between the surveillance and survey data. The surveillance data showed hygiene education to have an impact on the diarrheal disease rates across the whole population while the survey data showed an increased likelihood of bloody diarrhea after hygiene education. Responses from households about the hygiene education showed a mixed uptake of the messages and continued confusion about the use of salt as a water treatment method. While it is not clear how the use of salt as a protective measure against diarrhea began, this practice is pervasive and needs to be strongly discouraged in hygiene education messages. As behavior change is often difficult to affect, hygiene education messages should be kept simple and short, making it easier to remember and incorporate in daily behaviors.

Clorin alone also was not found to consistently reduce diarrheal disease risk. These findings are similar to results of an earlier study in Zambia which found that inconsistent household use diminished Clorin's overall effectiveness.[54] However, some beneficial effects of Clorin can be seen in the water quality results where only the households that received Clorin showed a decrease in fecal coliform contamination. But even this reduction was less than would be expected from use of Clorin and an improved water vessel. Chlorine residuals produced by Clorin are intended to provide additional disinfection potential after initial pathogen de-activation, but this was not demonstrated as over 40% of Clorin intervention households had drinking water which showed contamination with fecal coliforms. Clorin proved to have wide acceptance and was popular among study households, even though the evidence does not show it to be effective in this study population and it was the least cost-effective of the interventions examined. Evidence suggests that its use spread among villages after introduction in project sites. However, its effectiveness may have been compromised by the use of turbid water as a drinking water source in many households. Turbid water can protect infectious microbes from becoming inactivated by Clorin, in effect shielding them from the disinfecting action. Therefore, to ensure effectiveness, turbid water should be filtered first, through a cloth or other means.[30] This additional step of filtering has not been clearly advocated in the marketing of Clorin in Afghanistan. It is likely that the turbid water impacted Clorin's overall effectiveness in project sites. Clorin's effectiveness may also have been impacted by inadequate dosage for the pathogen load, inconsistent household use and problems with quality control of the product. There has been a concern about the quality of Clorin batches produced in Kabul. Quality assurance testing by CDC in Atlanta, Georgia on batches distributed during the study period did meet minimum standards. However, subsequent batches did not meet the standards by failing to have a sufficient dose of sodium hypochlorite. These batches would not harm health; however, they would not provide adequate protection of drinking water. COMPRI-A recalled these batches from distributors and worked to resolve the quality issues (personal communication with COMPRI-A).

Additional findings give insight into population-level drinking water characteristics in rural Afghanistan. According to baseline results, current water sources were able to provide adequate minimum quantity of water at an average of 25L /person/day, but not adequate quality as demonstrated by the 67% of source waters contaminated with fecal coliforms. Sources and household water persisted in showing elevated levels of contamination even after interventions were in place, with the All group having the lowest contamination of drinking water at 33% of those sampled. To be considered "safe," drinking water should be free of any detectable fecal coliforms.[55] The water quality testing was based on convenience sampling and therefore the results should not be strictly interpreted. These data should be used more as an indication of contamination levels with source and household water supplies. The location and self-reported use of hand washing facilities in or near the kitchen had a strong association with decreased diarrheal disease rates, reducing the odds of having diarrhea by 34% (OR [95% CI] = 0.66 (0.44,0.99], p=0.04). Self-reported handwashing behaviors were markedly higher than observed handwashing practices suggesting that there is an awareness of its importance but it is not the norm.

Asset Index analyses point to a differential impact of intervention uptake due to socio-economic status (SES). This is particularly evident in the All intervention households where children in the lowest 40% SES households had more than twice the likelihood of having diarrhea during the previous two weeks than children in the highest SES quintile. These findings are consistent with results from a PSI study in Afghanistan which demonstrated that women of higher SES were significantly more likely to treat drinking water than women of lower SES.[56] Possible explanations for this observed difference include: the unequal diffusion of innovations which suggests that higher SES households accept and implement change more easily; the possibility that wells are sited closer to households with higher SES; and the impact of increased resources being available for maintaining improved hygiene conditions (such as for soap) in households with higher SES. The location and use of hand washing facilities appears to have a strong association with diarrheal disease rates.

The results strongly suggest that households with higher SES can adopt interventions more readily than households with lower SES. This is reinforced by the results for the Control group which showed no difference in the likelihood of diarrheal disease occurrence between the high and low SES households. There is certainly great importance in targeting interventions to lower SES households so as to improve the impact and decrease risk across SES levels.

The role of latrines providing protection or causation of diarrhea is unclear in the study results. While baseline survey results clearly associated latrine ownership with an increased risk of diarrhea, the opposite was true in the follow-on survey. Field evidence suggests that most latrines are not situated, constructed, used or maintained in a manner that would provide protection from fecal contamination or the surrounding environment. Sewage draining from latrines was a common sight along with open defecation around compounds. Any diarrhea reduction programs must include a comprehensive and aggressive approach which includes improvement in sanitation.

SWSP had begun assessing existing wells in the spring of 2006 to determine their vulnerability to contamination. However, a decrease in security halted this process. The limited observations that were made show a wide range of existing well conditions from protected sources with sealed handpumps, intact concrete platforms and no obvious routes of contamination from surface runoff to wells with cracked platforms and sewage-laden drainage canals within 5 meters. Unfortunately, due to curtailment this assessment provided little in the way of results.

The difficulty in well drilling experienced during SWSP points to a critical area in need of further national discussion; specifically, how best to equitably provide improved water to the rural population where suitable drilling equipment for the terrain is lacking. In the recent past, NGOs lead the rural water supply development. Due to donor, time and budgetary requirements, they focused on the most accessible regions that could be served with the simplest, most cost-effective equipment. More difficult regions were passed over, leaving the most vulnerable populations at an increasing disadvantage. Villages closest to the major cities with higher water tables have tended to receive the bulk of the boreholes.[39] Addressing water needs across the country will require alternative strategies to provide protected water. Drilling tubewells will not work in all villages; flexibility in drinking water strategies is essential to addressing the country's drinking water needs.

6.1 Significance to Future Programs

In conclusion, no single intervention was adequate to break disease transmission due to widespread routes of contamination and very low hygiene. Multiple routes of disease transmission found in project sites along with minimal knowledge of appropriate hygiene protections leads to the need for a comprehensive strategy to have any measurable affect on diarrheal diseases. With the current state of low access to improved water sources and sanitation, no one intervention alone consistently demonstrates a significant impact on childhood diarrhea. The combination of interventions does strongly demonstrate a marked impact on reducing diarrhea rates across the study population.

Example of drinking water contamination source, Kabul 2007
Waste pile includes fecal matter from cleaning of neighborhood latrines.

The overall project success points to a significant finding: research is possible in insecure settings with thoughtful adaptations, flexibility and close coordination with local government and NGOs. Countries recovering from recent conflict or humanitarian emergencies are in particular need of studies to provide an evidence base for sound policy development. As each situation is

different, the local context is critical to understanding effective interventions for improving the health of populations.

6.2 Limitations

There were a number of study limitations encountered during the course of field work and data analysis. Insecurity and adverse weather conditions prevented Kabul-based staff from traveling to the field on a number of occasions. Monitoring in the field was increasingly curtailed due to ongoing threats in the project area against government personnel, NGOs and international workers. The Afghan CHWs proved to be very effective data collectors as they were able to continue field work with fewer obstacles, completing surveys and regular disease data collection in a timely manner. However, the reduction in field monitoring may have allowed greater errors in field data.

The Hawthorne effect may have played a role in the study outcomes. The Hawthorne effect refers to a theory that changes in behavior(s) may occur in persons who are being studied due to the presence of an observer.[57] The visits of outside entities into these villages, asking about water and working to implement interventions in neighboring villages probably lead many villages to increase their awareness and interest in improved water, regardless of which intervention group the village was enrolled. The increased use of Clorin across intervention groups attests to the likelihood of this occurrence.

There is the possibility of a systematic bias due to the systematic randomization method used to assign interventions to the villages. The method was based on ordering the villages from largest to smallest according to village population estimates reported by village leaders. This would tend to have one intervention consistently assigned to comparatively larger villages. This may have been at least partially mitigated in practice as it was also found that village leaders tended to exaggerate the population totals to differing degrees. The result was a variation in the number of households assigned to each intervention group.

The different timing of intervention commencement may have affected an intervention's overall effectiveness, especially in the hygiene group. While hygiene educators visited households twice in the summer of 2005, the data analysis was primarily based on disease rates from May 2006 (follow-on survey) through September 2006 (the end of the surveillance period). The intention of SWSP was to mimic as much as possible true field conditions as these interventions would be implemented on a national basis. In this respect, it is likely that house-to-house hygiene education would not be implemented more than two times in a year, which is how this project was designed. However, it must be considered that the hygiene group's peak effect was not measured due to the lag time between intervention and disease surveillance.

Another limitation was encountered through the definition used to determine a household which made it difficult to track a household. Project surveyors were instructed to determine separate "households" according to who ate together the previous night. Several households may share a compound; as sons marry and start their own families, they often live in the same compound as their parents. Sometimes these families will share meals together and other times they will eat separately. Also, the most common reason given for households lost, i.e. moving, was often due to relocation in search of employment.

The project was designed to have the principal female of a household interviewed about disease and hygiene in that household, but approximately half of the time the females were not permitted or were unavailable to speak with the data collectors. In most cases, this meant that

the male head of household provided responses. There may have been a bias introduced when disease occurrence information, especially on behalf of children, was given by males vs. females.

7. Recommendations

Based on the above discussion, the following recommendations are made to the Ministry of Public Health:

1. A multi-barrier approach to improving drinking water is required to address high rates of diarrhea in rural Afghanistan. Numerous transmission routes of fecal contamination require a combination of methods to adequately target risks. The combination should include the provision of a protected water source which is tested to ensure good quality source water; point-of-use treatment with a chlorine product; use of a dedicated and protected storage vessel to maintain water quality and minimize recontamination; and hygiene education to prevent disease transmission.
2. Equal access to improved drinking water must be a higher priority across the country. Greater availability of advanced drilling equipment and alternative sources of improved water need to be examined.
3. Drinking water interventions need to specifically target low SES households to provide equitable access to and an understanding of the health benefits of improving household drinking water. Without specific targeting of interventions or messages, households did not benefit equally from the interventions as measured by impact on diarrhea rates.
4. Behavior change messages as delivered in hygiene education programs should be clear and simple. The following five key points should be made: wash hands with soap; use the most protected water source available for drinking water; maintain latrines properly; protect food from contamination; use ORS when diarrhea occurs. While these are part of most hygiene education programs in Afghanistan, the way they are delivered has evolved into too many messages which become confusing to household members.
5. Maintain a high level of interaction and cooperation between MoPH, MRRD and NGOs as they are all crucial to improving health through water, sanitation and hygiene. This symbiotic relationship cannot be underestimated; improvements in water and sanitation are likely to have a great impact on improving health across the country. However, the roles and responsibilities of each ministry should be clear: MOPH has the responsibility for health as MRRD oversees projects. As new water points and sanitation projects are developed, water quality monitoring and hygiene education should come under MOPH.
6. The national drinking water protection strategy should include the following progressive elements:
    - Drinking water quality standards
    - Database of all drinking water sources
    - Database of water quality results
    - Regional MoPH drinking water quality laboratories
    - Quality assurance and quality control standards for laboratory testing facilities
    - Monitoring system for water points within network systems and villages
    - Sanitation standards for public areas, such as parks, restaurants, wedding halls, markets and offices

Areas of Further Research

Results from SWSP point to the need for further research to better understand the impact of household and community level characteristics on diarrheal disease prevalence. The impact of latrine design and maintenance on disease rates are critical study areas. In conjunction with the multi-barrier approach described in the report and latrines, research into appropriate behavior change models aimed at improving hygiene levels are needed. Without addressing the widespread fecal matter present in the environment due to poor sanitation, efforts to decrease diarrheal disease rates will likely continue to be hindered.

Other important areas of study include examining the affect of SES on behavior change and intervention uptake; effect of tribal affiliation on hygiene behaviors and diarrhea rates; and the availability of alternative protected water supplies in rural Afghanistan.

ARI constitutes a significant threat to the health of the population, especially children less than five years of age, and suggests a significant area in need of further studies. These studies should include the effect of household characteristics and hygiene variables on ARI rates.

The further development of the environmental health system of Afghanistan will require monitoring and evaluations protocols. As part of this system, ongoing study into the long-term impacts, sustainability and quality control measures of drinking water and sanitation interventions are needed.

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Annex 1: Survey Instruments

Survey 1: Baseline Survey

The purpose of this survey is to find out baseline information that will make it possible to identify the communities for allocation into the various study arms. No unique identifiers are to be noted .The questions are intended for the wife (principal) or mother in the household on the data form record:
Date of interview *Village name* *House #*
Interviewer Name

SCRIPT: We would like to ask you a series of questions about diarrhea in your household during the past two weeks, use of water in your household, use of latrines and handwashing practices. As part of this survey we will ask to look a the place your household washes its hands

A. Demographic information

No	Question	Answer	Instruction
1	Age at last completed year of person being interviewed	Age:________	
2	Person interviewed	Husband.................................. 1 Wife (principal)......................... 2 Wife (other)............................. 3 Mother-in-law........................... 4 Father-in-law............................ 5 Child....................................... 6 Other relative........................... 7 Non-relative............................. 8	
3	Has the person being interviewed ever attended school?	1-Yes...................................... 1 2-No 2	If "NO" then skip to Q5
4	What was the highest level of school they attended?	Primary................................... 1 Secondary............................... 2 Higher than Secondary........... 3 Madrassa................................ 4 Less than one year of school.. 5 Non-Standard Curriculum....... 6 Don't Know the level............... 7	
5	How long has your household been living in this village? *Prompt with available answers.*	Less than one year................. 1 One to three years .... 2 More than three years............. 3	

B. Household diarrhea in past 2 weeks

Diarrhea in household members													
Please tell me if anyone in your household has been sick with diarrhea in the past week. Please tell me the names of everyone in your household. Start with the youngest person and finish with the oldest. Include yourself in the list of household members													
Interviewer: *For every household member that is listed, ask if they have had diarrhea in the past week. If they have had diarrhea, complete the remaining columns in the table. If they did not have diarrhea, do not fill in any details, but go on to the next person in the household.*													
First name	Age	M/F	Diarrhea in the past week		No. of days with diarrhea in past week	Blood Y / N		Diarrhea in past 24 hours		Visited clinic for diarrhea			
			Yes	No		Yes	No	Yes	No	Yes	No		

C. Water supply

No.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
8	What is the principal source of drinking water for members of your household? [1] (CHECK ONE)	Protected tubewell or borehole............... 11 Unprotected tubewell or borehole .... 12 rotected dug well .... 13 nprotected dug well................................ 14 Spring .... 15 Surface Water……………………………..41 Other ____________________________ 88 (specify) Don't know.. 99	
9	Where is your principal source of drinking water located?	In dwelling... 1 In yard/compound .... 2 Outside yard/plot/, shared private source 3 Outside yard/plot/, shared public source.. 4 Don't know.. 99	
10.	How long does it take you to go to your principal water source, get water, and come back? (RECORD IN THREE NUMBERS ONLY)	MINUTES [ ][ ][ ]	
D. WATER STORAGE, HANDLING AND TREATMENT			
11.	Yesterday, how much water did you collect? Please show vessel(s).	Number:.. ___ Don't know.. 99	
12.	Container volumes (AFTER OBSERVING VESSEL(S), CIRCLE ALL THAT APPLY)	2.5 liters .... 1 5 liters .... 2 20 liters .... 3 Other: number of liters......................... ___	
13.	What is the primary vessel(s) you use for storing water? Ask to see the vessel(s). MATERIAL	Clay jars.. 1 Plastic containers .... 2 Metal containers .... 3 Other ____________________________________88 (specify)	
14.	VOLUME of primary vessel(s)	2.5 liters .... 1 5 liters .... 2 20 liters .... 3 Other: number of liters......................... ___	
15.	What types of neck do they have? (CONFIRM AND CIRCLE ALL THAT APPLY)	Narrow necked .... 1 Covered .... 2 Open... 3 Other ____________________________________88 (specify)	

No.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
16.	*How do you get water from the drinking water container? *For these questions, do not give the answers, let them answer.	Pouring .... 1 Dipping .... 2 Both pouring and dipping .... 3 Container has a spigot .... 4 Other....... 88 (specify) Don't know....... 99	
17.	Do you think the water you drink is safe directly from the source?	Yes .... 1 No .... 2 Don't know....... 99	
18.	In the past 2 weeks have you done anything to your household drinking water to make it safer? **Note: people may still treat even if they believe water is safe**	Yes .... 1 No .... 2 Don't know....... 99	 ➔21 ➔21
19.	In the past 24 hours, have you done anything to your household drinking water to make it safe?	Yes .... 1 No .... 2 Don't know....... 99	
20.	What did you do to the water to make it safer to drink? (CIRCLE ALL THAT APPLY)	Boil....... 1 Bleach/chlorine (other than Clorin)....... 2 Add Clorin....... 3 Filter it through cloth....... 4 Water filter (ceramic, sand, composite).... 5 Solar disinfection .... 6 Other ________________ 88 (specify) Don't know ________________ 99	

E. Household hygiene practices

21.	Do you have a bar of soap for hand washing in your household today?	Yes .... 1 No....... 2 Don't know 99	
22.	Have you used soap for handwashing during the past 24 hours?	Yes .... 1 No....... 2 Don't know 99	

23.	When you used soap during the past 24 hours, what did you use it for? If for washing hands is mentioned, probe what was the occasion, but do not read the answers. (DO NOT READ THE ANSWERS, ASK TO BE SPECIFIC, ENCOURAGE "WHAT ELSE" UNTIL NOTHING FURTHER IS MENTIONED AND CHECK ALL THAT APPLY)	Washing cloths..1 Washing my body....................................2 Washing my hands ....3 Washing my children................................4 Washing child's bottoms ....5 Washing my children's hands ....6 Washing hands after defecating ....7 Washing hands after cleaning child ....8 Washing hands before feeding children ...9 Washing hands before preparing food....10 Washing hands before eating ....11 Other .... 88 (specify) Don't remember 96	
24.	When is it important to wash your hands? (DO NOT READ THE ANSWERS, ENCOURAGE BY ASKING IF THERE IS ANYTHING ELSE UNTIL S/HE SAYS THERE IS NOTHING ELSE) **(CIRCLE ALL THAT APPLIES)**	Before preparing food or cooking.............1 Before eating..2 Before feeding children ....3 After changing baby ....4 After defecating ....5 After eating...6 Other ______________________________88 (specify) Don't know 99	

F. Observation of Handwashing Place and Essential Supplies

25.	Do you have a place where you <u>usually</u> wash hands, and if so, where is it? (*Check all that apply*)	Yes, inside or next to sanitation facility .... 1 Yes, inside or next to kitchen .... 2 Yes, inside living quarters .... 3 Yes, outside in yard................................ 4 No.. 5	
26.	Observation only: is there water? Interviewer: turn on tap and/or check container and note if water is present	Yes, found in handwashing place .... 1 Brought by caretaker within 1 min............ 2 No 3	
27.	Observation only: is there soap or detergent or ash? (*circle the item present*)	Found in handwashing place.................... 1 Brought by caretaker within 1 min............ 2 No.. 3	
28.	Observation only: is there a handwashing device such as a tap, basin, bucket, sink, or tippy tap?	Yes, found in handwashing place .... 1 Brought by caretaker within 1 min............ 2 No.. 3	
29.	Observation only: is there a towel or cloth to dry hands?	Yes, found in handwashing place .... 1 Brought by caretaker within 1 min............ 2 No.. 3	

G. Sanitation

30.	Does this household have a sanitation facility? If yes, ask to see it.	Yes .... 1 No.. 2	➔end

31.	What type of sanitation facility is available to this household? (CHECK ONE)	Type : Pit latrine.. 11 Pour-flush latrine .... 12 Other ________________________ 88 (specify) Don't know... 99	
32.	Location of sanitation facility (CIRCLE ONLY ONE)	In dwelling... 1 In yard/compound .... 2 Outside yard/compound, shared private facility.. 3 Outside yard/compound, shared public facility .... 4 Don't know.. 99	
33.	Sanitary condition of facility	Fecal matter present inside facility ……….1 No fecal matter present…………………….2 Cannot assess…………………………….8	
34.	Hand washing available in/by sanitation facility	Yes………………………………………….1 No…………………………………………..2	
35.	How many households share this sanitation facility?	Households	

Survey 2: Follow-on Survey

The purpose of this survey is to follow up with households that have been taking part in the study over the last year. No unique identifiers are to be noted .The questions are intended for the wife (principal) or mother in the household. On the data form record:

Interviewer Name *Village name* *House #* *Date*

SCRIPT: We would like to ask you a series of questions about diarrhea in your household during the past two weeks, use of water in your household, use of latrines, handwashing practices and other household questions. As part of this survey we will ask to look at the place your household washes its hands

A. Demographic information

No	Question	Answer	Instruction
1	Age of person being interviewed, at last completed year	Age:________	
2	Person interviewed	Husband................................. 1 Wife (principal)....................... 2 Wife (other)............................ 3 Mother-in-law.......................... 4 Father-in-law........................... 5 Child....................................... 6 Other relative.......................... 7 Non-relative............................ 8	
3	Has wife (principal) ever attended school?	1-Yes...................................... 1 2-No 2	⇨ SKIP to #5
4	What was the highest level of school she attended?	Primary................................... 1 Secondary............................... 2 Higher than Secondary........... 3 Madrassa................................ 4 Less than one year of school.. 5 Non-Standard Curriculum....... 6 Don't Know the level............... 7	
5	Has husband ever attended school?	1-Yes...................................... 1 2-No 2	⇨ SKIP to #7
6	What was the highest level of school they attended?	Primary................................... 1 Secondary............................... 2 Higher than Secondary........... 3 Madrassa................................ 4 Less than one year of school.. 5 Non-Standard Curriculum....... 6 Don't Know the level............... 7	
7	How long has your household been living in this village? *Prompt with available answers.*	Less than one year .... 1 One to three years .... 2 More than three years............. 3	

8	Does any member of the household own any of the following: *Read each choice, circle all that apply* A sewing machine	A	
	A clock or watch	B	
	A pressure cooker	C	
	A radio	D	
	A bicycle	E	
	A motorbike	F	
	A electricity generator	G	
	A car	H	
	sheep	I	
	None	J	
9	Did any member of the household own any of the following one year ago: *Read each choice, circle all that apply* A sewing machine	A	
	A clock or watch	B	
	A pressure cooker	C	
	A radio	D	
	A bicycle	E	
	A motorbike	F	
	A electricity generator	G	
	A car	H	
	sheep	I	
	None	J	

C. Water supply

No.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
10	What is the principal source of drinking water for members of your household? (CIRCLE ONE)	Protected tubewell or borehole............... 11 Unprotected tubewell or borehole .... 12 rotected dug well .... 13 nprotected dug well .... 14 Spring .... 15 Kareze .... 16 Surface Water……………………………..41 Other ______________________________ 88 (specify) Don't know... 99	
11	Where is your principal source of drinking water located?	In dwelling... 1 In yard/compound .... 2 Outside yard/plot/, shared private source 3 Outside yard/plot/, shared public source.. 4 Don't know... 99	
12	How long does it take you to go to your principal water source, get water, and come back? (RECORD IN THREE NUMBERS ONLY)	MINUTES [ ] [ ] [ ]	
D. WATER STORAGE, HANDLING AND TREATMENT			
13	Yesterday, how much water did you collect?	Number:... ___ Don't know... 99	
14	What is the primary vessel(s) you use for storing water? Ask to see the vessel(s).	Clay jars.. 1 Plastic containers .... 2 Metal containers .... 3 Other _________________________________88 (specify)	
15	VOLUME of primary vessel(s)	2.5 liters .... 1 5 liters .... 2 20 liters .... 3 Other: number of liters......................... ___	
16	What types of neck do they have? (CONFIRM AND CIRCLE ALL THAT APPLY)	Narrow necked ....A Covered ....B Open..C Other _________________________________D (specify)	
17	*How do you get water from the drinking water container? *For these questions, do not give the answers, let them answer.	Pouring ....1 Dipping ....2 Both pouring and dipping ....3 Container has a spigot ....4 Other...88 (specify) Don't know...99	

No.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
18	Do you think the water you drink is safe directly from the source?	Yes .... 1 No .... 2 Don't know 99	
19	In the past 2 weeks have you done anything to your household drinking water to make it safer? **Note: people may still treat even if they believe water is safe**	Yes .... 1 No .... 2 Don't know 99	 ➔21 ➔21
20	In the past 24 hours, have you done anything to your household drinking water to make it safe?	Yes .... 1 No .... 2 Don't know 99	
21	What did you do to the water to make it safer to drink in the last 2 weeks? (CIRCLE ALL THAT APPLY)	Boil .... A Bleach/chlorine (other than Clorin) .... B Add Clorin .... C Filter it through cloth .... D Water filter (ceramic, sand, composite) .... E Solar disinfection .... F Salt .... G Other ____________ H (specify) Don't know ____________ I	

E. Household hygiene practices

22	Do you have a bar of soap for hand washing in your household today?	Yes .... 1 No .... 2 Don't know 99	
23	Have you used soap for handwashing during the past 24 hours?	Yes .... 1 No .... 2 Don't know 99	
24	When you used soap during the past 24 hours, what did you use it for? If for washing hands is mentioned, probe what was the occasion, but do not read the answers. (DO NOT READ THE ANSWERS, ASK TO BE SPECIFIC, ENCOURAGE "WHAT ELSE" UNTIL NOTHING FURTHER IS MENTIONED AND CHECK ALL THAT APPLY)	Washing cloths .... A Washing my body .... B Washing my hands .... C Washing my children .... D Washing child's bottoms .... E Washing my children's hands .... F Washing hands after defecating .... G Washing hands after cleaning child .... H Washing hands before feeding children .... I Washing hands before preparing food ...... J Washing hands before eating .... K Other .... L (specify) Don't remember .... M	

25	When is it important to wash your hands? (DO NOT READ THE ANSWERS, ENCOURAGE BY ASKING IF THERE IS ANYTHING ELSE UNTIL S/HE SAYS THERE IS NOTHING ELSE) **(CIRCLE ALL THAT APPLIES)**	Before preparing food or cooking............. A Before eating... B Before feeding children............................ C After changing baby .... D After defecating .... E After eating..F Other ______________________________ G (specify) Don't know ....H	

F. Observation of Handwashing Place and Essential Supplies

26	Do you have a place where you usually wash hands, and if so, where is it? (*Check all that apply*)	Yes, inside or next to sanitation facility ....A Yes, inside or next to kitchen ....B Yes, inside living quarters ....C Yes, outside in yard.................................D No...E	
27	Observation only: is there water? Interviewer: turn on tap and/or check container and note if water is present	Yes, found in handwashing place .... 1 Brought by caretaker within 1 min............ 2 No 3	
28	Observation only: is there soap or detergent or ash? (*circle the item present*)	Found in handwashing place.................... 1 Brought by caretaker within 1 min............ 2 No.. 3	
29	Observation only: is there a handwashing device such as a tap, basin, bucket, or sink?	Yes, found in handwashing place .... 1 Brought by caretaker within 1 min............ 2 No... 3	
30	Observation only: is there a towel or cloth to dry hands?	Yes, found in handwashing place .... 1 Brought by caretaker within 1 min............ 2 No... 3	

G. Sanitation

31	Does this household have a sanitation facility? If yes, ask to see it.	Yes .... 1 No.. 2	 → **END**
32	What type of sanitation facility is available to this household? (CHECK ONE)	Type : Pit latrine... 11 Pour-flush latrine .... 12 Other ______________________ 88 (specify) Don't know.. 99	
33	Location of sanitation facility (CIRCLE ONLY ONE)	In dwelling... 1 In yard/compound .... 2 Outside yard/compound, shared private facility.. 3 Outside yard/compound, shared public facility .... 4 Don't know.. 99	
34	Sanitary condition of facility	Fecal matter present inside facility ……….1 No fecal matter present……………………..2 Cannot assess……………………………..8	
35	Hand washing available in/by sanitation facility	Yes…………………………………………..1 No…………………………………………...2	
36	How many households share this sanitation facility?	Households	

B. Household diarrhea and ARI in past 2 weeks

Diarrhea and ARI in household members

Please tell me if anyone in your household has been sick with diarrhea or acute respiratory infection in the past two weeks. Please tell me the names of everyone in your household. Start with the oldest person and finish with the youngest. Include yourself in the list of household members

Interviewer: For every household member that is listed, ask if they have had diarrhea or acute respiratory infection (ARI) in the past two weeks. If they have had diarrhea or ARI, complete the remaining columns in the table. If they did not have diarrhea or ARI, do not fill in any details, but go on to the next person in the household.

First name	Age	M/F	Diarrhea in past two weeks	No. of days with diarrhea in past two weeks	Bloody Diarrhea	Visited clinic for diarrhea	ARI in past two weeks	Visited clinic for ARI
			Yes		Yes	Yes	Yes	Yes

Survey 3: Latrine Study

The purpose of this study is to follow up with households taking part in the Safe Water Systems Project. The questions are intended for the male head of household or principal wife in the household.

Village: ________________________ Household number: _______

SCRIPT: We would like to ask you a series of questions about latrines. As part of this study, we will ask to look at the latrine.

#	Question	Answer	Instruction
1	Does your household have a latrine?	Yes……………………….1 No………………………...2	 ⇨ **FINISHED**
2	How many households share the latrine?	______________________	
3	Where is the latrine located? May I please see it?	In compound yard……...1 Inside house………......2 Outside compound……..3	
4	Type of latrine? **Observation**	Vault……..……………….1 Elevated Vault………….2 Pit (>1 Meter deep)…….3 Pour-flush………………4 Other……………………99 ____________________ (If 99 circled, describe "other") ____________________	 ⇨ **Go to 6** ⇨ **Go to 6** ⇨ **Go to 6**
5	If household has a vault latrine, is the cover for its opening: **Observation**	Closed (<1/2cm)..……...1 Loosely fitted……………2 Open…………………….3	
6	Does the latrine have a separate urine pipe? **Observation**	Yes, goes into ground…..... 1 Yes, open at back of latrine..2 Yes, but broken…………….3 No……………………………4	
7	Does the latrine have a ventilation pipe? **Observation**	Yes……………………….1 No………………………...2	
8	Are feces present on the floor of the latrine? **Observation**	Yes……………………….1 No………………………...2	
9	Are feces present on the outside of the latrine? **Observation**	Yes……………………….1 No………………………...2	

10	Is semi-solid or liquid waste draining from latrine on any side? **Observation**	Yes……………………….1 No………………………..2	
11	Distance from latrine to drinking water source:	_______________meters	
12	Is the latrine on ground that is higher or lower than the principal source of water?	Latrine higher……………….1 Latrine lower……………….2 Same level…………………3	
13	How often is the latrine used by household members?	Never………………………..1 Sometimes (less than half the time)…………………………2 Often (more than half the time)…………………………3 Always…………………......4	
14	How often is the latrine emptied?	Every Year..…………………1 Every 6 months……………..2 Every 3 months……….. …..3 Every Month…………………4 Every Week………………….5 Every Day……………………6 Never…………………………7 Other……………………99 ____________________ (If 99 circled, describe "other") ____________________	⇨ **FINISHED**
15	Where are feces from latrine disposed?	In field……………………....1 Outside, next to compound…………………..2 Inside compound, buried….3 Inside compound, but not buried………………………..4 Other………………………99 ____________________ (If 99 circled, describe "other") ____________________	

Surveyor:____________________________ Date: ____________________

Annex 2: Details of Cost-Effectiveness Analysis

Table 1: Annual Cost per Case of Diarrhea Averted by Intervention and Varying Well Lifespans

All : Annual Costs for village of 100 households, 700 individuals, 608 cases of diarrhea averted/yr						
Item	7.5 year hp 15 year well	15 year hp 15 year well	7.5 year hp 20 year well	15 year hp 20 year well	7.5 year hp 25 year well	15 year hp 25 year well
Wells (4)	538.67	538.67	404	404	323.2	323.2
Replacement Handpump	26.66	0	40	20	48	16
HP Maintenance ($0.50/yr)	30	30	40	40	50	50
Clorin & Hygiene Educators w/transport	544	544	544	544	544	544
Clorin (1 bottle/month)	300	300	300	300	300	300
Vessel	300	300	300	300	300	300
Training of Trainers	$36.00	$36.00	$36.00	$36.00	$36.00	$36.00
TOTAL	1775.33	1748.67	1664	1644	1601.2	1569.2
Annual cost per case of diarrhea averted	$2.92	$2.88	$2.74	$2.70	$2.63	$2.58

Clorin ** not statistically significant**	Annual Costs for village of 100 households, 700 individuals					
Item	7.5 year hp 15 year well	15 year hp 15 year well	7.5 year hp 20 year well	15 year hp 20 year well	7.5 year hp 25 year well	15 year hp 25 year well
Clorin Educators	$408.00	$408.00	$408.00	$408.00	$408.00	$408.00
Clorin	$300.00	300	300	300	300	300
Vessel	$300.00	300	300	300	300	300
Training of Trainers	$36.00	$36.00	$36.00	$36.00	$36.00	$36.00
TOTAL	$1,044.00	$1,044.00	$1,044.00	$1,044.00	$1,044.00	$1,044.00
195 Cases of diarrhea averted annually						
Annual cost per case of diarrhea averted	$5.35	$5.35	$5.35	$5.35	$5.35	$5.35

ygiene Education: Annual Costs for village of 100 households, 700 individuals, 448 cases of diarrhea averted/yr						
Item	7.5 year hp 15 year well	15 year hp 15 year well	7.5 year hp 20 year well	15 year hp 20 year well	7.5 year hp 25 year well	15 year hp 25 year well
Hygiene Educators	$408.00	$408.00	$408.00	$408.00	$408.00	$408.00
Training of Trainers	$36.00	$36.00	$36.00	$36.00	$36.00	$36.00
Total	$444.00	$444.00	$444.00	$444.00	$444.00	$444.00
Annual cost per case of diarrhea averted	$0.99	$0.99	$0.99	$0.99	$0.99	$0.99

Wells: Annual Costs for village of 100 households, 700 individuals, 384 cases of diarrhea averted/yr						
Item	7.5 year hp 15 year well	15 year hp 15 year well	7.5 year hp 20 year well	15 year hp 20 year well	7.5 year hp 25 year well	15 year hp 25 year well
Wells (4)	$538.67	$538.67	$404.00	$404.00	$323.20	$323.20
Replacement Handpump	$26.66	$0.00	$40.00	$20.00	$48.00	$16.00
HP Maintenance ($0.50/yr)	$30.00	$30.00	$40.00	$40.00	$50.00	$50.00
TOTAL	$595.33	$568.67	$484.00	$464.00	$421.20	$389.20
Annual cost per case of diarrhea averted	$1.55	$1.48	$1.26	$1.21	$1.10	$1.01

ANNEX 3: Additional Results

Table 1: Summary of behaviors and household characteristics found at baseline (pre-intervention) and households at follow-on (post-intervention)

Summary	*Baseline n = 1514 Households*	*Baseline Proportions*	*Follow-on n = 1361*	*Follow-on Proportions*
Median Age of person interviewed	35		35	
Average household size	7.3		7.51	
Person Interviewed: Husband	742	49%	352	26%
Person Interviewed: Principal Wife	688	46%	651	48%
Ever Attended School	375	21%		
Attended Primary School	112	8%		
Attended Secondary School	47	3%		
Attended higher than secondary	151	11%		
Returned to village in last 3 years	44	3%	36	3%
Water source: protected tubewell or borehole	70	5%	391	29%
protected dug well	128	9%	17	1%
unprotected tubewell or borehole	228	15%	75	6%
unprotected dug well	593	39%	484	36%
spring	247	16%	79	6%
surface water	175	12%	211	16%
kareze			104	8%
combination	53	4%		
Mean time to collect water in minutes per household	31.05		29.00	
Mean liters of water collected yesterday per household	25.5		24.31	
Private water source	807	54%	615	45%
Primary water vessel, plastic	1349	89%	1273	94%
Primary water vessel, 20 liters	1250	83%	1124	83%
Primary water vessel narrow necked	1401	93%	1282	94%
Primary water vessel with spigot	8	1%	8	1%
Pour from primary water vessel	1345	89%	1275	94%
Dip from primary water vessel	98	6%	65	5%
Consider household drinking water safe	811	54%	888	65%
Treated water in last 2 weeks	141	10%	521	38%
Treated water in last 24 hours	89	6%	478	35%
Water Treatment in last 2 weeks: Boiled	100	7%	92	7%
Chlorine (other than Clorin)	6	0%	4	<1%
Clorin	3	0%	480	35%
Filtered through cloth	15	1%	1	<1%
Water filter (ceramic, sand, composite)	2	0%	0	0%
Solar	9	1%	0	0%
Salt			8	1%
Other	15	1%	4	<1%

Has Soap for handwashing, self-reported	1168	77%	1143	84%
Used soap in last 24 hours for handwashing	1046	71%	1119	85%
When asked to list what soap was used for in last 24 hrs : clothes	1265	84%	1289	95%
my body	692	46%	1047	77%
my hands	716	47%	1068	78%
my children	475	31%	463	34%
child's bottom	332	22%	225	17%
children's hands	174	11%	176	13%
after defecating	139	9%	141	10%
after cleaning child	73	5%	36	3%
before feeding children	21	1%	22	2%
Before preparing food	153	10%	62	5%
before eating	96	6%	120	9%
Important to wash hands: before food preparation	1261	83%	807	59%
before eating	1039	69%	1154	85%
before feeding children	696	46%	418	31%
After changing baby	442	29%	248	18%
after defecating	790	52%	863	63%
after eating	729	48%	708	52%
Household has a place they usually wash hands	1360	90%	1304	96%
Location of handwashing: sanitation facility	942	62%	1054	77%
kitchen	93	6%	320	24%
living quarter	172	11%	115	8%
outside in yard	379	25%	330	24%
none	154	10%	57	4%
Observation of handwashing location:				
water available	752	51%	775	57%
soap, detergent or ash available	809	55%	775	57%
tap, basin, bucket or sink available	798	54%	803	59%
towel or cloth available to dry hands	818	56%	690	51%
Household has sanitation facility	1203	80%	1178	87%
Type of sanitation facility: Latrine	1200	100%	1169	99%
Latrine located in dwelling or compound	913	61%	899	75%
Observed fecal matter inside latrine	343	23%	404	34%
Observed handwashing in/by latrine	381	25%	37	3%
Number of households sharing latrine: One	597	50%	570	48%
Two	218	18%	248	21%
Three	202	17%	166	14%
Four	89	7%	100	8%

Table 2: Data Collection Summary of "lost" households within SWSP villages

Reason	*Follow-on Survey*	*Surveillance*
Refusals	3	2
Moved	76	58
Sharing household	48	25
Not home on day of survey	12	
Not found	12	16
Wrong household	2	
Unknown reason		5
Total "Lost"	153	106

Table 3: Comparison of mean household demographic proportions across study groups in baseline survey comparing households enrolled at baseline to households found at follow-on (includes all villages meeting inclusion criteria)

Intervention Group	*Clorin*		*Hygiene*		*Wells*		*All*		*Control*	
Survey	B	F	B	F	B	F	B	F	B	F
Household size	7.0	7.3	7.5	7.6	7.5	7.5	7.3	7.3	7.2	7.3
Children <5 per hh	1.3	1.2	1.4	1.4	1.5	1.5	1.2	1.2	1.2	1.2
Children <1 per hh	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Wife, any education	3.3	2.2	8.1	8.1	4.2	4.2	9.2	9.2	10.1	11.4
Husband, any education	31.3	35.0	37.7	37.7	35.0	35.1	31.9	31.9	43.2	44.6
Use unprotected dug well	36.4	34.6	37.2	38.1	44.2	42.9	40.1	40.1	38.0	36.1
Treated drinking water in last 2 weeks	9.1	11.2	11.4	13.1	10.2	10.2	8.8	8.8	7.9	6.0
Household has latrine	80.8	78.2	83.1	82.9	77.9	77.4	87.7	87.7	72.1	76.3
Minutes to collect drinking water	36.0	40.9	25.4	25.4	27.6	28.1	34.6	34.6	31.0	30.3
Liters of drinking water collected per person	27.2	29.9	24.4	24.1	24.0	24.1	25.5	25.5	26.0	26.2

B=Baseline survey results F= Baseline results for households found at Follow-on

Table 4: Diarrhea in Children <1 year, DID Analysis (Follow-on – Baseline) comparing intervention group to control

Intervention	*n*	*Ratio of odds ratios*	*p*	*95% CI*
Clorin	178	1.08	0.89	0.36 - 3.28
Wells	208	1.14	0.46	0.80 - 1.64
Hygiene Ed	173	0.88	0.63	0.53 - 1.47
All three	173	0.84	0.89	0.07 - 10.17

Table 5: Bloody diarrhea in children <1 year, DID Analysis (Follow-on – Baseline) comparing intervention group to control

Intervention	*N*	*Ratio of odds ratios*	*p*	*95% CI*
Clorin	113	1956.46	0.000	524.20 - 7302.12
Wells	84	*	*	*
Hygiene Ed	157	672.65	0.000	305.75 - 1479.82
All three	57	**	0.000	**

* Co-linearity with variables controlled for left no cases available for analysis
* * No bloody diarrhea cases occurred in children <1 in the All intervention group

Table 6: Asset index scores by asset

Asset Variable	*Unweighted*		*Asset Factor Score*	*Household score if*	
	mean	sd		has asset	does not
sew machine	0.453689	0.498242	0.3296	0.361399	-0.30013
clock	0.77551	0.417574	0.3831	0.205957	-0.71149
pressure cooker	0.762951	0.425607	0.3614	0.201288	-0.64785
radio	0.566719	0.495918	0.4447	0.388532	-0.50819
bike	0.185243	0.3888	0.3953	0.828378	-0.18834
motor bike	0.065934	0.248362	0.3147	1.183558	-0.08355
generator	0.036107	0.186702	0.2981	1.539008	-0.05765
car	0.036107	0.186702	0.268	1.38361	-0.05183
sheep	0.340659	0.474303	0.0166	0.023076	-0.01192

Figures 1-8: Weekly diarrhea incidence from June 2005 thru September 2006 comparing intervention groups with the control group

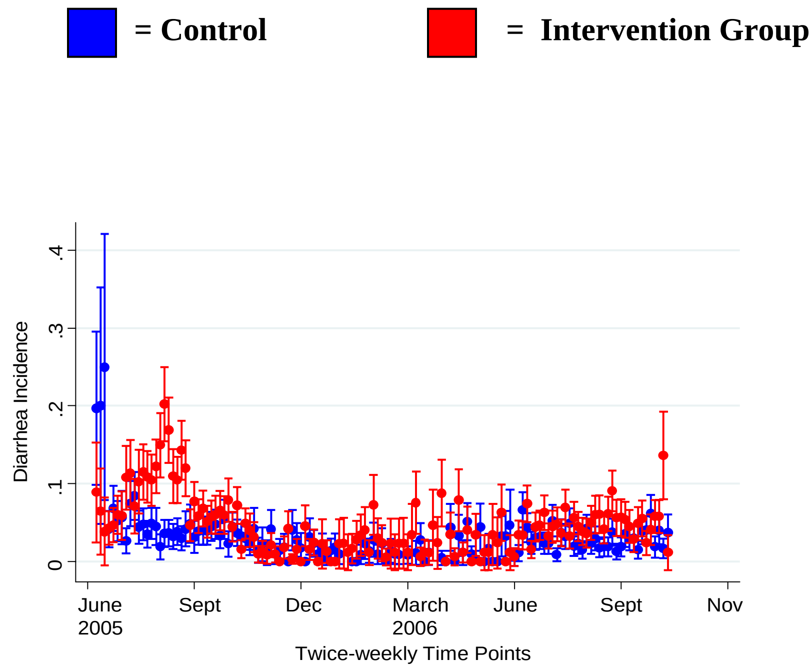


Figure 1: Clorin vs. Control in children less than five years

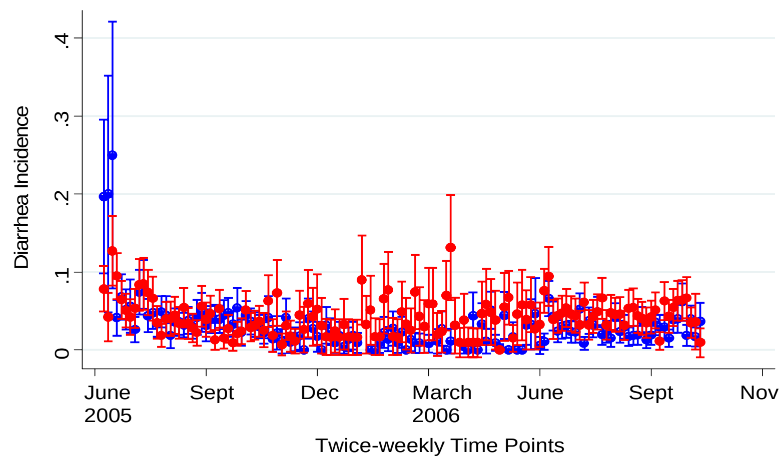


Figure 2: Wells vs. Control in children less than five years

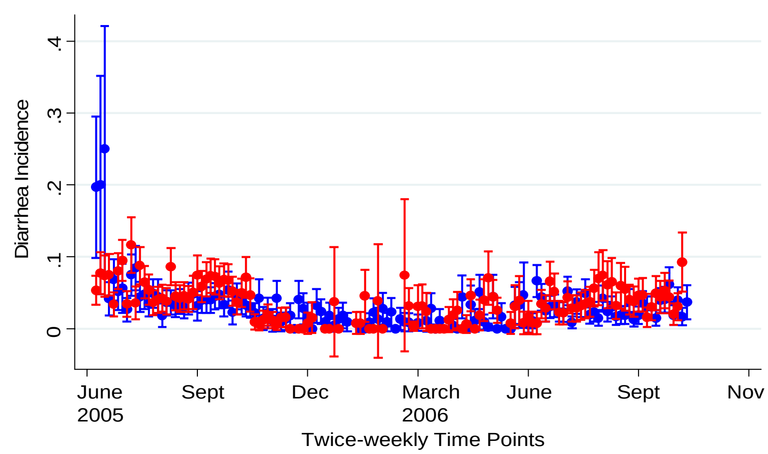


Figure 3: Hygiene vs. Control in children less than five years

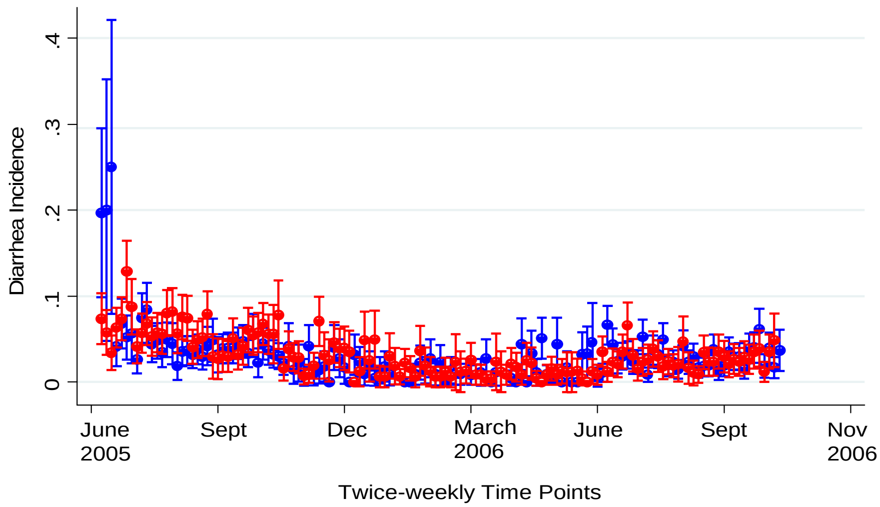


Figure 4: All vs. Control in children less than five years

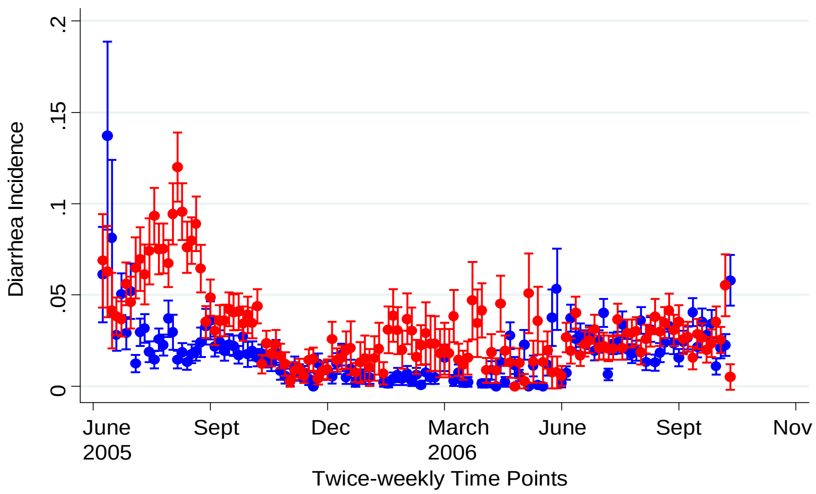


Figure 5: Clorin vs. Control in all age groups

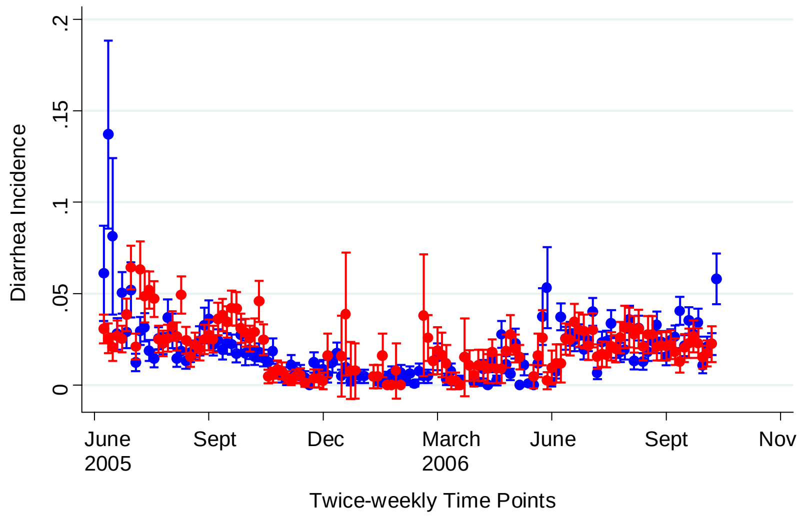


Figure 6: Hygiene vs. Control in all age groups

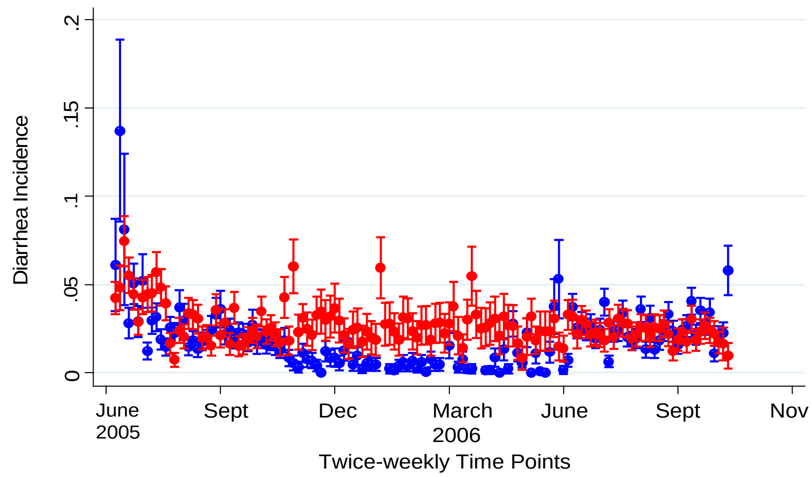


Figure 7: Wells vs. Control in all age groups

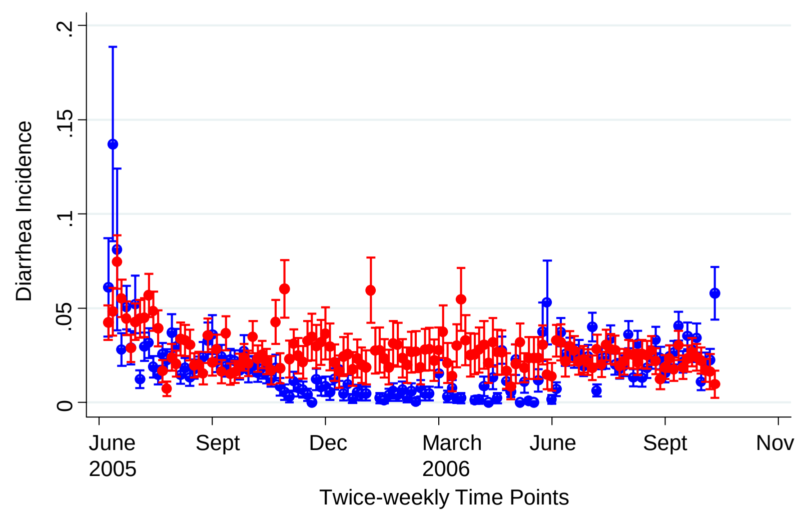


Figure 8: All vs. Control in all ages groups

Table 7: Baseline and Follow-On Survey Summary Responses by Intervention Group

	AllB	AllF	ChlorinB	ChlorinF	HygEdB	HygEdF	WellsB	WellsF	ControlB	ControlF	TotalB	TotalF
Mean												
Person's per household	7.3	7.6	7.0	7.1	7.5	7.6	7.5	7.6	7.2	7.6	7.3	7.5
Children <5 per household	1.2	1.2	1.3	1.2	1.4	1.3	1.5	1.3	1.2	1.2	1.3	1.3
Children <1 per household	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2
litres of water collected per HH the previous day	186.3	168.6	194.0	177.2	181.3	172.9	180.2	194.6	187.4	196.6	186.0	182.8
time in minutes it takes to get water	34.6	26.3	36.0	30.8	27.5	30.7	27.6	30.2	31.0	31.3	31.3	29.9
litres of water per person	25.5	22.3	27.6	24.8	24.1	22.8	23.9	25.5	26.0	26.0	25.5	24.4
% of households participating												
whose principal source of drinking water is:												
unprotected dug well	40.1	26.7	36.4	39.3	37.2	36.7	44.2	39.2	38.0	30.3	39.2	34.7
protected tubewell	2.2	47.1	2.5	11.8	3.2	31.5	7.6	34.7	6.8	25.3	4.5	29.7
unprotected tubewell	18.3	6.3	16.4	8.3	16.1	2.6	10.1	4.8	13.8	4.3	14.8	5.3
protected dug well	10.4	2.0	4.0	2.8	9.1	2.6	8.8	0.0	9.8	0.0	8.4	1.4
spring	15.4	13.3	17.0	2.1	14.7	0.0	19.8	7.1	16.9	6.6	16.9	5.8
kareze		2.8		8.0		3.4		7.4		14.5		7.4
surface	11.1	2.0	19.4	27.1	16.8	23.2	5.8	6.8	8.0	19.1	12.1	15.7
multiple	2.5	0.0	4.0	0.0	2.5	0.0	2.1	0.0	5.8	0.0	3.4	0.0
other	0.0	0.0	0.3	0.0	0.4	0.0	1.5	0.0	0.9	0.0	0.7	0.0
% of households participating:												
whose principal drinking water source located:												
outside yard or plot shared public	41.5	54.9	51.9	53.7	46.0	51.1	42.8	57.7	46.9	59.1	45.9	55.5
in dwelling	2.2	0.8	0.6	0.0	1.1	1.1	2.2	1.0	3.7	1.7	2.0	0.9
in yard or compound	29.2	27.5	21.3	25.3	23.0	21.1	29.9	22.3	27.5	24.3	26.2	24.0
outside yard or plot shared private	27.1	16.9	24.1	21.1	29.9	26.7	25.2	19.0	20.4	15.0	25.1	19.6
% of households participating:												
using narrow-necked containers	92.8	96.9	95.1	95.8	91.5	88.0	89.1	93.9	94.5	96.7	92.6	94.3
% of households where interviewer:												
observed water in hand washing location	46.7	62.0	43.9	62.9	61.9	58.4	57.1	55.3	46.7	49.7	50.9	57.4
observed soap in hand washing location	58.2	62.4	47.2	58.0	62.6	60.7	54.8	54.3	51.8	53.3	54.5	57.5
observed tap/basin in hand washing location	48.7	58.8	48.9	63.2	60.4	62.6	60.5	56.0	53.4	56.3	54.4	59.2
observed towel/cloth in hand washing location	57.7	56.5	54.8	51.7	58.7	55.8	56.1	43.1	51.5	48.7	55.6	50.8
observed latrine	87.7	94.5	80.8	86.5	83.1	91.0	77.9	83.3	72.1	79.6	80.0	86.6

observed fecal matter on floor in latrine	18.0	42.3	33.5	33.3	20.1	32.5	25.2	36.3	16.4	28.5	22.8	34.6
observed hand washing location by latrine	29.6	6.2	24.2	2.4	31.7	2.1	22.5	4.3	19.4	0.4	25.2	3.1
% of households participating that:												
share latrine w/ one or more other households	44.5	41.9	54.1	56.2	42.2	43.6	59.1	56.0	50.8	58.7	50.4	51.4
lived in village more 3 years or more	95.6	95.7	96.0	96.2	98.2	97.4	99.1	99.4	96.3	97.7	97.1	97.3
% of households participating:												
that obtain water by												
pouring from container	87.1	94.5	93.0	95.1	88.1	86.1	85.6	95.5	87.9	95.7	88.4	93.5
dipping from container	8.2	3.5	4.0	4.2	8.1	10.1	7.3	3.2	6.4	4.3	6.7	5.0
pouring and dipping from container	4.7	0.0	2.7	0.0	3.2	3.8	5.8	0.6	4.9	0.4	4.3	0.9
container has spigot	0.0	2.0	0.3	0.4	0.7	0.0	1.2	0.6	0.3	0.0	0.5	0.6
% of households participating:												
that treated drinking water in past 2 weeks	8.8	79.2	9.1	82.6	11.4	10.1	10.2	10.7	7.9	9.9	9.4	37.2
that treated drinking water in past 24 hours	6.6	76.5	5.4	74.0	7.3	8.6	6.5	10.0	4.9	8.2	6.1	34.2
households treating in last 2 weeks used:												
boiled water	4.8	0.5	5.8	0.0	10.5	18.5	9.7	18.2	3.7	36.7	6.9	4.3
added chlorine	1.1	1.0	0.3	0.4	0.4	3.7	0.3	0.0	0.0	0.0	0.4	0.8
added clorin	0.0	98.0	0.3	99.2	0.4	51.9	0.0	75.8	0.3	46.7	0.2	91.9
filtered through cloth	1.5	0.0	0.0	0.0	3.3	0.0	0.3	0.0	0.3	3.3	1.0	0.2
water filter	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.1	0.0
solar	0.0	0.0	0.0	0.0	1.8	0.0	0.3	0.0	1.0	0.0	0.6	0.0
other	0.0		1.3		1.1		1.7		1.0		1.0	
salt		0.5		0.0		22.2		3.0		3.3		1.7
% of households participating:												
that have soap for handwashing self report	75.3	86.7	71.9	81.6	81.4	85.8	73.8	84.2	82.0	83.5	76.8	84.3
% of households in past 24 hrs that:												
washed hands with soap	72.5	83.1	67.0	80.6	74.7	85.7	68.2	81.7	71.8	82.1	70.7	82.5
used soap to wash clothes	83.9	95.3	84.2	95.1	86.7	94.8	82.1	93.9	81.5	94.1	83.6	94.6
washed body with soap	41.9	78.8	43.0	75.7	56.1	73.8	44.6	76.5	43.6	78.0	45.7	76.6
washed hands with soap	53.4	78.8	41.5	77.1	37.9	80.9	49.1	80.1	50.6	76.0	46.5	78.5
washed children with soap	35.1	36.9	28.1	30.6	28.1	30.0	34.2	31.2	31.8	40.5	31.4	33.8
washed child's bottom with soap	19.4	16.5	19.2	13.5	23.9	15.7	23.9	20.9	23.9	15.1	22.1	16.4
washed children's hands with soap	14.0	15.3	11.6	13.5	7.4	13.1	11.2	14.5	11.8	8.9	11.2	13.0
washed hands w/ soap after defecating	10.4	12.2	9.8	9.7	8.1	12.4	10.6	10.0	6.1	7.6	9.0	10.3
washed hands w/ soap after cleaning child	5.4	6.3	4.6	2.1	3.2	1.9	6.4	1.6	4.9	1.3	4.9	2.5

washed hands w/ soap before feeding children	0.7	2.4	2.1	1.4	1.1	0.4	1.2	2.6	1.5	1.0	1.4	1.5
washed hands w/ soap before preparing food	9.7	5.9	6.7	3.8	9.8	4.1	11.5	5.1	11.8	4.9	9.9	4.8
washed hands with soap before eating	4.7	7.1	3.4	9.0	8.1	9.7	7.0	8.0	7.9	10.9	6.2	9.0
% of households participating that:												
usually wash hands in/by latrine	58.4	80.0	55.5	80.9	61.4	76.4	67.9	75.9	65.8	73.7	61.9	77.3
usually wash hands in kitchen	3.2	29.8	8.8	20.8	9.8	17.2	3.9	24.1	4.2	23.4	6.0	23.0
usually wash hands in living quarters	15.8	9.4	12.2	9.7	6.7	7.1	7.6	6.1	13.3	10.5	11.1	8.6
do not usually wash hands	11.8	3.9	8.5	2.1	8.4	3.0	9.4	5.8	13.0	6.3	10.2	4.3
% of household participating that believe												
the drinking water is safe from source	53.9	74.9	50.3	61.8	57.9	69.3	60.8	72.4	47.3	51.3	53.9	65.6
it is important to wash hands before preparing food	83.5	65.1	86.6	59.4	74.7	56.6	80.9	55.6	86.7	63.5	82.7	59.9
it is important to wash hands before eating	66.0	81.2	65.2	83.3	73.0	82.4	71.2	83.6	71.5	89.9	69.4	84.2
it is important to wash hands before feeding children	46.6	31.4	46.3	26.7	46.0	27.0	37.0	33.8	54.9	30.6	46.1	30.0
it is important to wash hands after changing baby	30.1	25.9	27.4	17.4	35.8	13.9	25.8	15.8	32.4	20.1	30.2	18.5
it is important to wash hands after defecating	20.9	60.4	48.5	59.4	49.8	64.8	54.6	66.9	58.2	64.5	52.5	63.3
it is important to wash hands after eating	46.2	49.4	49.7	57.6	46.7	55.8	43.9	50.8	57.0	46.7	48.8	52.4

Table 8: Relative risk estimates for diarrhea in children under five, comparing intervention groups to control

Group	*Relative Risk*	*95% Confidence Interval*
Clorin	1.51	1.06-2.16
Wells	1.21	0.83-1.76
Hygiene Education	1.06	0.72-1.58
All Three	0.73	0.46-1.16

Table 9: Relative risk estimates for bloody diarrhea in children under five, comparing intervention groups to control

Group	*Relative Risk*	*95% Confidence Interval*
Clorin	1.56	0.45-5.36
Wells	0.50	0.09-2.62
Hygiene Education	0.79	0.18-3.42
All Three	1.22	0.31-4.78

Table 10: Relative risk estimates for ARI in children under five, comparing intervention groups to control

Group	*Relative Risk*	*95% Confidence Interval*
Clorin	4.35	1.85-10.25
Wells	1.93	0.75-4.99
Hygiene Education	3.45	1.43-8.32
All Three	2.47	0.96-6.35

Table 11: Relative risk estimates for eye infection in children under five, comparing intervention groups to control

Group	*Relative Risk*	*95% Confidence Interval*
Clorin	2.01	0.87-4.67
Wells	1.75	0.74-4.13
Hygiene Education	0.59	0.19-1.86
All Three	1.60	0.64-3.99

Table 12: Estimated number of annual diarrhea cases attributable to applying an intervention to the population of Afghanistan, based on CSO total population of 21,800,000 (2003)

Intervention Group	*Annual Diarrhea Cases*	*95% Confidence Interval*
Clorin	-149,722	-442,799 to 143,355
Wells	-321,251	-591,807 to - 50,695
Hygiene Education	-406,678	-688,508 to -124,849
All Three	-507,814	-779,019 to -236,608

Table 12: SWSP Latrine Study Results, summary statistics by percent of households

1	Households with a latrine	84.35
2	Number of households sharing the latrine	1: 52.05 2: 23.56 3: 13.79 4: 3.12 ≥ 5: 3.46
3	Location of latrine	In compound yard 51.23 Inside house 15.68 Outside compound 32.02
4	Observed type of latrine	Vault 64.61 Elevated Vault 33.42 Pit (>1 Meter deep) 0.99 Pour-flush 0.25
5	For households with a vault latrine, the observed opening is:	Closed (<1/2cm) 27.22 Loosely fitted 33.44 Open 39.92
6	Observed presence of urine pipe in latrine	Yes, goes into ground 9.29 Yes, open at back 12.49 Yes, but broken 0.9 No 75.84
7	Observed presence of vent pipe latrine	4.84
8	Observed feces present on floor of latrine	20.54
9	Observed presence of feces outside the latrine	27.42
10	Observed presence of semi-solid or liquid waste draining from latrine on any side	20.28
11	Distance from household latrine to drinking water source	≤10 m 8.05 11-20 m 23.07 21-29 m 12.8 ≥30 m 55.42
12	Elevation difference between latrine and principal source of water?	Latrine higher 64.12 Latrine lower 11.25 Same level 23.89
13	Frequency of latrine use by household members	Never 0.25 Sometimes, < half the time 1.31 Often, > half the time 11.74 Always 84.15
14	Frequency of emptying latrine	Every Year 6.16 Every 6 months 24.49 Every 3 months 32.05 Every Month 33.36 Every Week 2.3 Every Day 0.41 Never 0.16
15	Place feces from latrine are usually disposed	In field 24.01 Outside, next to compound 69.9 Inside compound, buried 2.47 Inside compound, but not buried 2.80

Annex 4: Qualitative Research Details

FGD 1: Community Focus Group Discussion Results

A. Water Questions

1. What are your sources of water in this village?
   Hand dug wells most common. Streams also commonly used.

2. What do you consider the best water source? Why?
   Covered wells most commonly mentioned, especially those with handpumps.

3. Is water available throughout the year? If not, when is it different and how?
   Yes, but quantity is limited by the end of the summer. Water was not available in some villages the last 3 or 4 years due to drought.

4. From each source, how is the water used? (washing, drinking, agriculture . . .)
   Washing and drinking from wells. Springs and streams most commonly used for agriculture. In villages that depend on streams, they use the same source for all purposes.

5. What is the most important thing you consider when choosing your water source for drinking water? (appearance, taste, distance to water . . .)
   Appearance and taste
   It should not smell bad.
   Distance not a factor is choosing water sources

6. How would you define clean drinking water?
   Good-tasting
   Clear, not muddy
   Doesn't smell bad

7. What should be the appearance, taste and smell of safe drinking water?
   Color: "white", clear or green
   Taste: good, sweet
   Smell: no smell

8. How do you make water safe?
   Many do not treat their water to make it safe.
   Boiling was the most common method for treating, but some stated they could not afford to boil.
   Many added salt.

9. Have you tasted water that has been treated with Clorin?
   Most had not tasted water with Clorin but seemed familiar with the product.
   For some, they had tasted chlorine in water after NGO's had treated the wells.

10. Is this treated water acceptable for adults? For children? For pregnant women?
    All respondents stated that treated water is acceptable for all people.

11. Is your family willing to pay for Clorin? Why?

Many said they could not afford Clorin but there was a strong willingness to use it. One participant stated that only 5% of people are able to afford Clorin (Ambokhak N); another said only 2% could afford Clorin as families can't even afford to buy pens for their children. Others said if people had hygiene education and understood how important chlorine is to protect health, they would buy it.

12. What are the various ways water is transported from the water source to the household?

Plastic containers were the most common. Some use mud containers.

13. How do most people transport it?

Plastic containers and by donkeys

14. Do water transport methods vary with the distance needed to transport it?

With greater distance, donkeys and wheelbarrows are used. Close by, the water is transported by hand or shoulder.

15. How does water transport vary with the season?

All talked of the difficulty transporting water in the winter. The fear of breaking bones while slipping on mud and ice was mentioned repeatedly.

16. How is water stored in the household?

Either in the containers used to transport water or in 100L steel containers.

17. Who is responsible for managing the water in the household (wife, daughter, male head of household . . .?)

Most of the time, the wife and/or daughter, but in one village (Ambokhak N) males may be responsible.

B. Diarrhea Questions

18. Do most households experience diarrhea each summer? Is diarrhea with blood a health problem in this community?

All households experience diarrhea each summer. Bloody diarrhea is common.

19. Who has diarrhea most commonly in your community?

Children

20. What do you believe are the common causes of diarrhea?

Dirty water, dirty fruit, dirty food, heat

21. Is more diarrhea caused by dirty food or dirty water in your village?

Both

22. Is more diarrhea in your village due to animal or human wastes?

Both

23. Does anyone know of deaths in the past 3 months in the community from diarrhea?

Children? Adults?

In two villages, men tended to say they knew of deaths while the women said there had been none in the last three months.

In one village, there had been at least two children who died from diarrhea in the last three months (men and women agreed). This is the village that commonly uses stream water for drinking water.

In one village, there had been no deaths (men and women agreed).

24. How do you prevent diarrhea? (Be sure to record if people list handwashing and/or using latrines as preventive measures.)

Boiling water, cleanliness most often mentioned.
Some did not know.
Giving espighole, khak sheer *
Latrines

25. What are the ways in which diarrhea is treated in this community?

Try homemade treatment
Take patient to clinic/doctor
ORS

26. Have you heard of ORS?

Most have heard of ORS

27. What does it do?

Some knew that it was to replace body fluids.
One woman said it was to wash the intestines.

28. Where do you get ORS?

Clinics, hospital, stores

29. How much does it cost?

Free from clinics
In stores, from three afs to 15 afs
Many women did not know.

NOTES:

* espighole: home remedy; seed cover

- expands, becomes like jelly
- effective against diarrhea
- antacid
- eat spoonful
- like wheat
- recommended by doctors for all ages

* khak sheer: home remedy

- seeds
- used for fever

FGD 2: Disease Surveillance Data Collectors' Focus Group Discussion Results

Location:
Swedish Committee for Afghanistan (SCA) Training Center, Saydabad, Wardak

Identification:
- Four sessions were held: two for men, two for women
- Total of 21 men and 10 women participated

Background:
Committee Health Workers (CHWs) conducted disease surveillance on behalf of the Safe Water Systems Project (SWSP) from June 2005 through September 2006. They were required to have a female partner work with them, except in several villages where this was deemed unacceptable. Also, they could not work in their home village. They collected data on diarrhea, bloody diarrhea, Acute Respiratory Infection and eye infection. Also, in some villages they distributed Clorin on behalf of the project. They received incentives for their work. On October 17, Focus Group Discussions were held to better understand the impact of the partnership between SWSP and CHWs.

Responses:
1. How did your participation in the Safe Water Systems Project impact your normal duties as a Community Health Worker?
- **Males:** For some, undertaking the surveillance work negatively impacted their other work, such as teaching. They were unable to completely perform other duties. Other participants said it positively impacted their other work as they gained more respect in the community.

Comments:
"Many NGO's came, gave promises but did not work, so when we started working no one trusted us and laughed at us."
"The people were very happy and hopeful for this project, because they thought that our work was practical and we came from government side."

As none of the women participants were CHWs, they were asked:
How did your participation in the Safe Water Systems Project impact your normal duties?
- **Females:** The women mainly spoke of positive gains, learning how to better protect their families by being better informed about safe water from the project. They also spoke of villagers being very interested in the interventions and especially happy when wells were drilled and Clorin distributed.

Comments:
"Along with home chores, I learned health education as well."
"I got information about safe and unsafe water. Before I was drinking unsafe dirty water of streams but now, I am using only safe water."

2. What did you find the most challenging in your work with the Safe Water Systems Project?

- **Males:** There was a variety of challenges discussed. First, villagers requested more medicines other than ORS to treat diseases. Before Clorin was distributed, some villagers were upset that the CHWs continued to come without giving them anything. Another difficulty was dealing with villagers upset at not being included in the study and therefore not being visited. There was some difficulty with listing female names and missing head of household names on the original study list. They initially had a hard time finding the correct households to visit. Security was also discussed. Some households did not trust the purpose of collecting names, especially of females. There was the risk of Taliban and thieves. One CHW said that being accompanied by a woman during the surveillance posed a problem as the villagers did not see him as a "noble man." Finally, lack of potable water caused some households to refuse ORS as they said they had nothing to mix it with.

Comments:
"Some people did not have any water when we carried ORS to them. They said, 'What can it do for us? We do not have water. Please provide water for us. And dig wells for us.' Many people did not get ORS saying this is in vain."
"Two people opposed me and gave me a challenge, 'do not come to our village again.' The cause of their opposition was that we did not make any wells for them."
"Some people said, 'You are spies.'"
"From one side there was risk of Taliban and from other side risk of thieves. Even people said, 'You have become Christians.'"

- **Females:** Challenges included disputes with villagers not surveyed; transportation; having their children along during hot weather; lack of Clorin distribution in all villages during surveillance; and the use of unsafe water in villages where children are suffering.

Comments:
"The weather was hot and we had to take our children."
"This was a problem that whatever we said they did not accept and said, 'Why do you not give us chlorine?' They also said that the most important thing is chlorine, which prevents diseases not the water vessels."

3. Was it difficult working in a neighboring village rather than your own village? Why? Why not?

- **Males:** Difficulties included distance, people being unfamiliar with them, distrust especially in the beginning. More often the CHWs spoke of the benefits of working in a neighboring village rather than their own saying they got more respect outside their village and there was no enmity with others.

Comments:
"…people of that village said to us, 'Why are you working in our village? Working in this village is the right of our people.'"
"One benefit of another village was that when people saw that I had a female couple for females with me, they considered me a noble person. They told me, 'You are good because you have female partner for females with you."
"This (having female partner) created an opposite meaning as well and people thought that we (CHWs) were spies. However, people directly have not said anything to us. In

the beginning it was difficult to work in another village but now as people recognized us, we do not have any problems."
"If a person in his own village has enmity with someone then it is also a problem."
"Other village is good because I do not have any enmity."

- **Females:** Overall it was difficult for the females to work outside their home village due to transportation, having children along, dealing with people who were not familiar with them, especially at the beginning of the project.

Comments:
"Our problem was walking to other villages along with our children. At the beginning, the people were not aware, but they did very well with us after understanding the advantages of the program."
"Transportation problems are present. We have to walk during the hot summer. Walking is very troublesome."

4. Were households you visited on behalf of the project receptive to you?

- **Males:** Overwhelming the CHWs felt that the people respected them due to the information and supplies they gave them, especially since they continued their work through the winter months.

Comments:
"Yes, they respect us. Because they think that we suffer from the trouble of cold winter or snow and come to their village for them. It is why they respected us. Besides, we distributed these supplies with our own hands and caused people (to be) happy."
"They were respecting us a lot especially after constructing handpumps. I wish our project did this work before. Now whenever we go to the village they invite us for tea and meal."
"There are different families, some are ignorant and some wise. Wise people respected us and ignorant people did not, still they were mistreating us."
"Those people who did not have respect they were very few but hundred percent people recognized Ministry of Public Health."

- **Female**: Overall, the females felt accepted by the households once they were familiar with them and the project was explained.

Comments:
"At the beginning, the villagers were not familiar with us; they have become closer after explaining the program. They became happy and welcomed our revisiting."
"Now we are feeling closer to the people of neighboring village, so we think they are our relatives, and they will become sad if we stop going there."
"Before people were not trusting us and we were not any value for them. They were not letting us to enter their houses. Both male and female had a bad look for us. As we gave them Clorin and health education therefore currently, they are happy from us. Their attitude is also good."

5. Did you find the weekly/biweekly meetings at the clinic helpful? Why? Why not?

- **Males:** ALL CHWs said the meetings were very helpful. The benefits were that mistakes were corrected quickly, supplies and payment could be given out, people recognized that they were affiliated with the clinic and problems could be solved.

Comments:
"We conveyed the views of the people to them."
"Our meetings with the clinic people were a linking bridge."

"Besides, people watched us that we were in link with the clinic and could solve their problems. In addition, that showed our relation with the clinic."

- **Females:** The females also felt the clinic meetings were good.

Comments:
"When we went to the clinic, we received salary, health education, ORS and some medicines. We were distributing these medicines in the villages. People trusted us."

6. How did the process of getting supplies (ORS, Clorin) from project staff compare to getting supplies from the Ministry of Public Health? This question was only put to the CHWs, all males.

- **Males:** Distribution generally went well, people liked the taste of the ORS. One CHW mentioned that he felt some households were not truthful in order to get ORS and didn't report other illnesses as the CHWs did not have supplies to address other illnesses.

Comments:
"Compared to that of MoPH our ORS was good and tasty."
"Some people said, 'Do not give us only ORS because in the clinic along with ORS they give us other medicines as well."
"During illness, all people demanded ORS and instead of going to the clinic, they used ORS and usually got better."

7. For those of you who distributed Clorin, did households seem eager to use Clorin? Do you think they used the vessels for their drinking water?

- **Males:** Most felt that the majority of people were eager to use the Clorin and vessels. The stated that people became accustomed to using it for drinking water and washing fruits/vegetables and wanted to continue using it.

Comments:
"When one family used the given Clorin and he told its benefits to the neighboring house, then the neighboring house also bought it in the bazaar."
"People became very encouraged. They were very pleased for the barrels (vessels), which were new and nice in color."

- **Females:** They stated that if a household was reluctant to use Clorin, they educated them on the benefits and encouraged the households to use it. They felt most used it.

Comments:
After health education sessions, ""They (villagers) became very happy and used it (Clorin) with great interest."
"For some houses this had advantage and for some did not. But when we gave health education to the people they became very pleased and started using Clorin."

8. Would you participate in a similar project again? Why? Why not?

- **Males:** ALL said they would participate again. Reasons include the ability to serve the people, honor, familiarity with the people and project, and the salary.

Comments:
"It had economical benefits and it was very helpful for the community as well."
"Our benefit is that our knowledge is increased and in addition it is a way of serving our country."
"….if this ends then we have to go to Iran for daily waged labor."

- **Females:** All said they were willing to work on a similar project – some even said they would work for free.

Comments:
"Yes, we are happy and we do work. It is useful for our economy and also useful for people in preventing diseases."
"I am glad that I am saving my money and will get a better life after completing my school."
"I will work in spite of the hardest conditions."

9. Has your work on this project made it more or less likely that you will continue as a CHW? If you are not already a CHW, are you interested in becoming one?

- **Males:** All who responded were interested in continuing as a CHW or becoming one, "one hundred percent."

Comments:
"A man gave me a good moral. He told me that his uncle had performed Hajj. He gave me privilege on him, considered me more pious, and called me a good Muslim because we served people and honestly carried out our work in his village."
"Our interest is in getting knowledge and information and to do good for people. Teacher-ship and this work are both works of goodness or public welfare. Community health workers solve a great problem of people."

Women were asked, "**Are you interested in becoming a Community Health Worker?" Has this project impacted your decision whether or not to become a CHW?**

- **Females:** All were interested in becoming CHWs.

Comments:
"I want to become a CHW because I want to serve my people, get salary and learn something."
". . . in spite of being remote we want to work in the remaining villages as well."

10. What difficulties did you encounter?

- **Males:** While some said they didn't face any problems, others mentioned the following: no medicines for the diseases being asked about, inability of households to give correct ages, writing names of females, transportation, lack of wells being installed in some villages, and villagers not included in the survey who were upset at being left out.

Comments:
"People said, 'Only ORS is not enough.' We need medicines for the diseases of eyes and respiratory system also."

- **Females:** Some mentioned the difficulty with transportation and having children along. Others said they had no problems.

Comments:
"Our problems were hot weather of summer and walking in winter and summer. There was a long distance."

11. What benefits did this work with the project have for you?

- **Males:** Benefits included health education, salary, increased respect. One participant mentioned the certificate he received at the end as his only benefit other than salary.

Comments:
"We were a linking bridge between the community and Ministry of Public Health and this was a good name for us."
"Its first benefit was that all of our family members, our villagers and us received health education."

- **Females:** Several mentioned getting familiar with people as a benefit. Others mentioned being able to help their families with their pay and awareness of disease prevention.

Comment:
"We received salaries. We became familiar with people and got the love of the people."

12. Have recent changes in security affected your work? How?

- **Males:** This question seems to have been inadvertently left off the males questionnaire.

- **Females:** Most of the women mentioned that security had improved as the project progressed.

Comments:
"Security is improved now. And women can go to the field."
"At first, we were afraid, security was not good but currently it is good. We are in contact with people."

13. What did you learn from your participation?

- **Males:** The participants said they became familiar with Clorin, ORS, MoPH, Drs in the clinics and how to conduct a survey.

Comments:
"We became familiar with doctors in the clinic and we learned plenty of things from it. We also became familiar with the villagers and their habits."
"Nobody was familiar with Clorin. Because of this project, our villagers and we became familiar with it."

- **Females:** The women spoke with pride about learning about Clorin, hygiene education and protecting village health since participating in the project. Several also mentioned gaining greater respect from their husbands and courage to work.

Comments:
"We achieved more information. Our husbands had great trust in us. And they accepted that women have rights to work side by side with men."
"With getting salary, our husbands increased their love with us."
"Meeting with people resulted in my good health and I forgot my disease."

14. What suggestions do you have for similar projects in the future?

- **Males:** There was a strong recommendation that with the original survey, the surveyor should be someone from within the village who knows the names and heads of families. Several mentioned that wages should be increased. Also mentioned was having more medicine available to distribute to villagers. If similar projects occur in their area, several said they felt they should be hired as they are now trained and experienced.

Comments:
"Other organizations are spending more money. Therefore, if our salaries are a little bit increased our work will improve."
"You should continue this program for longer. In this way, these aids and teachings will reach to all villagers alike."

- **Females:** All said that they recommended that the project continue.

Comments:
"We want to continue our work in this project and want it to be permanent."
"I am very interested in this project. I want to help my people more via this project. This is a project that relieves both poverty and diseases."

15. Any other comments about your work with the project that you would like us to know?

- **Males:** There were strong recommendations from many participants to provide water (either through handpumps or tankers) to those villages that had not received wells with handpumps. Several also recommended that latrines be provided to the villagers. One participant suggested that visiting only once a week would be better. Also mentioned was extending this project to include other diseases in surveillance, such as TB, Malaria, jaundice and tetanus – and implement this across the country.

Comments:
"Also, make latrines. These will stop diarrhea and other problems. If this work remains incomplete, this project will be incomplete."
"You should implement this program in all Afghanistan."

- **Females:** Ideas included increasing the salaries of women who are educated, wanting the project to be extended further, and suggesting that latrines be built. One participant requested further training and increasing supplies.

Comments:
"Since I am educated my salary should be increased and should be given a high-level job to make other women also educated."
"We want to cooperate with your project because you have helped our people and us."
"We need extra trainings for the improvement of our knowledge."

Annex 5: SWSP Project Village List by Intervention Group

Name	***Group***	***Total Households***	***Total Population***
Chawdara	All 3	19	115
Durrani	All 3	67	470
Godan	All 3	73	575
Ghaze Khel	All 3	54	358
Khuwaja Zhawar	All 3	11	79
Sadiq Khel/ Charmaghz	All 3	55	443
SUBTOTAL ALL		279	2040
Hosi Khel	Wells	41 and 42	303 and 289
Zhawar	Wells	11	91
Tala	Wells	29	220
Shapos	Wells	28	195
Kody (Towp)	Wells	52	437
Abghar	Wells	24	186
Bady Khel	Wells	73	534
Timor Khel	Wells	30	231
SUBTOTAL WELLS		330	2486
Loar	Clorin	75	550
Dag Baghri	Clorin	59	449
Barikak Ghar	Clorin	45	282
Zarnay	Clorin	107	689
Eirgen	Clorin	42	335
SUBTOTAL CLORIN		328	2305
Kheryan	Hygiene Ed.	120	905
Cheganak	Hygiene Ed.	22	158
Khwaja Kodgay (Towp)	Hygiene Ed.	68	514
Landa Khel	Hygiene Ed.	37	300
SUBTOTAL HYGIENE EDUCATION		247	1877
Ambokhak Ulia	Control	54	391
Doab	Control	93	694
Ambokhak South (Noor Mohammad Khel Mula Jan Khel Khan Khel)	Control	74	579
Yeast Kelay	Control	40	298
Zara Khel (Towp)	Control	25	147
Lash Timor Khel	Control	21	114
Maro Khul	Control	23	184
SUBTOTAL CONTROL		330	2407
TOTAL AT BASELINE		1514	11,115

Annex 6: English Translations from Pashto

Hygiene Education Teaching Cards

1.1
In Afghanistan thousands of children die each year from the sickness of diarrhea; we can save a lot of them. This picture shows what to do if your child gets diarrhea.
In diarrhea a child loses the liquids of the body. These liquids are for staying alive; if other liquids don't take their place, the body will be dry and if by affection of diarrhea the body loses a lot of water, at first it will cause atony and then the child will die.

1.2
Right terms and time treatment of diarrhea is so simple that every family can learn them. The important one is to give a lot of liquids to the sick child. It must take the place of the lost liquids.
To the young child, after using latrine you must give a glass of liquids. For the children who newly walk you must give half a glass of liquids or more than the quantity that they lost using the latrine.
If it is hard diarrhea, a lot of liquids must be given to the child and take the child to the health facility.

1.3
Two children that both have diarrhea: one of them didn't drink liquids and becomes weak and is in danger of death but the other child that drinks liquids is healthy and safe from the danger of diarrhea (death). Drinking many liquids won't stop defecating but keeps the child strong. In fact the best treatment for all kind of diarrhea is to drink a lot of liquids.

1.4
For the sick child approximately all the liquids are good. Those things that treat the sickness must be given to the child. Some of the liquids that take the place of lost liquids are below:

- ORS
- Mother's Milk
- Soup with a little salt
- Rice water
- Fresh fruit juices
- Soft tea with sugar (not hard tea)
- Water from the clean surface (if could first be boiled and then let the water cool) with a little food such as boiled potato with bread or rice
- Soluble made of boiled water (mint or tea with lemon)

The child must drink the above liquids during diarrhea. The liquids that aren't beneficial are sweet beverages like commercial fruit juices.

1.5
The best liquid that should be given to the child during diarrhea is Oral Rehydration Solution (ORS). The child should drink ORS at the first in diarrhea. Continue giving ORS to the child during night time. Throw away the remaining ORS at end of the day and prepare fresh ORS everyday. In case the child is vomiting, give a little ORS but if the child is vomiting continuously then wait ten minutes and start giving slowly as before.

The method of making of the ORS:

- Pour the whole packet of ORS in a clean and washed dish
- Add four glasses of water
- Stir until the powder is dissolved in water
- Cover the dish or jug that the ORS is made in
- Give the child ORS as described above. In general, the child must drink after every use of the latrine
- Giving ORS must also continue at the night time. At the end of every day the ORS must be thrown away and every day you must prepare new ORS.
- If a child is vomiting give a little ORS but if the child continues to vomit – wait for ten minutes and then give ORS slowly. Continue giving the ORS.

2.1

If your child gets diarrhea don't withhold giving food. Give strong food to the child that has habit with strong food and for the small child give mother's milk. The foods that can be easily dissolved are the best during having diarrhea such as: vegetables, soup, and banana, boiled and sliced potato.

Prevent from giving foods like the powder that is made of pomegranate's skin or powder made of mango's seeds that the stomach can't dissolve easily and makes diarrhea harder.

2.2

Some times it is said that don't give food or drinks for the child who is in diarrhea until he is well. This idea is completely wrong. If parents during or after the disease don't give food to the child, the child won't grow physically and mentally. Children need food to strengthen their ability against disease.

2.3

Mother's milk has all those things that the child needs until six months old. Mother's milk is the best food for growing children and is a safe liquid that is always beneficial for children. If you give the children under six months other liquids except mother's milk, they will be in danger of diarrhea because it is possible that the liquid is contaminated. Feeding by bottle is dangerous because the nipple of the bottle keeps pathogens. Feeding by mother's breast is better and safe. If feeding is not possible by breast then use a cup with a spoon.

2.4

After the diarrhea stops, for two weeks give the sick person extra food. Diarrhea stops growing the body. Many children in Afghanistan have small bodies because they don't get many kinds of different food properly and chronic diarrhea makes this problem more difficult. Eating extra food daily for two weeks can help a child make up for the lost food during diarrhea. When the child becomes completely healthy after diarrhea at least he must get back his weight.

2.5

The foods that help youth and children to be healthy are these:

- Foods that have Vitamin H (Pumpkin, Carrots, Cheese, Yogurt, Butter, Mango, Milk)
- Foods that have iron (Spinach, Meat)
- Foods that have Vitamin C (Orange, Lemon, Fruits)

To vegetables, if possible, add one or two spoons of oil. It helps children fight against diarrhea in the future. Prevent giving foods like the powder that is made of pomegranate’s skin or powder made of mango’s seeds that the stomach can’t dissolve and makes diarrhea worse.

3.1
Children with diarrhea need more food and liquids. In most cases after some days the child will be healthy and out of diarrhea. Sometimes they need more help.

3.2
Some times diarrhea attacks suddenly and the child must see the doctor immediately if any of these occur:
- Child is unable to drink
- Child is unable to defecate
- Child becomes too weak
- Blood come with excreta
- Child has fever
- Child can’t stop vomiting
- Child stops eating food
- If the child’s stomach skin comes up when pinched but doesn’t return to normal

3.3
Diarrhea usually stops after 3-5 days. If it continues more than 5 days, take the child to the health facility. Anytime you’re taking the child to the health facility, continue giving liquids along the way.
If the child has lost a lot of liquids, the doctor may have some specific things to give the child such as liquids by syringe for the lost liquids. If the doctor gives medicine, in that time it is also necessary to give the child liquids.
When the child is in recovering, follow what the doctor’s directions.

4.1
Human and animals defecating in open areas can spread microbes. Feces and wastes gather and pollute the water resources like lakes and rivers.
Microbes which are in the wastes lie on hands, food and water when humans start swallowing, it causes diarrhea.
Feces usually exist in open areas which cause the danger of diarrhea.

4.2
Yard floors get dirty by children defecations. Polluted soil will be easily delivered to hands, food and water.
Flies deliver the small pieces of microbes and defecate on food or open water resources.

4.3
One of the important works to prevent spreading of microbes is to keep defecates in safe places. All the family members including children should be encouraged to prevent defecating in open areas; in its place they should use sanitized facilities (toilet or latrines). Wash facilities everyday and keep it clean. In case of using open areas, cover it with soil or sand to prevent flies settling on it.
Never defecate near the places that you are using for drinking water or bathing.

5.1
Touching mouth with dirty hands will cause the small pieces of dirt with microbes to enter into the mouth.
Touching with dirty hands to foods will deliver microbes to food. Keeping clean everything which touches the mouth, especially hands, will prevent increasing diarrhea.

5.2
Washing hands is the one of the best ways for preventing diarrhea. Washing hands with soap cleans dirt and microbes off the hands; washing hands only with water can't clean hand. Better way to wash hands is to use soap. Hands including fingernails should be washed in right way and then dried by a towel.

5.3
Wash your hands before touching anything that enters your mouth.
1. Before preparing food.
2. Before eating food.
3. Before feeding children.

Washing hands prevents microbes from entering the food and mouth.

5.4
Wash your hands after touching polluted things.
1. After touching anything that is in the toilet or latrine.
2. After defecating.
3. After cleaning child's bottom.
4. After working or cleaning up feces or polluted places.
5. After touching the animals.

5.5
Children often touch things that are polluted by human feces and mostly small children put their hands on their mouths; therefore their hands should always be washed.

5.6
A special place for washing hands makes it is easy to wash hands every time. Every family can make such a place that contains soap and clean towel and all members of the family should use it for washing hands.

6.1
The best way for preventing diarrhea is to drink clean and safe water. Acquire drinking water from the cleanest sources like a deep well.

6.2
Whenever you have clean or boiled water keep it clean otherwise it will become dirty. Using clean dishes with covers will prevent dust, soil and microbes in the air from entering. Using a vessel for keeping water at home is appropriate. Wash the inside and outside of the vessel once a week.

6.3
For drinking water storage if you don't have a narrow mouth vessel, make sure water that your hands or some other device doesn't contaminate the water; even if your hands seem

to be clean, they can deliver pathogens to the water. Hands should not touch drinking water at any time.
In place of using hands to take out water, pour the water into dishes or use devices that have long handles. Utensils that are used to take water should be hung at a distance from the ground and regularly washed with soap.

6.4
Keep food safe after cooking from flies and dust. It is unknown that the fruits and vegetables are in touch with the pollution or not; it is better to wash all fruits and vegetables well. Only with clean hands and dishes should be in touch with fruits and vegetables.

Clorin Education Cards

7.1

Clorin is an anti-sickness liquid which is added to water and keeps water clean and healthful. Water that has Clorin exist in it is for drinking, cooking, washing vegetables and fruits, making ice, brushing teeth, making juice and washing dishes and other kitchen materials.

A bottle of Clorin is enough for a family for a whole month.

7.2

Six simple steps exist for using Clorin:

1. Get water from the constant source and take it home.
2. Pour the Clorin from the water to the cap to measure how much to add to water. Look at the bottle's cap marks. Up to first mark is for 10 Liters of water and up to the second mark is for 20 Liters of water.
3. Pour the measured Clorin into the water container.
4. Shake the water container well.
5. Wait approximately a half hour.
6. Now your water is safe for drinking.

7.3

How much Clorin should be added?

The cap shows how much should be added.

Up to the first mark is sufficient for 10 Liters water.

Up to the second mark is sufficient for 20 Liters water.

7.4

Necessary precautions

Some steps are necessary to observe when using Clorin.

- Don't drink from the bottle. In case someone drinks directly from the bottle, don't urge vomiting and take him/her to the doctor.
- Keep the bottle in cold, dark place and far from the sunlight.
- Keep out of reach of children.

7.5

If you use a clean vessel or container when adding Clorin, there will be an extraordinary affect and benefit so:

1. Wash clean the container or the dish once a week.
2. The dish should be covered or capped.
3. The dish or water storage shouldn't have a hole.

Annex 7: HMIS Clinic Data

Results from the HMIS database of the MOPH are shown below. The clinics represented are the four clinics SWSP utilized to meet with disease surveillance data collectors and are the closest clinics to the study populations. Note: the calendar used in these graphs corresponds to the Afghan solar calendar while project data shown elsewhere in this report are in the Gregorian calendar.

Figure 1:

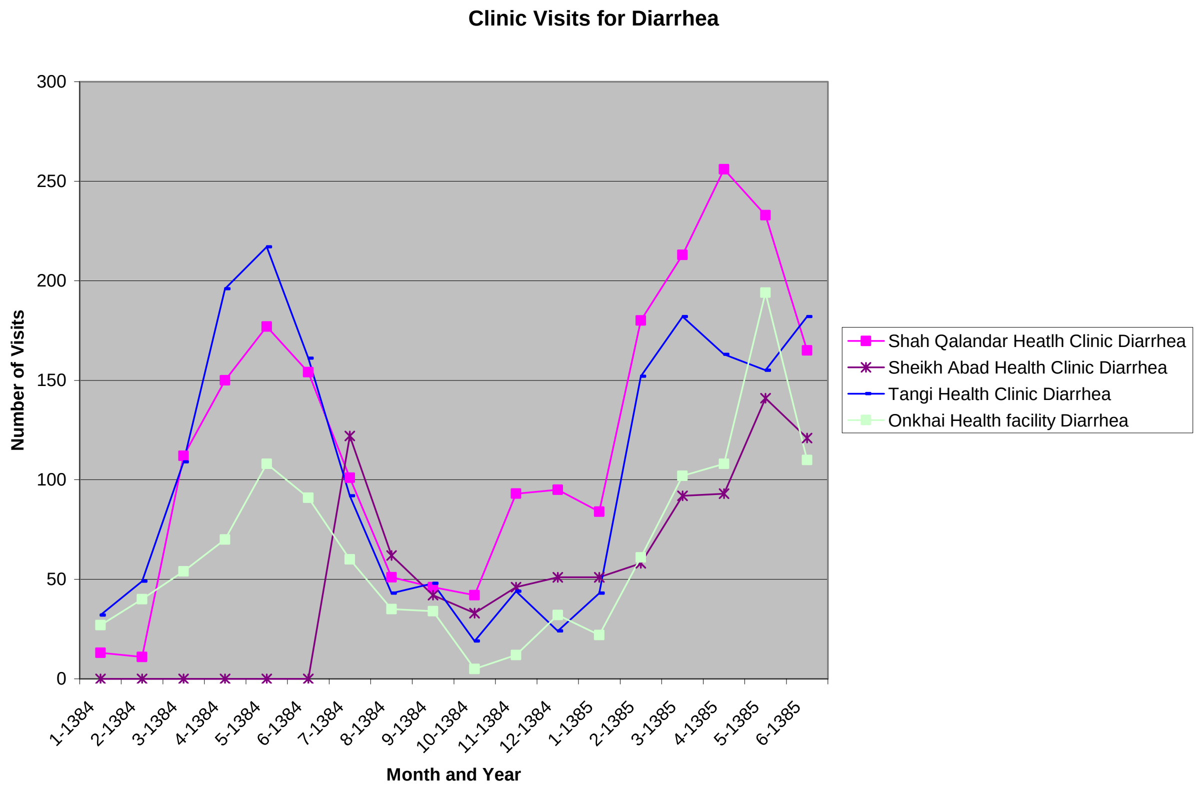
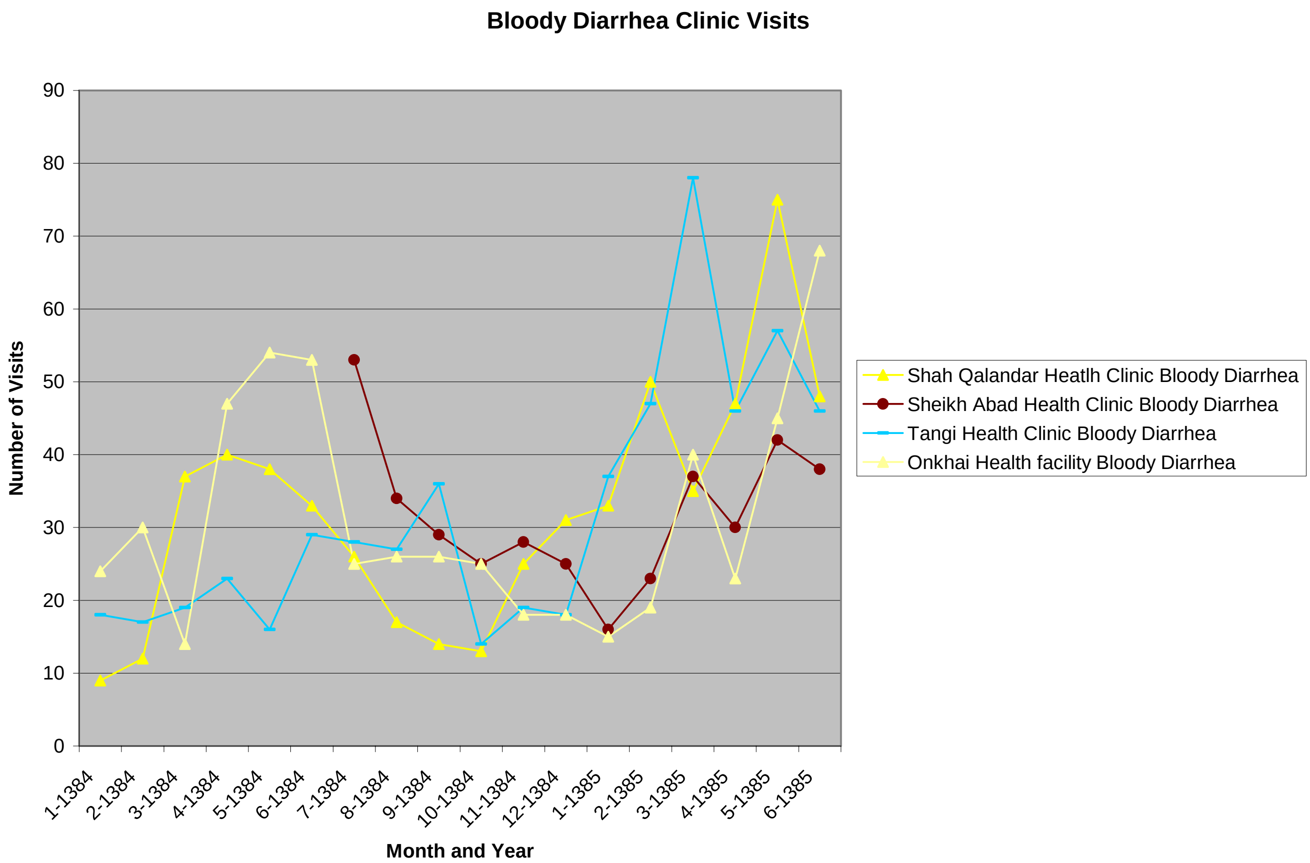
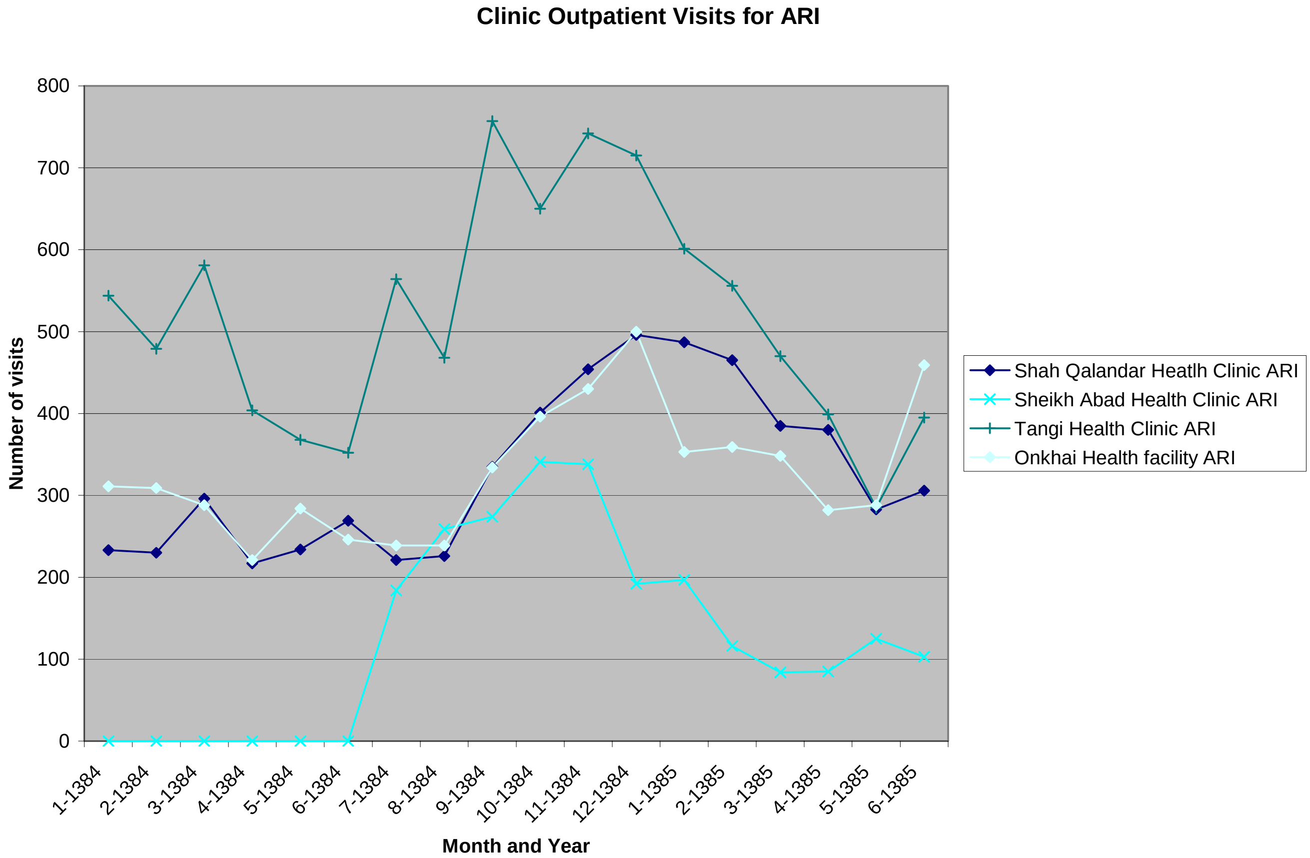


Figure 2:



Bloody Diarrhea Clinic Visits
Number of Visits
90
80
70
60
50
40
30
20
10
0
1-1384
2-1384
3-1384
4-1384
5-1384
6-1384
7-1384
8-1384
9-1384
10-1384
11-1384
12-1384
1-1385
2-1385
3-1385
4-1385
5-1385
6-1385
Month and Year
Shah Qalandar Heatlh Clinic Bloody Diarrhea
Sheikh Abad Health Clinic Bloody Diarrhea
Tangi Health Clinic Bloody Diarrhea
Onkhai Health facility Bloody Diarrhea

Figure 3:

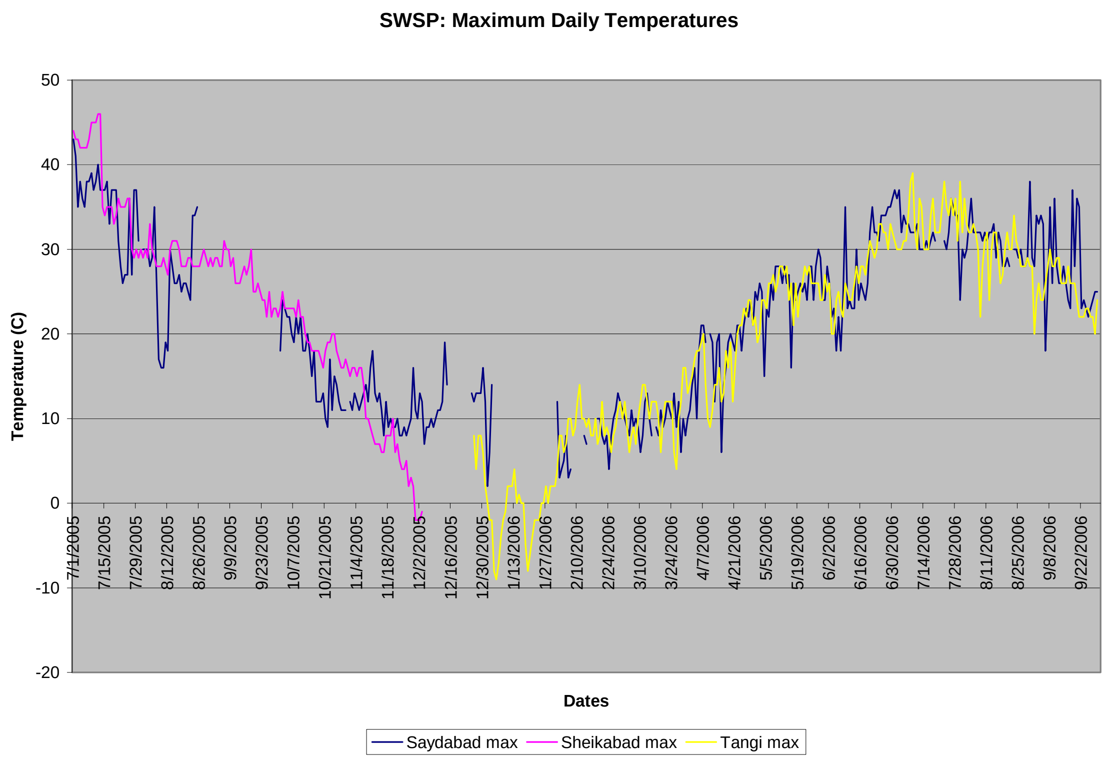


Clinic Outpatient Visits for ARI
800
700
600
500
400
300
200
100
0
Number of visits
1-1384
2-1384
3-1384
4-1384
5-1384
6-1384
7-1384
8-1384
9-1384
10-1384
11-1384
12-1384
1-1385
2-1385
3-1385
4-1385
5-1385
6-1385
Month and Year
Shah Qalandar Heatlh Clinic ARI
Sheikh Abad Health Clinic ARI
Tangi Health Clinic ARI
Onkhai Health facility ARI

Annex 8: Maximum Daily Temperature and Precipitation

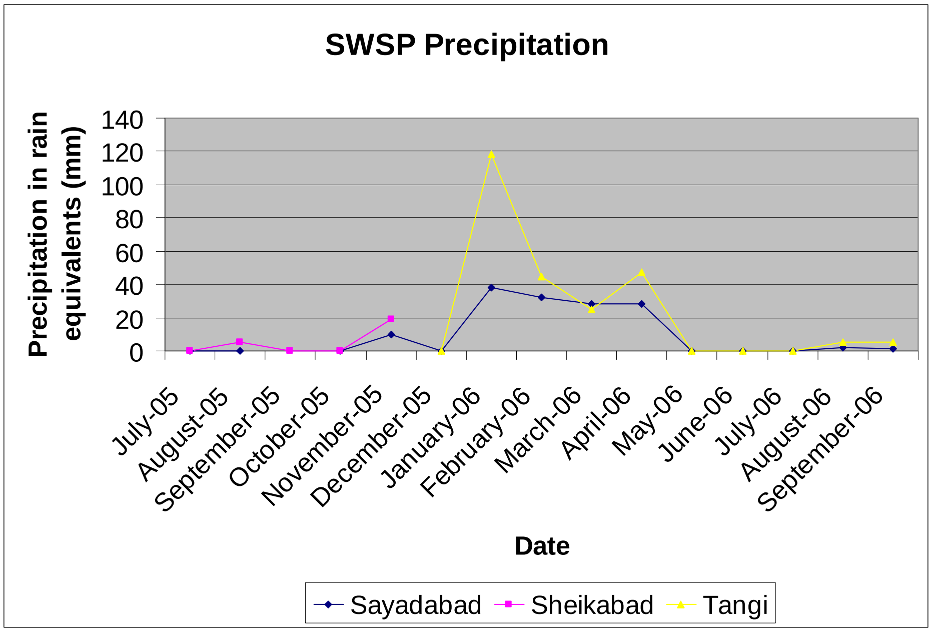
Temperatures ranged from a daily maximum of -8C to 46C. From December 2005 through April 2006, daily minimum temperatures regularly dropped below the freezing point (0C). Precipitation was near zero from July through October 2005 and again from May through September 2006. Precipitation peaked in January 2006 with 11.8 cm of rain equivalents. (1 cm of snow = 1 mm of rain equivalents, NOAA 2006)
Reference: National Oceanographic and Atmospheric Administration, NOAA Magazine, March 1, 2006 retrieved from www.magazine.noaa.gov/stories/mag191.htm, on December 15, 2006.

Figure 1:



After a high level of precipitation in the spring of 2005 that broke a seven-year drought, very low levels of snow and rainfall in late 2005 and early 2006 signaled a return to drought conditions for much of the country (Ref). Below is a graph of precipitation measured at two clinics in the SWSP area.

Figure 2:



SWSP Precipitation
Precipitation in rain equivalents (mm)
140
120
100
80
60
40
20
0
July-05
August-05
September-05
October-05
November-05
December-05
January-06
February-06
March-06
April-06
May-06
June-06
July-06
August-06
September-06
Date
Sayadabad
Sheikabad
Tangi