Multi-Method Evaluation of a Point-of-Use Water Filtration and Education Program in Rural Guatemala

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Abstract

Background: According to recent estimates by UNICEF, more than 768 million people do not have a secure source of safe drinking water, while 2.5 billion lack access to proper sanitation. Consequently, point-of-use (POU) biosand filters (BSFs) have become a common intervention in resource-limited countries. However, rigorous review of POU filtration programs to document their level of “success” is often lacking, and can overlook the role that socio-cultural, historical, and political factors play in determining program efficacy.

Methods: The primary purpose of this project was to design and implement a mixed-methodology protocol for assessing a POU filter and education program in San Martín, Sololá, Guatemala. Quantitative tools included: (1) environmental surveys of the filter set-up, and (2) E. coli and total coliform testing of post-filtered water. Qualitative tools involved interviews and focus groups with five key groups of stakeholders: (1) participants, (2) non-participants, (3) local health leaders, (4) community leaders, and (5) in-country project leaders.

Results: The qualitative interviews revealed a strong consensus among key stakeholders that the program was beneficial for the health of the community. All participants self-reported increased knowledge of proper sanitation and hygiene practices and expressed enthusiasm for the classes. Also, 19 out of 21 participants reported a decrease in the frequency of water-related illness of their families. The interviews indicated that the selection process for the program could be a potential source of tension amongst community members. Out of the 21 filters tested for E. coli, 7 filters levels of E.coli bacteria (<30 CFUs/100 mL), and 5 showed high levels of E. coli (≥30 CFUs/100 mL). Comparisons between the environmental surveys and filter testing results revealed that contamination might be associated with dirty or scratched post-filtration containers, misuse of bleach in the cleaning process, or dipping hands into the container.

Discussion: This multi-level approach comprehensively assessed perceptions of the program, changes in health knowledge and habits, changes in diarrheal disease burden, and intra-community relationships. Ultimately, the program was deemed to be a “success” by both researcher and participant standards, although the quantitative evaluation highlighted areas for potential improvement in the filter program. This mixed-methodology protocol reveals the importance of triangulating multi-level qualitative interviews with a quantitative evaluation of the filter technology, in order to obtain a holistic assessment of the efficacy and success of POU programs.

Introduction

I. Water, Sanitation, and Disease

According to recent estimates by UNICEF, approximately 2.5 billion people lack access to proper sanitation facilities, while regular availability of clean drinking water is unattainable for 768 million people (UNICEF 2014). Consequently, the World Health Organization estimates that 3.4 million people die each year from water, hygiene, and sanitation-related illnesses, particularly diarrheal diseases (WHO 2013). The effects of poor water quality and supply are particularly pronounced in children under five years of age, as well as persons who are malnourished or immunosuppressed. Moreover, water and hygiene-related illnesses have been
associated with decreased school attendance, decreased productivity, and increased rates of malnutrition (Guerrant et al., 2008). Studies have also suggested that malnutrition and recurrent episodes of diarrhea during childhood contribute to long-term epigenetic changes associated with diseases such as metabolic syndrome, as well as decreased cognitive function (Petri et al. 2008; Checkley et al. 1998; WHO/UNICEF 2014).

In Guatemala, approximately 78.7% of inhabitants have access to “improved” water sources, which are constructed to protect the water against outside contamination (PAHO 2014; Ministry of Public Health and Social Assistance 2014). Nevertheless, many Guatemalan water delivery systems function erratically, and water may not comply with U.S. Environmental Protection Agency standards even if from an improved source. The Pan American Health Organization estimates that although 65% of Guatemala’s “total water volume is available” for use, approximately 40% of this supply cannot be used because of high levels of contamination. In a 2008 water quality survey of piped water systems, over half of the systems sampled had insufficient chlorine levels, and one-fourth showed bacterial contamination (PAHO 2014). Unsurprisingly, diarrhea, intestinal parasites, intestinal amoebas, dengue, and malaria still rank amongst the top twenty causes of morbidity in Guatemala (Ministry of Public Health and Social Assistance 2014).

II. Point-of-Use Water Filtration and Education Program in Rural Guatemala

Program Design

Since 2007, the University of Virginia-Guatemala Initiative (UVA-GI) has been working in the Lake Atitlan region of Guatemala to improve health outcomes and “develop mutually beneficial and sustainable relationships” (UVA Center for Global Health 2014). In 2011, UVA-GI students and in-country leadership conducted a water needs assessment survey of three different communities around the urban center of San Lucas Tolíman. Ultimately, the community of San Martín was selected to engage in a point-of-use (POU) water filtration and education program. Over the next two years, UVA graduate students Andrea Maddox and Amanda Below worked with in-country project leaders and community partners to develop and initiate a health education and POU filter program. Maddox and Below crafted an interactive curriculum that would be taught over the course of 18 weeks, concluding with the distribution of Hydraid BioSand filters to each of the graduating participants. The curriculum was divided into three main units: hygiene, nutrition, and filter use and maintenance. Subsequently, a local nurse, Felipa Archila Julajui, was hired to administer the curriculum as the health educator (Maddox, 2013). The community leadership committee, the Concejos Comunitarios de Desarrollo (COCODEs), chose the first group of 21 participants, prioritizing families of lower economic status with a greater number of small children. Men were not excluded from participating in the classes, however since women are primarily responsible for water within the home, all participants were women.

Evaluating Short-Term Outcomes

At the initiation of the program, Maddox and Below developed and implemented several tools for evaluating the progress of the course and functionality of the filters (Maddox, 2013). Pre- and post-tests were used during each unit to assess any short-term changes in knowledge resulting from the classes. A member of the UVA-GI in-country staff also conducted structured interviews with participants in the absence of the health educator, in order to encourage participants to speak candidly about how they felt about the course. Furthermore, the health educator provided monthly reports about the progress of the classes, specifically commenting on the goals reached, problems encountered, and participant attendance. Maddox and Below also assessed the care, maintenance, and effectiveness of the Hydraid filters in each participant’s home. Post-filtered water was tested for the presence of E. coli, total coliforms, and nitrates, with the goal of assessing the functionality of the filter itself. The short-term evaluation revealed
that the first round of classes was generally successful. Participants often explicitly stated that they were learning new information from the education courses, and pre- and post-tests revealed short-term knowledge retention. The overall program received positive reviews, and women generally expressed that the POU filters were a good and necessary project for the community. The primary concern among participants was filter malfunction (Maddox 2013).

III. Long-Term Evaluation

The Program Evaluation framework released by the Centers for Disease Control suggests that a more long-term evaluation should be conducted over the life of the program to ensure that the intervention has not just worked, but continues to work (CDC, 2014). In the published literature, many long-term quantitative evaluations of POU water filtration programs have used E. coli, total coliforms, and bacterial testing as proxies for program success. Most of these studies compare E. coli counts in the source water to post-filtered water, in order to assess the efficacy of the filter in removing disease-causing organisms (Sisson et al., 2013; Stauber et al., 2008; Stauber et al., 2006; Huang, 2002). Measures of turbidity in pre- and post-filtered water have been used to estimate the ability of the filter to remove particulate matter (Huang, 2002). A few studies have used self-reports of diarrheal illness to supplement water testing (Stauber et al., 2008).

In combination, these varied quantitative approaches to POU filter assessment enable researchers to gather data on the functionality of the filter by measuring changes in E. coli concentrations, changes in turbidity, as well as measuring the overall lifespan of the filter. Nevertheless, purely quantitative approaches often ignore other factors that contribute to the success or failure of POU water filtration systems. Without a qualitative evaluation of community members’ perceptions, knowledge, and attitudes, a POU program evaluation lacks the tools necessary to fully understand elements of the quantitative evaluation. In the published literature, the majority of purely qualitative evaluations of POU filtration programs assess perceptions and attitudes towards the program, as well as overall changes in health knowledge and habits resulting from the intervention. Several studies use randomized interviews with POU technology recipients to elucidate opinions of the program and discuss factors that contributed to the participant’s willingness to use the technology, as well as modifications the participant made to his or her hygiene routine as a result of the program (De Ver Dye et al., 2011; Mosler et al., 2014; O’Reilly et al., 2008). Studies have also correlated, or triangulated, researcher observations with participant responses during interviews, and in some cases have relied on pure observation to further understand changes in health, sanitation, and hygiene resulting from the intervention (Wood et al., 2008). Additionally, several qualitative studies have interviewed various stakeholders within the community aside from program participants, in order to obtain a more complete understanding of the factors that contribute to the adoption and proper maintenance of POU filtration technologies (Dubois et al., 2010; Christen et al., 2011).

Therefore, qualitative studies provide a social dimension to participants’ responses to the intervention, helping to illuminate sources of potential motivation and discouragement for adopting a POU filter system. Furthermore, qualitative assessments can help uncover areas that researchers did not originally anticipate to be impacted by the program, such as self-perceived productivity at work or school and feelings of community empowerment. However, a purely qualitative study’s dearth of quantitative data limits understanding of filter maintenance and functionality, as well as the impact of the program on the community’s waterborne disease burden.

While a combination of qualitative and quantitative tools seems to be an ideal method for gauging program success, the number of published studies that use a mixed-methodology for POU filter program evaluation is limited. Duke and colleagues endeavored to evaluate the long-term efficacy of a POU system by correlating
qualitative participant interviews with results of post-filtered water tests (Duke et al., 2006). Nonetheless, even mixed-methods approaches such as this study can sometimes fail to accurately represent key stakeholders within the community, such as non-participants, local project leadership, and community leadership.

Thus, in order to implement a longer-term evaluation of the POU water filtration and education program in San Martín, UVA program leaders developed a set of criteria that could be used to measure program success, including (1) filter maintenance and functionality, (2) perceptions of the education program, (3) perceptions of the filter program, (4) changes in health, and (5) overall perceptions of the program. This study utilizes many of the qualitative and quantitative tools adopted by the aforementioned studies, including interviews, focus groups, and water testing. However, unlike previous studies, this study sought to analyze the program at various levels within the community, in order to obtain feedback from all stakeholders involved, including community leaders. Program leaders also designed the evaluation to include a high number of contact hours with program participants and community members, further differentiating this evaluation from previous POU filter assessments. By pairing new approaches with the methodologies used by previous evaluation studies, the program intended to develop a novel approach for evaluating POU filter programs that will help generate a more holistic understanding of program success.

Methods

Population

San Martín is located in the Sololá department of Guatemala, and is home to 110 indigenous Mayan families, with a total population of 461 individuals. This evaluation took place over a four-week time period, beginning on July 3, 2013. Twenty-one women had completed the first-round education class in November 2012, approximately seven months prior to the evaluation. Filters were installed in their homes shortly after graduating from the course. An additional 28 women were enrolled in the second-round of classes. This group graduated from the program and received filters during the third week of the evaluation. Four women initially participated in the first or second round of classes, but dropped out. Out of the 110 families, 57 had not yet been offered the opportunity to engage in the program by the COCODIFEs, and were considered “non-participants” during this evaluation.

Quantitative Data Collection

The quantitative evaluation included (1) environmental surveys of the filter set-up and (2) E. coli and total coliform testing of filtered water for first-round participants. Since second-round participants received their filters during the evaluation, it was not feasible to include them in the quantitative evaluation. The environmental survey noted each participant’s process of water collection and deposition into the filter from source to storage container, the timeline and method of water storage, method of cleaning, and potential sources of process-related contamination. Potential sources of contamination were identified prior to conducting the environmental surveys, in order to create a standardized set of criteria. Table 1 contains the sources of process related-contamination, and the rationale for classification. Additionally, post-filtered water was tested

Source: Author, 2014
Table 1. Potential Sources of Contamination in the POU Water Filtration Process

<table>
<thead>
<tr>
<th>Potential Source of Contamination</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dirty secondary storage container (e.g., particulate matter, dirt)</td>
<td>May indicate infrequent cleaning, improper cleaning, and presence of contaminants</td>
</tr>
<tr>
<td>Scratched secondary storage container</td>
<td>Scratches can harbor bacteria if not sufficiently cleaned.</td>
</tr>
<tr>
<td>Damaged tube (e.g., scratches or breaks)</td>
<td>Scratches or a break in the tube can harbor bacteria if not sufficiently cleaned.</td>
</tr>
<tr>
<td>Tube tied to prevent outflow</td>
<td>Causes “back-up” of water in the filter. Excess water at the top of the filter can kill the biolayer.</td>
</tr>
<tr>
<td>High flow rate (&gt; 0.8 L/min)</td>
<td>May indicate air pockets, or “holes” in the sand or rocks. Water passing through the system too quickly may not be sufficiently filtered.</td>
</tr>
<tr>
<td>Chlorine used improperly to clean apparatus, or not at all</td>
<td>Chlorine used on diffuser plate will kill the biolayer. Not using chlorine to clean increases the chances that existing contaminants continue to survive.</td>
</tr>
<tr>
<td>Dipping of hands or pitcher into secondary storage container</td>
<td>Outside contamination (i.e. bacteria or viruses) from kitchen utensils or hands can contaminate the entire water supply in the secondary storage container.</td>
</tr>
</tbody>
</table>

*Criteria are specific to the Hydraid BioSand filter systems used in the community of San Martín.*

for E. coli and total coliforms, whose presence indicates that water may be contaminated by human or animal wastes (EPA, 2014). The day before collection, all households were instructed to clean their filters as normal, and to put water in the filter the next morning. On the day of collection, two 100 mL samples of filtered water were taken from each filter, cultured on separate plates, and incubated. Two plates of bleached water and two plates of bottled drinking water were also incubated to serve as controls.

**Quantitative Data Analysis**

After incubating testing plates for 24 hours, the number of coliform colonies per sample was noted and recorded using pre-established guidelines for interpreting the test results, with consideration of four different factors. First, many rural Guatemalans have an aversion to the taste and smell of chlorine in drinking water, which has been documented in published literature, and was verified by first hand experience in the community (Maddox, 2014; Nagata et al., 2011). While women use chlorine for cleaning, the overwhelming majority of women in the community will not use chlorine for the purpose of decontaminating water. Second, the U.S. Environmental Protection Agency’s drinking water regulations state that water should have 0 colony-forming units (CFUs) per 100 mL of water. However, this guideline assumes that drinking water has been chlorinated after filtration (EPA, 2014). Third, the doubling time of E. coli is short (15 to 20 minutes) in comparison to the average time elapsed between taking the sample in San Martín and plating it, which ranged from two to eight hours. Lastly, while the aim of the program was to ensure the sterility of the equipment, lab conditions were not ideal. These factors were considered in developing threshold levels for filter cleanliness, seen in Table 2.

**Qualitative Data Collection**

The qualitative assessment involved data collection from five key groups of stakeholders: (1) participants, (2) non-participants, (3) local health leaders, (4) community leaders, and (5) in-country project leadership, using both individual interviews and focus groups. The
Table 2. Guidelines for Interpretation of E. coli Test Results of Post-Filtered Water from Hydraid POU Filter Systems in the Community of San Martín

<table>
<thead>
<tr>
<th>E. coli Test Results</th>
<th>Interpretation</th>
<th>Rationale</th>
<th>Need to retest?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Negative</td>
<td>Clean</td>
<td>No E. coli present.</td>
<td>No</td>
</tr>
<tr>
<td>1 Negative, 1 Low Positive (&lt; 5 CFUs/100 mL)</td>
<td>Clean</td>
<td>Given doubling time of E. coli and potential for lab-related contamination, positive result could be due to human error.</td>
<td>No</td>
</tr>
<tr>
<td>2 Low Positive (&lt; 30 CFUs/100 mL)</td>
<td>Low Levels of E. coli</td>
<td>With two low positive results, contamination could be related to the filter or filter maintenance, or due to the lab environment.</td>
<td>Yes</td>
</tr>
<tr>
<td>2 High Positive (≥30 CFUs/100 mL)</td>
<td>High Levels of E. coli</td>
<td>With two high positive results, contamination is probably related to filter or filter maintenance.</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Transtheoretical Model of health behavior change was used to develop the interview questions, and the theory of Community Organization and Community Building helped identify key stakeholders (Glanz, Rimer, and Lewis, 2002).

Program leaders conducted 21 individual interviews with first-round participants, and two focus groups with seven to eight second-round participants. Questions pertained to participants’ opinions of the filter program, the education program, overall perceptions of the program, and changes in health. Program leaders facilitated ten individual interviews with female non-participants, and asked questions about current water usage and hygiene habits, perceptions of the program, the health of their families, and their desire to participate in the program.

Community leaders, the COCODEs, local health leaders, including the local physician and community health promoter, and UVA-GI program leaders were also interviewed. Program leaders from UVA-GI facilitated two focus groups with the COCODEs, met with Dr. Rafael Tun - the physician at the clinic in San Lucas Tolíman - and interviewed one of San Martín’s health promoters. Program leaders worked closely with the in-country leaders — the filter specialist and health educator — on a daily basis, and often had informal conversations about the program. However, more formal individual interviews were conducted with each person as well. All of these interviews and focus groups inquired about the stakeholder’s perceptions of the program, the need for a POU filter program in the community, changes in community health they attributed to the program, and potential expansion of UVA-GI in San Martín and surrounding communities (see Table 3).

Since participants were not familiar with recording devices, program leaders chose not to record the interviews in order to make the participants feel more comfortable. All interviews were conducted in Spanish by undergraduate or graduate students from the University of Virginia. The in-country leaders were present for all interviews, and would translate into the local Mayan language, Kaqchikel, when necessary.

Qualitative Data Analysis

Notes from the interviews and focus groups were synthesized and entered into an electronic database. Since the interviews were not recorded, participant responses were paraphrased, not directly transcribed. The questions were divided into four categories:
Table 3. Description of Key Stakeholders and Type of Qualitative Tool Used

<table>
<thead>
<tr>
<th>Key Stakeholder</th>
<th>Description of Role in Program or Community</th>
<th>Type of Qualitative Tool Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round 1 Participants (n=21)</td>
<td>Women who completed the education component in November 2012, filters were subsequently installed. Had been using filters for approximately 6 months at the time of the evaluation.</td>
<td>Interviews in participant’s home. Filter specialist/health educator was present to help translate and facilitate interview.</td>
</tr>
<tr>
<td>Round 2 Participants (n=28)</td>
<td>Women who completed the education component in July 2013 during the evaluation. Program leaders helped install their filters with the health educator and filter specialist.</td>
<td>2 focus groups with 7—8 women each in the meeting hall at the local school. Filter specialist or/health educator was present to help translate and facilitate the discussion.</td>
</tr>
<tr>
<td>Non-Participants (n=57)</td>
<td>Women and men who had not yet been given the opportunity to participate in the program.</td>
<td>Interviews with a sample of 10 non-participants.</td>
</tr>
<tr>
<td>Community Leadership, the COCODEs (n=11)</td>
<td>Group of 11 men, chosen by community members, who serve as the community’s governing body. Responsible for selecting the group of families who were given the opportunity to participate in the program. At the time of the evaluation only 2 of the COCODEs had wives participating in program (Round 2).</td>
<td>2 focus groups in the community meeting hall, and then in the meeting hall of the local school. Second focus group was facilitated by in-country program Director, Jessica Ohana-Gonzalez.</td>
</tr>
<tr>
<td>In-country Leaders (n=2)</td>
<td>Filter specialist and health educator. Filter specialist conducts follow-up after filter installation. Health educator teaches the course and also helps conduct follow-up filter evaluations.</td>
<td>Interviews and numerous informal conversations and interactions. Both the filter specialist and health educator helped program leaders conduct the interviews and focus groups with key stakeholders.</td>
</tr>
<tr>
<td>Community Health Promoter</td>
<td>Responsible for overseeing and monitoring the health of children, and people with chronic illnesses like diabetes. The community health promoter was also a participant in the 1st round.</td>
<td>2 interviews in participant’s home — the first as a round 1 participant, and the second as the community health promoter</td>
</tr>
<tr>
<td>Local Physician</td>
<td>Dr. Rafael Tun worked with the UVA-GI program founder. Sees patients from 26 communities surrounding San Lucas Toliman.</td>
<td>Interview in office at clinic in San Lucas Toliman.</td>
</tr>
</tbody>
</table>

(1) perceptions of the education program, (2) perceptions of the filter program, (3) changes in the health of participants, and (4) perceived impacts of the overall education and filter program on the community. Since the survey tools were tailored to each stakeholder group, Versus coding was used to highlight common trends in responses between all participant groups. Themes in participant responses were identified based on the aforementioned categories. Stakeholder responses were compared internally first to elucidate common themes or discrepancies between members of the same participant group. Responses were subsequently compared to the underlying themes of all groups, likewise endeavoring to reveal commonalities and disagreements between stakeholders.

This protocol was approved by the University of Virginia's Institutional Review Board SBS #2013019900.

**Results**

**Quantitative Results**

In accordance with the established guidelines, the houses of 7 first-round participants had post-filtered water that was clean, and the remaining 14 houses yielded either high and low levels of E. coli contamination (see Table 4 and Figure 1).
Table 4. Post-Filtered Water E. coli Test Results for First-Round Participants

<table>
<thead>
<tr>
<th>E. Coli Test Results</th>
<th>Interpretation</th>
<th>Number of filters (n=21)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Positive</td>
<td>Clean</td>
<td>4</td>
</tr>
<tr>
<td>1 Positive, 1 Low Negative (&lt; 5 CFUs/100mL) or “Mixed”</td>
<td>Clean</td>
<td>3</td>
</tr>
<tr>
<td>2 Low Positive (&lt; 30 CFUs/100mL)</td>
<td>Low levels</td>
<td>9</td>
</tr>
<tr>
<td>2 High Positives (≥ 30 CFUs/100mL)</td>
<td>High levels</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 1. Post-filtered Water E. coli Test Results of First-Round Participants (n=21) Subdivided by Household

![Graph showing post-filtered water E. coli test results](image)

* Houses 1, 3, 4, 12, 13, 14, 15 = Clean; Houses 7, 9, 10, 16, 17, 18, 19, 20, 21 = low levels of E. coli; Houses 2, 5, 6, 8, 11 = high levels of E. coli*

The test results were subsequently correlated with the environmental surveys, looking for any patterns in the potential sources of contamination for a filter system, and the level of E. coli present in post-filtered water. Specifically noted were houses with a dirty or scratched secondary storage container, misuse or non-use of bleach, damaged tube, tied tube, high flow rate, and using a hand or pitcher to dip into the secondary storage container, comparing the number of potential sources to the actual E. coli results. Ultimately, 28 out of 35 total incidents of process-related contamination were documented at houses with two positive E. coli test results. (see Figure 2).

Qualitative Results

See Table 5 for a summary of themes that emerged from stakeholder responses.
Figure 2. Potential Sources of Contamination in the San Martín POU Filter System, Correlated with Results of E. coli Testing of Post-filtered Water

<table>
<thead>
<tr>
<th>Source of Contamination</th>
<th>2 Positive Results (n=14)</th>
<th>Mixed Results (n=3)</th>
<th>2 Negative Results (n=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damaged tube</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Tube tied to prevent outflow</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>High flow rate</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dirty secondary storage container</td>
<td>10</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Scratched secondary storage container</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Open/dip into secondary storage container</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Did not use, or misused chlorine</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

*The numbers indicate the number of households where the process related contamination was observed. The colors are meant to help visualize the frequency, with darker red indicates higher frequency of process-related contamination.*

Table 5. Themes in Stakeholders’ Responses to Questions Regarding the Education Program, the Filter Program, and Overall Changes in Health

<table>
<thead>
<tr>
<th>Perceptions of Education Program</th>
<th>Perceptions of Filter Program</th>
<th>Overall Perception of Program</th>
<th>Perceived Changes in Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Participants enjoyed classes</td>
<td>• Using the filter greatly increases the quality of water</td>
<td>• Program addresses longstanding need to improve the quality of water within the community</td>
<td>• Program benefits the health of the community</td>
</tr>
<tr>
<td>• Participants learned new information about nutrition, hygiene, bacteria, filter maintenance, how to care for children and household</td>
<td>• Some women no longer have to buy water — filter has saved them money</td>
<td>• Community members expressed interest in partnering with UVA-GI in the future, namely to move the source pump on Lake Atitlan</td>
<td>• Decrease in the frequency of diarrheal illness amongst participating families</td>
</tr>
<tr>
<td>• Information is important and necessary to learn</td>
<td>• If a participant is experiencing a problem (e.g., low flow rate, worms/ dirt at top of filter) she continues to use filter</td>
<td>• Classes have benefitted participating women</td>
<td>• Fewer people need medication for treatment of diarrheal illness, and fewer people have been visiting local clinic because of waterborne illness</td>
</tr>
<tr>
<td>• Classes have benefitted participating women</td>
<td>• Class structure is good as it is (e.g., hour, time commitment, information, exams)</td>
<td>• Husbands do not always understand why their wives need to attend the classes</td>
<td>• Some community members think that in order to solve their water problems, the source pump should be moved in addition to continuing the filter program</td>
</tr>
<tr>
<td>• Unclear how well women have retained the knowledge</td>
<td>• More review sessions should be implemented to reinforce the knowledge</td>
<td>• Unclear how well women have retained the knowledge</td>
<td>• More follow-up should be done</td>
</tr>
<tr>
<td>• More review sessions should be implemented to reinforce the knowledge</td>
<td>• Program addresses longstanding need to improve the quality of water within the community</td>
<td>• Program benefits the health of the community</td>
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</tr>
<tr>
<td>• More follow-up should be done</td>
<td>• Community members expressed interest in partnering with UVA-GI in the future, namely to move the source pump on Lake Atitlan</td>
<td>• Fewer people need medication for treatment of diarrheal illness, and fewer people have been visiting local clinic because of waterborne illness</td>
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</tr>
</tbody>
</table>

27
Perceptions of Education Program

Before entering the community, program leaders discussed the education program with the health educator, Felipa Archila Julajú. During these conversations, she highlighted the importance of the program as a necessary supplement to receiving a filter. Before taking the class, she said that many women did not know why drinking unclean water was harmful to their health, nor did they understand the importance of hygienic behaviors and maintaining a clean household. Since the first round of women graduated, Julajú said she has noticed a difference in the cleanliness of some of their households when she conducts home visits. She has also noticed that one of the participating women has started to sell healthier snacks to children coming home from school – instead of selling packaged foods, she now sells cut mango and other less processed foods. She thinks that this change reflects the new knowledge about proper nutrition that the woman learned during class.

However, Julajú is concerned that women are not retaining all of the information they learned. She held a meeting with the first-round women three months after the filters had been installed in their homes, and organized some games designed to quiz the participants about the course information. She reported that some women recalled a lot of the information, while others did not. She wants to conduct more follow-up evaluations of knowledge retention. An interview with the local physician underscored the importance of conducting follow-up evaluations as well as having “refresher” courses for community members. Dr. Rafael Tun stated that education is an important part of the program, but also highlighted the benefits of covering the information more than once, in order to ensure that the information is properly relayed.

Julajú also mentioned that the classes deter some women from participating in the program. A few women in the first and second round of classes dropped out, and she thinks it may be related to the time commitment. Some people want shorter classes, especially at the beginning of the education program when they have just started to take the class. She also said that the class is hard to schedule because of women’s extensive duties in the household. Originally she told women that they couldn’t bring their children to class, which also may have discouraged them from participating.

Additionally, in her experience working with families in San Martin, she found that sometimes men do not understand the importance of taking the class, and think that it detracts from their wives’ household responsibilities. This topic was addressed in a conversation with the COCODEs, a group of 11 male community members, wherein the leader responded that many women have time commitments both internal and external to the home, including selling goods during market days in nearby cities. Accordingly, the class can be difficult to schedule, and can detract from a woman’s commitment to fulfill her familial responsibilities. However, two members of the COCODEs had wives participating in the second round of classes, and expressed that the classes made their wives more animated, and actually increased their productivity in the household.

Accordingly, program leaders wanted to gauge the participants’ perspective about the structure of the classes and the time commitment. All 21 first-round participants and all second-round participants in the focus groups said that the class was good or excellent, and they would not change anything about the structure of the course. One woman said that the classes took time away from her other commitments, but she still said she would not change the course.

The majority of participants stated that they enjoyed the class, and learned new information, particularly about nutrition, hygiene, bacteria, and caring for their children. Several second-round women now tell their children to buy healthier snacks when at school. Women in both the first and second round also thought that the class taught them how to be organized and on time. A few women even expressed interest in having longer classes. Finally, program leaders interviewed non-participants about
barriers to program participation related to the education course. One woman said that she would be interested in participating, but may not be able to because she has to travel; another non-participant said that she is not interested because her family is moving.

Perceptions of Filter Program

All stakeholder groups viewed the filter program as beneficial for the community, and the quality of drinking water. First and second-round participants, the COCODEs, and the community health promoter stated that this program has been the first to address the water problem within San Martín. Families without filters must use approaches such as boiling, buying water, or collecting water in rain barrels. Buying water is cost-prohibitive for the majority of families, and boiling water can also be expensive because of the cost of firewood. Accordingly, all of the participants use the filters that have been installed in their homes, and nine out of ten non-participants expressed interest in participating in the program, sometimes citing the high price of firewood as a reason.

None of the first-round participants experienced difficulty in using their filters; however seven participants stated that they would need outside help if they experienced a problem with their filter, either from a neighbor or from the filter specialist, while 11 felt confident that they could fix the problem on their own. The filter specialist and health educator originally suggested that if one woman experienced a problem with her filter, other participants’ opinions and filter usage could be impacted. However, when first-round participants were asked similar questions during the interviews, none of the participants said they would be affected. A few women declared that they would try to help the person experiencing the problem. Others said that some women do not take care of their filter, so it is not unreasonable to expect that they would have problems.

While the filter specialist explained that he would not change anything about the installation process, the health educator said that the filter delivery and installation process could be a source of contention within the community. After women graduate from the education course, they expect to receive a filter. However, for both the first and second-round participants, the filters arrived much later than expected. The health educator said that she felt uncomfortable entering the community when the filters were late, as the participants often blamed her, even though she had no control over the delivery process. Moreover, the filter installation process can be problematic, as some women blame filter problems on the person who installs it. For this reason, the health educator felt that filter installation should be a thoughtful and well-planned process, to minimize the potential for future problems.

Perceived Changes in Health

Before using the filters to purify drinking water, participating families - children in particular - suffered from diarrhea, vomiting, stomach pain, amoebas, skin allergies, and the flu. Only one first-round participant said her family did not get sick often before the filter installation. This baseline level of illness was confirmed by interviews with second-round participants, non-participants, the community health promoter, and the local physician.

Since the installation of the filter, all but one first-round participant reported a decrease in the frequency of sickness of family members, and seven first-round participants explicitly stated that their health was better because of the filters. The community health promoter stated that fewer people approach her for advice or medication for diarrhea and vomiting. The local physician, who usually treats patients for giardia, ascariasis, and amoebas, also said that he has seen fewer patients from San Martín since the filters were installed.

Overall Perceptions of Program

All key stakeholder groups, including non-participants, felt the education and filter program was beneficial for the community. During the focus groups with the second-round participants,
one woman stated that the program had “improved the quality of life” of community members. Furthermore, second-round participants said that the program has changed the way women think about water, and how they use it. The filter specialist and health educator both thought that the program was the right, or appropriate, project for the community.

When asked about the goals of the program, common responses included: making the water cleaner, helping the community become healthier, providing filters to each family, and overall community betterment — all of which closely align with the goals of UVA-GI and program leadership. However, many stakeholders felt that the project goals had not yet been achieved, because many families still lacked a filter. When asked about the presence of foreigners in the community, no participants expressed concern that the success of the program had been negatively impacted by the involvement of American students.

Although the COCODEs thought that the program responded to the community’s need for clean drinking water, they felt the problem could not be completely resolved until the source pump on Lake Atitlan was relocated. Accordingly, they expressed interest in partnering with UVA-GI to investigate the infrastructure of the source pump, as well as possible solutions.

Nonetheless, interviews with non-participants, as well as the health educator, unearthed several criticisms of the program. First, the overall selection process seemed to be a source of community strife. Due to the staggered nature of the classes, women who are not offered the opportunity to participate in a given round can get upset. Two non-participants said that they had been involved in health efforts within the community before the program started, and were upset that they had not been chosen for the first rounds of classes. One wanted to be involved with the program in the future, but the other stated that she did not wish to participate.

The health educator also said that families who have filters can become “proud” once they get their filter, which can upset those who do not yet have filters.

Discussion

The quantitative metrics helped gauge the cleanliness of post-filtered water, and also highlighted certain steps in the filtration process that could serve as potential points of contamination. Seven of the 21 first-round households generated post-filtered water that was clean. These households typically adhered to the recommended cleaning process, using soap and water, and sometimes chlorine, to clean the tube and storage container. Correlating the environmental survey and filter results of the other 14 houses — which yielded two positive E. coli results — revealed potential markers for contamination, such as a scratched tube or storage container, and/or deviation from the recommended cleaning protocol. These filters, particularly the five households with high levels of E. coli (≥ 30 CFUs/100 mL), were not functioning at optimal capacity, probably due to process-related contamination. Ultimately, by pairing water quality testing with an evaluation of the each household’s filtration system, UVA-GI program leaders were able to make recommendations for participants regarding their filter systems, which were delivered by the local program leaders. It is likely that the adoption of a standardized cleaning process,
combined with the replacement of scratched storage containers and damaged tubes, will decrease the number of water systems with high levels of E. coli and total coliforms.

While the quantitative results suggest that the filter program should be modified and improved to minimize the number of houses with positive E. coli results, the qualitative results indicated that all key stakeholders regard the program as generally beneficial for San Martín. All groups of stakeholders noted how the program addressed the community’s need for cleaner water, and had improved the health of community members. Moreover, while some community leaders thought the educational component required an excessive time commitment, interviews with program participants indicated that the women enjoyed the classes and felt that they learned new information pertaining to hygiene, nutrition, and caring for the health of their families.

The qualitative results also revealed that the process of selecting participants could be a source of contention amongst community members. Originally, UVA-GI deferred to the community leaders, the COCODEs, to select the first, second, and last round of participants, in order to avoid conflict. However, a few non-participants felt they had been passed over, deterring some from future involvement in the program. Since this project evaluation preceded the last round of the program, it was undetermined if the attitudes of some non-participants would change if they were given the opportunity to participate.

Moreover, the individual interviews with first-round participants showed that the lifetime of the filter was a potential point of concern. A few women indicated that they were satisfied with the program, but were worried about what they would do if they encountered a major problem with the filter when the filter specialist was no longer coming into the community on a weekly or monthly basis. Additionally, a few women asked what would happen when the filter “expires” after its ten-year lifespan.

Correlating the quantitative results with the qualitative interviews enabled program leaders to achieve a holistic idea of the program’s impacts on the community. From this mid-term evaluation, the program was regarded as a success by both researcher and participant standards, although the qualitative evaluation highlighted areas for potential improvement in the filter program, and the qualitative assessment suggested the need for modifying the participant selection process and follow-up protocol.

By using both qualitative and quantitative methods to evaluate the POU filter program in San Martin, this study differentiates itself from previous POU filter research, which typically relies exclusively on one type of tool. Furthermore, this study used a high number of contact hours to interview key stakeholders at multiple levels within the community, which also distinguishes this evaluation from prior studies. Working closely with local program leaders improved facilitation of interviews with community members, and also ensured that the results of the water testing and suggestions for the households would be communicated in a way that was meaningful for program participants. Engaging program leaders in the evaluation process guaranteed that the evaluation informed future decisions about the program as well.

Limitations

From a quantitative perspective, a primary limitation of this study was the inability to test the functionality of the filter itself. Given the recent installment of the filters compared with their ten-year lifespan, program leaders assumed that the filters were removing 99% of the bacterial, viral, and parasitic contaminants of pre-filtered water. Accordingly, high E. coli counts in post-filtered water was presumed to be process-related — essentially the “fault” of the participant. There was also substantial variation in the amount of time from collection to plating for post-filtered water, which undoubtedly influenced the results of the E. coli testing. Moreover, the lab used for plating and incubating the samples was not without limitations, which
may have resulted in contamination of the samples in some cases.

The qualitative results could be impacted by self-reporting bias, especially the data concerning changes in health. While the program uses stool sample testing before and after filter installation to gauge changes in waterborne illness, program leaders were unable to access the data, making it impossible to verify self-reported changes in the frequency of diarrheal and other water-related illness. While changing health knowledge is also an important goal of the program, program leaders did not identify an effective way to evaluate long-term changes in health behavior. Since the health educator and filter specialistdo not live in the community, it is difficult to use observation as a consistent and valid tool for analyzing behavior changes. Moreover, giving written post-tests is complicated by low literacy rates.

Additionally, program leaders’ association with UVA-GI may have influenced participant responses. Generally, participants may have been less inclined to give negative reviews of the program if they thought they could continue to benefit from the program in the future.

Global Implications

This evaluation demonstrates the importance of triangulating various sources of data to obtain a multidimensional assessment of the efficacy and impact of POU filtration programs. Gauging the success of POU water filtration community engagement programs should involve qualitative interviews and focus groups with community members at multiple levels, which seek to evaluate (1) perceptions of the program, (2) its effect on intra-community relations, and (3) self-reported and observation-based assessment of health and behavior change. Furthermore, a quantitative assessment should endeavor to (4) evaluate the functionality of the intervention, and (5) verify self-reported changes in health and behavior. Finally, the evaluation process necessarily involves extensive time working on-site and a high number of contact hours with local stakeholders to enrich the interview process.

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Works Cited


