Evaluating Demand for Water and Sanitation Technologies in Udaipur, India: A Mixed Methods Approach

by

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William Pan

Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in the Duke Global Health Institute in the Graduate School of Duke University

2015
ABSTRACT

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Abstract

This paper utilizes a mixed methods approach to evaluate household demand for reduced diarrhea risk through an assessment of willingness to pay (WTP) for water and sanitation technologies in Udaipur, India. Using data from a survey of 900 households, responses to a contingent valuation scenario were analyzed using multivariate logit regression to determine WTP for a water purification device. Furthermore, transcripts from 10 focus groups were analyzed for specific determinants of WTP for a ceramic filter, an open well chlorination tank, and a composting latrine by identifying preferences based on the frequency and type of responses given by group participants. The mean WTP estimated from the logit model was $1.03; this is the monthly WTP amount per person in this sample. The specific determinants for WTP include the randomized price levels, and factors like education level and household socio-economic characteristics. In addition, the qualitative work did not reveal a clear preference by all groups for any one of the three offered technologies, but demonstrated the influence of factors such as perceived health improvement and increased convenience on demand. Understanding what drives demand for these technologies could help implementers in designing more effective behavior change interventions, educational campaigns or social marketing schemes.
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1. Introduction

Improving access to clean drinking water and sanitation remains a top health concern in many low and middle income countries. Nearly 1 billion people worldwide lack access to improved water sources and almost 1.3 million children die of water related illness annually (MDGs, 2013). Despite longstanding efforts by the Indian government, drinking water supply and sanitation continues to be inadequate; 92 million still collect drinking water from unimproved sources while 792 million do not have access to sanitation facilities (WHO & UNICEF, 2012). Not surprisingly, diarrheal diseases are a common cause of death and disability across the country, especially in the under-five age group (WHO, 2010). Until adequate drinking water coverage is achieved, there is a definite need for incremental improvements in water supply and sanitation, although adoption and continued use remains low among susceptible populations.

In 2013, an interdisciplinary research collaboration was established between Duke University, Seva Mandir (Udaipur based NGO) and the Indian Institute of Management-Udaipur. The ultimate goal of this collaboration is to better understand what drives adoption of improved cook stoves (ICS), as well as how the uptake of ICS can affect demand for household water treatment. Although the current focus of the study is on ICS, the ICS promotion campaign will eventually be followed by a water or sanitation based intervention. It is therefore useful to measure demand for different water/sanitation technologies at this point in time to improve the chances of a successful
intervention later on. Thus, this study will aim to evaluate demand, guided by two research questions: 1) What is household willingness to pay (WTP) to reduce disease risks for diarrhea, and 2) What are the specific determinants for WTP?

1.1 Background and Significance

Historically, much of India’s struggles in improving access to drinking water were directly linked to an inefficient, centralized government that failed to manage the developing needs of a growing population. The introduction of the Water Sector Reform Policy in 2000 was meant to be a stepping stone for decentralizing the provision of services by placing more power in the hands of local governments. However, it has become clear that local officials lack sufficient abilities to control and manage the current infrastructure, as well as the financial means to make improvements to the system (Starkl, Brunner, & Stenstrom, 2013). Moreover, when the public funding is available, it is mostly spent on the rehabilitation of poorly maintained water systems instead of adding much needed infrastructure (Chaplin, 2011).

Programs aimed at sanitation have also had their own challenges. India’s Total Sanitation Campaign (TSC), launched in 1999, aimed to eliminate the practice of open defecation by 2012 through the promotion of latrine construction in rural areas. Additionally, the TSC initially included a focus on social mobilization and behavior change activities to try and encourage adoption and continued use of the improved facilities (Patil et al., 2014; S. K. Pattanayak et al., 2009). However, while the program
was meant to be a demand driven, community-centered approach, it ended up being quite the opposite: government led, supply driven, and subsidy based. Meanwhile, population growth continued to outpace latrine construction during the same period (Hueso & Bell, 2013). The program was ultimately labeled as a failure by the Indian government and has since been rebranded as Nirmal Bharat Abhiyan in 2012; meanwhile, the practice of open defecation in rural areas continues to occur at staggering rates.

1.1.1 The Need for Technologies

For the millions of people in India who still lack access to improved water sources and sanitation, diarrheal diseases remain a constant issue. However, the range of technologies available for improving access to clean water and sanitation is extensive, and the vast majority are meant to be low-cost, readily available, and easy to use (Albert, Luoto, & Levine, 2010). For example, point of use (POU) water treatment technologies are meant to combat water contamination at the household level and include methods like boiling, liquid hypochlorite solution, disinfectant powders, solar disinfection, and various types of filtration devices. POU treatment has consistently demonstrated improvements in the microbial quality of household water, thereby reducing the burden of diarrheal disease by about 30% in users (Clasen & Menon, 2007). Meanwhile, improved sanitation technologies are mostly concerned with the proper management of human excreta, which is generally achieved through the promotion of various types of
pit latrines or pour-flush toilets that discharge to septic tanks (Norman, Pedley, & Takkouche, 2010). Other hygiene related interventions are also promoted to reduce the incidence of diarrheal illness (e.g. hand washing promotion), although they will not be explored in this study.

Since diarrheal diseases are transmitted through multiple routes, one intervention alone may not be enough to completely stop the spread of illness (Clasen, Schmidt, Rabie, Roberts, & Cairncross, 2007). Various meta-analyses and systemic reviews have been conducted to measure the effectiveness of various WaSH interventions in reducing diarrheal illness, although they each present conflicting results regarding which types of interventions are most effective (Clasen et al., 2007; Esrey, Feachem, & Hughes, 1985; Fewtrell et al., 2005; Norman et al., 2010). That said, these conflicting results could certainly be due to differences across comparison groups, or heterogeneity among the combinations of interventions.

Regardless of the quantification of impacts from each technology type, the fact remains that WaSH related morbidity and mortality will remain high until sufficient water and sanitation infrastructure is achieved in India. Until that time, targeted, interim approaches that result in health gains for the population are necessary. That being said, the effectiveness of each health intervention requires correct and consistent use of the technology in question. Less frequent or non-use is not only associated with an
increased incidence of diarrheal disease, but can also largely diminish the health benefits recognized from use of these technologies (Clasen et al., 2007; Waddington et al., 2009).

The various environmental, health, and economic losses associated with inadequate drinking water supply and poor sanitation are well known, yet adoption and continued use of water and sanitation technologies remains hard to achieve (Starkl et al., 2013). The fact remains that acceptance and usage remains low among susceptible communities, and there is little indication as to how consumers can be convinced to use the technologies (Luoto et al., 2012). The bottom line here is that unless demand for these products increases, it is unlikely that the burden of diarrheal illness will decrease, in India or elsewhere.

1.1.2 Why Measure Demand?

Water and sanitation interventions have historically been top down and supply driven, largely ignoring local contexts and user preferences in the design and execution of infrastructure projects (Chaplin, 2011; Hueso & Bell, 2013). Not surprisingly, this type of approach has resulted in numerous failed projects and lost investments, and many are now looking towards more demand driven, community centered interventions instead. However, in order to implement demand driven projects, it is first necessary to understand consumer preferences for the different technologies available, especially when considering how to properly market the products (Subhrendu K. Pattanayak & Pfaff, 2009; Poulos et al., 2012).
There are other potential reasons for why demand for these technologies remains low. Some say that the problem begins with design frameworks that do not take sustainability of the proposed outcome into account. This is evidenced by the fact that few interventions have allocated time for follow up evaluations to examine subsequent impacts of the study (deWilde, Milman, Flores, Salmeron, & Ray, 2008). Furthermore, it is not uncommon for the use of household water treatment technologies to diminish over time due to broken equipment, lack of replacement consumables, or simple reversion back to former behaviors once the intervention has ended (Hensher, Shore, & Train, 2005; Luoto et al., 2012).

Other studies point to the fact that behavior change interventions, such as educational campaigns or social marketing, may be necessary to stimulate demand for water treatment products (Somanathan, 2010). These technologies, although effective and relatively easy to use, do offer their own challenges. For instance, there is a wait time associated with using many of the products (e.g. when using filters, flocculent powders or chlorine tablets) that may deter people from using them. Additionally, the use of chlorine tablets is often associated with a bad taste, which may make people less likely to use them (Clasen et al., 2012; Jeuland, Fuente, Ozdemir, Allaire, & Whittington, 2013). Any of these factors, along with price, can also affect the demand for these treatment products.
It is evident that more research focused around the needs and wants of the consumers is needed. Moreover, understanding the reasons that households choose to use certain treatment products could also be useful in promoting more effective advertisement of available products (S. K. Pattanayak et al., 2009). Existing literature has made it clear that there are significant barriers to the adoption of these technologies. It seems that the standard intervention method is not persuasive enough to convince people that change is necessary for health outcomes to be recognized. Therefore, understanding what drives demand for these technologies is imperative to ensure future success in implementation.
2. Methods

For this study, I will utilize a mixed methods approach to test the hypothesis that household WTP for reduced diarrheal risk depends not only on the price of the technology offered, but also on existing health behaviors, water quality perceptions, prior WaSH education, and other socio-economic factors. To investigate this relationship, I will first utilize a stated preference methodology called contingent valuation to determine household willingness to pay for a water purification device. Meanwhile, I will utilize qualitative data from focus group transcripts to further indicate specific determinants of WTP by identifying preferences for different technologies based on the frequency and type of comments made by group participants.

2.1 Setting

Udaipur is located in the Northwestern state of Rajasthan and is home to roughly 600,000 people. The district is made up of seven sub-divisions, which are further divided into units called tehsils. Around 50% of Rajasthani tribespeople reside in Udaipur, including the Bhils, Minas, Sahariyas, and the Damors, among others (City of Udaipur, 2013). These tribespeople subsist mainly off of agricultural activities and often live on less than $0.35 per day (Seva Mandir, 2013).

2.2 Procedures

The qualitative portion of this research was conducted from June through August 2014 in eight rural villages across Udaipur district. Focus group participants
were segregated by gender to reduce the likelihood that women would be talked over, and to encourage them to give their true opinions regarding the technologies. At the outset of each focus group discussion, participants were told in detail about the objectives of the study and were asked to give verbal consent to proceed with the discussion. If the participant did not want to give consent, they were asked to leave the room.

Each group was conducted in Hindi by a trained professional, who then also back-translated the discussion to English so that it was possible to follow along and take notes. In addition, a recording device was used throughout the conversation and each separate transcript was later translated to English. The quantitative survey data was collected in the summer of 2013 and was used as secondary data for this study. All study procedures were approved by the ethical review boards at Duke University and the Indian Institutes of Management-Udaipur.

2.3 Contingent Valuation Method

The contingent valuation method (CVM) is one of the most common techniques used to quantify the value of health outcomes in low and middle income countries. Using CVM, household demand can be captured using a set of hypothetical pricing schemes that measure how much consumers are willing to pay for a health improvement. Furthermore, CVM allow researchers to determine the value of goods that
have not yet been provided, as they are not typically bought and sold in the marketplace (Carson, Flores, & Meade, 2002).

CVM has been around for over 50 years and thousands of studies have been published on the topic. Within the domain of environmental health, studies using CVM are focused around environmental benefits such as improved water quality (Orgill, Shaheed, Brown, & Jeuland, 2013), reduced risk from contaminants, and the establishment of piped water systems in developing countries (Briscoe, de Castro, Griffin, North, & Olsen, 1990; Whittington, Briscoe, Mu, & Barron, 1990; Whittington, Pattanayak, Yang, & Bal Kumar, 2002). In terms of measuring the economic value of interventions like these, there are two standard measures: willingness to pay (WTP) and willingness to accept (WTA). WTP is the measure used when the consumer in question does not own the good, whereas WTA is appropriate when the consumer has the good and is being asked to give it up (Carson, 2000). Since we are concerned with the technology adoption issue, this paper will focus on WTP.

Historically, WTP surveys were implemented with open ended willingness-to-pay questions such as “what is the maximum price you would pay for X?” However, since the mid-80s, most surveys now used close ended questions wherein consumers are asked to value a product by accepting or rejecting specific dollar amounts (Hanemann, 1994). Phrasing the questions in this way helps researchers to move away from the abstract and hypothetical issues that CVM can pose; in this way, the value of the
intervention is based on a more specific and realistic situation. Much has been said regarding the importance of careful study design and implementation, and critiques of the method are widespread (Carson, 2000; Whittington, 2002). Thus, best practices were adopted to try and reduce various validity threats, such as hypothetical bias, enumerator bias, yea-saying, and strategic bias. For instance, both the survey and focus group guides were pretested to ensure they were understandable and realistic; furthermore, enumerators were carefully trained to conduct the surveys and focus groups and were asked to read descriptions in their entirety and not skip over or shorten important sections. In addition, enumerators were instructed to reduce the chance of certain biases by encouraging respondents to answer truthfully throughout the survey and focus group execution.

2.3.1 Data and Analysis: Quantitative

The data used in the quantitative analysis comes from a household survey conducted across 900 households (60 villages) from August – October 2013 in Udaipur, India. For my analysis, I will utilize a specific section of the survey that focuses on the reduction of risk for respiratory and diarrheal illnesses. Since I will only be focusing on diarrheal illness for the remainder of this report, I will only be focusing on those questions that ask about household WTP for a water purification device. This particular device is presented as decreasing the two-week diarrhea risk for a community from 10% to 5% (i.e., a 50 percent reduction in the risk of diarrhea).
As noted before, the demand for water supply improvements incorporates dimensions such as convenience of use, reliability, aesthetics, and cost. The purpose of the contingent valuation exercise carried out in the survey was to measure demand for diarrheal risk reductions that would not be contaminated by other features. As such, respondents were asked to imagine a hypothetical water purification technology that was costly but that would not affect these other features of their drinking water supply.

Besides conducting simple analyses of the relationship between price and willingness to pay for the water purification device, this paper also considers household-level characteristics hypothesized to be associated with demand, using multivariate regression methods. The specific explanatory variables for willingness to pay were chosen based on findings from previous literature that speaks to the demand for preventive health improvements. For instance, household with young children who are susceptible to diarrhea and believe that it can be prevented with the purification device may be more willing to pay. Dissimilarly, if they perceive their current water quality as safe already and/or they don’t believe that diarrhea can be prevented, they may be less willing to pay. Thus, the determinants included in the model encompass socio-demographic and socio-economic variables (education level, gender, household size, number of children under 5, etc.), as well as any current knowledge/behaviors for preventing disease risks (e.g. hand-washing, boiling water, or using other treatment products). The empirical model is:
\[ Y_i = \beta_0 + \beta_1 P_i + \beta_2 X_{1i} + \beta_3 X_{2i} + \ldots + \beta_n X_{ni} + \epsilon_i \]

In this simple logit model, \( Y_i \) is a dichotomous variable that is equal to 1 if respondent \( i \) accepted the price offer for a water purification device, and 0 if otherwise. Independent variables \( X_{1i} \) through \( X_{ni} \) include household-specific factors such as such as diarrheal incidence, adult education, head of household gender, and others that can influence demand for reducing disease risks (see Table 1 for more complete information on these variables). The beta coefficients indicate the average effect of each independent variable on the probability of accepting the price offer. \( \epsilon_i \) is the error term.

The regression output from this equation is then used to estimate the average willingness to pay in U.S. dollars by integrating the estimated demand curve (which is assumed to take an exponential form) over all prices wherein the probability of household \( i \) accepting the device at a price of 0 is:

\[ \text{WTP}_i = \frac{-e^{X_i \beta}}{\beta_p} \]

### 2.3.2 Data and Analysis: Qualitative

The data I will use for my qualitative analysis comes from focus group transcripts conducted across eight villages in rural Udaipur. Each of the focus groups was about an hour long and focused on six key areas: community challenges, environmental issues, incidence of several illnesses (including diarrheal disease), a ranking exercise for current environmental issues, the willingness to pay assessment, and priorities for moving out of poverty. A particular focus for this analysis will be on
the demand assessment, which was conducted for three separate technologies: a ceramic filter, an open well chlorination tank, and a composting toilet. Judging from results published in meta-analyses in the literature (Fewtrell et al., 2005; Waddington and Snilstveit, 2009), the first two technologies are expected to decrease the two-week diarrhea risk for a community from 10% to 7%, or by about 30%.

For each demand assessment conducted in the focus groups, participants were shown a picture of the technologies and was asked whether or not they were willing to pay a low, medium, or high price. The order, price, and type of technology was randomized to each group beforehand. Specific to the chlorination tank technology, participants were also asked to sample water that had been treated with chlorine disinfection tablets according to the manufacturer’s instructions. Respondents were not only asked to consider the price of the technology, but also whether or not they perceived the technology as useful, and whether they valued a reduction in diarrheal disease risk.

Based on these factors, each group member was asked to cast a private, anonymous vote of “yes” or “no” for each of the technologies at the randomized price points. After the voting was completed, each group was de-briefed to understand the reasons they were willing or not-willing to pay for technology. For this part of the analysis, we categorize specific comments related to the determinants of demand (price,
health improvement, understanding, etc.), indicate their frequency, and discuss any specific preferences expressed for particular technologies.
3. Results

3.1 Describing the Sample

Table 1 presents descriptive statistics for key variables from the household survey. The average household size is 5.6 people, and almost half of the sample (43%) had children under the age of five. The vast majority of respondents come from the scheduled tribe designation, and the average years of education among adults was between 9 and 12. Just over half (51%) of the population are using public water sources such as hand pumps, surface water, or public wells.

As far as water and sanitation behaviors are concerned, 95% report using some form of water treatment, but household water treatment drops to about 1% when simple filtration (using a cloth or sieve to filter water) is not included. Furthermore, 77% of respondents use an unsafe water removal method (pouring water directly from the drinking vessel or touching the water with their hands). The vast majority of respondents had received some WaSH messages before, and similarly, believed that diarrhea could be prevented. Furthermore, when measuring perceptions about the safety of drinking water on a scale of 0 to 10, respondents put an average of 6.4 (and 3.6) stones in a safe (and unsafe) pile; this suggests that respondents consider their drinking water to be somewhat safe.
Table 1: Descriptive Statistics for Key Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Units</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accepted WTP offer</td>
<td>= 1 if yes, 0 if no</td>
<td>880</td>
<td>0.57</td>
<td>0.50</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>WTP price</td>
<td>300, 500, 1000 or 2500 Rs.</td>
<td>900</td>
<td>1162</td>
<td>902</td>
<td>300</td>
<td>2500</td>
</tr>
<tr>
<td>Household size</td>
<td>Average across sample</td>
<td>902</td>
<td>5.59</td>
<td>2.03</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>No. of children under 5 years</td>
<td>Average across sample</td>
<td>902</td>
<td>0.43</td>
<td>0.66</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Gender of household head</td>
<td>= 1 if female, 0 if male</td>
<td>902</td>
<td>0.03</td>
<td>0.18</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>General/open caste</td>
<td>= 1 if yes, 0 if no</td>
<td>902</td>
<td>0.07</td>
<td>0.26</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Scheduled caste</td>
<td>= 1 if yes, 0 if no</td>
<td>902</td>
<td>0.03</td>
<td>0.17</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Scheduled tribe</td>
<td>= 1 if yes, 0 if no</td>
<td>902</td>
<td>0.83</td>
<td>0.38</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Average adult (&gt;18 years) education level</td>
<td>Years of schooling</td>
<td>902</td>
<td>3.10</td>
<td>3.25</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>No. of rooms in household</td>
<td>Average across sample</td>
<td>900</td>
<td>5.05</td>
<td>1.34</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Electricity at least sometimes</td>
<td>= 1 if yes, 0 if no</td>
<td>869</td>
<td>0.64</td>
<td>0.48</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Monthly consumption spending (Rs.)</td>
<td>Average across sample</td>
<td>879</td>
<td>6112</td>
<td>3633</td>
<td>1100</td>
<td>54600</td>
</tr>
<tr>
<td>Public drinking water source</td>
<td>= 1 if yes, 0 if no</td>
<td>902</td>
<td>0.51</td>
<td>0.50</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Private drinking water source</td>
<td>= 1 if yes, 0 if no</td>
<td>902</td>
<td>0.47</td>
<td>0.50</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Treats drinking water</td>
<td>Using any treatment other than 'none'</td>
<td>887</td>
<td>0.95</td>
<td>0.21</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Using treatment other than simple filtration</td>
<td>= 1 if yes, 0 if no</td>
<td>902</td>
<td>0.01</td>
<td>0.09</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Using unsafe water removal method (from container)</td>
<td>= 1 if yes, 0 if no</td>
<td>890</td>
<td>0.77</td>
<td>0.42</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Received some WaSH message before</td>
<td>= 1 if yes, 0 if no</td>
<td>902</td>
<td>0.99</td>
<td>0.10</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Believe diarrhea can be prevented</td>
<td>= 1 if yes, 0 if no</td>
<td>894</td>
<td>0.98</td>
<td>0.15</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Perception that drinking water is safe (0-10)</td>
<td>At least 1 candy in safe pile</td>
<td>897</td>
<td>6.42</td>
<td>1.93</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>No. of household members with diarrhea</td>
<td>Past two weeks</td>
<td>902</td>
<td>0.69</td>
<td>0.89</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total days lost to diarrhea</td>
<td>Due to most recent illness</td>
<td>902</td>
<td>2.34</td>
<td>5.34</td>
<td>0</td>
<td>53</td>
</tr>
</tbody>
</table>
3.2 Responses to the Price Offers

Figure 1 indicates the WTP responses for the water purification device at four randomized price levels. Not surprisingly, both lines indicate a downward sloping demand curve, which means that respondents are less likely to be willing to buy the purification device as the price increases. The upper green line illustrates the percentage of respondents that accepted each of the randomized prices. Meanwhile, the lower blue line illustrates the percentage of respondents that were certain or very certain that they would accept the price offer. In the analysis that follows, we use the certain or very certain demand responses to obtain conservative estimates of true WTP, given concerns over hypothetical bias.

Figure 1: Willingness to Pay for Water Purification Device (USD/yr)
### 3.3 WTP Model

Table 2 illustrates the results of the simple logit model for WTP. As expected and consistent with the results shown in Figure 1, the randomized price has a statistically significant and negative relationship with being willing to pay for the purification device. Average years of adult education and number of rooms in the household are also significant and positively correlated with accepting the price offer, as expected, since these variables indicate higher socio-economic status and likely greater awareness of the value of disease prevention. The belief that diarrhea can be prevented is also positively correlated with accepting the price offer. Mean WTP obtained from this model is $1.03 per person per month.

**Table 2: Logit Model Results**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Logit coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>WTP price (Rs.)</td>
<td>-0.045***</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
</tr>
<tr>
<td>Survey order effect (=1 if WTP for diarrheal disease risk reduction was asked first)</td>
<td>0.274*</td>
</tr>
<tr>
<td></td>
<td>(0.160)</td>
</tr>
<tr>
<td>Household size</td>
<td>0.059</td>
</tr>
<tr>
<td></td>
<td>(0.042)</td>
</tr>
<tr>
<td>No. of children under 5 years</td>
<td>-0.057</td>
</tr>
<tr>
<td></td>
<td>(0.111)</td>
</tr>
<tr>
<td>Gender of household head</td>
<td>-0.567</td>
</tr>
<tr>
<td></td>
<td>(0.496)</td>
</tr>
<tr>
<td>Lower caste (excluding general caste)</td>
<td>-0.476</td>
</tr>
<tr>
<td></td>
<td>(0.371)</td>
</tr>
<tr>
<td>Average adult (&gt;18 years) education level</td>
<td>0.112***</td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
</tr>
<tr>
<td>No. of rooms in household</td>
<td>0.129*</td>
</tr>
<tr>
<td></td>
<td>(0.066)</td>
</tr>
</tbody>
</table>
### 3.4 Determinants of Demand: Qualitative Findings

Similar to what was reported in Table 2, the randomized WTP price continues to be the most significant indicator for why participants were willing or not willing to pay for the technology. Of the 10 groups, 7 gave various reasons related to price for why they voted for or against the technologies. In most cases, the respondents who voted against the technologies were not able to afford the high price, which is indicated in comments like “We people don’t have Rs.4000 to spend on this technology,” or “[The]
technology is good, but it’s too expensive.” On the other hand, sometimes the price was a good thing: “… even if they have to pay a [high] price, they want to get secure from the diseases,” or “If this technology is available [for] Rs.500, then it’s worth it.”

The second most frequent indicator for why participants voted for or against the technologies was the health improvement factor. Four out of the 10 groups pointed to health improvement as a defining reason for votes in favor of the technologies. Most of the comments were centered on the fact that the water would be cleaner, and thus diseases will be reduced: “We find it good because after drinking this water, we will not fall ill,” or “Because the dirty water will get cleaned through this filter, it will reduce the chance of having diarrhea.” One man in particular was especially forward thinking in commenting on future benefits/cost savings from using the technology: “People have voted in favor because they want to prevent the water borne diseases from which they can suffer in a year, and if they will prevent the chances of suffering from diseases it will reduce their chances of visiting the doctor again and again, and will save their money and also reduce their physical troubles.”

The third most common factor influencing voting behavior had to do with a lack of understanding; this was indicated in 3 out of the 10 groups. It is important to note here that lack of understanding can be categorized in differing ways. For instance, sometimes a group member truly did not understand the technology, as noted by comments like “There [is] a problem in understanding the technology,” or “[Could] be they have not understood the technology as they came late.” In other instances, participants
commented that others in their village would not understand the technology, specific to the latrine: “People at our place will not understand this technology much. It’s good that it doesn’t need water, but people will not understand this.” Furthermore, sometimes respondents did not understand why we were asking them to give reasons for voting against the technology: “How can we know the opinion or reasons of some other person?”

Lastly, there were a few references to issues of convenience or safety, which were indicated by 2 of the 10 groups. In particular, convenience was associated with distance: “We think that the any women can go there and bring water from there,” or “Those who have a well, [the] tank will be built near them and people living nearby can access its water, but those who are living at a distance, for them it would be difficult to go and bring water from there, so they would have voted no.” Another important issue of note here regarding the open well tank system was that the taste of the chlorinated water did not serve as a barrier for the respondents. In particular, when asked what the water tasted like respondents reported that “The taste was a bit different, but it’s alright to drink,” or “It’s not a bad taste.” One woman even said that ‘The water [tastes] sweet once the medicine is added.” Women respondents also suggested that privacy and safety were attractive features of the latrine technology.

The voting exercise did not provide a clear ranking of technologies across these eight villages. Aggregating the total percentage of “yes” responses to the WTP offers for each of the three technologies (across all three price levels since samples are small
otherwise), the open well tank system was only slightly more popular than the other technologies, with 54.6% of the respondents indicating that they were willing to pay. The next most popular was the ceramic filter with 48.3% indicating that they were WTP, followed closely by the composting latrine at 47.0%.
4. Discussion

To design and implement more sustainable WaSH interventions in the future, it is necessary to collect and analyze information on consumer demand for the different technologies. This analysis utilized a mixed methods approach to evaluate demand for reduced diarrhea risk by estimating WTP for a water purification device. The mean WTP estimated from the logit model was $1.03 for a 50% reduction in diarrheal disease risk, which indicates the average monthly WTP amount per person among households in rural Udaipur. This result is comparable or lower than estimates from other similar studies. In a study conducted in Dhaka, Bangladesh, average WTP for a CrystalPur filter was lower, at $1.09 per household (Luoto et al., 2012), while in Cambodia average WTP for a month of chlorinated water was about $3 per household (Orgill et al., 2013). Furthermore, another study conducted in southern India using conjoint analysis methodology found that the predicted choice probabilities for a month’s worth of chlorine tablets ranged from $0.71 to $5.00 (Poulos et al., 2012).

The specific determinants for WTP include the randomized price level, various socio-economic factors like education level and household characteristics, as well as factors such as the potential for a reduced risk of diarrhea (health improvement), and convenience. Both the quantitative and qualitative results point to the importance of household budget in making health expenditure choices, which is understandable as many households in rural Udaipur face liquidity constraints. Furthermore, household
knowledge is an important factor in decision making. Greater education and awareness of the benefits of preventive health behavior translate into better understanding of the influence of environmental quality on health, and greater perceived value for behaviors that reduce disease risks (Subhrendu K. Pattanayak & Pfaff, 2009). Thus, it was not surprising that average adult education was positively correlated with accepting the price offer.

The focus group results do not indicate a clear preference for one particular technology over another; the open well tank was only slightly preferred compared with the ceramic filter or the composting latrine. In about half of the focus group villages, open wells were the main public source of water, and the vast majority of the groups had been exposed to chlorine tablets through previous government or NGO campaigns, so this slight preference may reflect greater familiarity with the technology. In addition, respondents did not appear bothered by the taste of the sample water. Nonetheless, the sample sizes are small, and the focus groups were not representative, so any differences in the number of “yes” votes should not be attributed to the differences in technologies. In addition, some of the women’s groups were more interested in the latrine for reasons of privacy and safety.

4.1 Implications for policy and practice

These results have several implications for increasing the adoption and use of water and sanitation technologies in lesser developed countries. In particular,
understanding the determinants that drive WTP could help implementers in designing more effective behavior change interventions, educational campaigns or social marketing schemes (S. K. Pattanayak et al., 2009; Somanathan, 2010). Furthermore, demand assessments could also be useful in forming regional advertisement campaigns, which would raise awareness about unknown technologies. Finally, these results could be used to design and plan more successful future water and sanitation interventions in this region.

4.2 Study limitations

Due to the small focus group sample size, it was not possible to infer a clear preference for the water or sanitation technologies offered. In addition, it proved very difficult to convince participants to take the voting exercise seriously; so, it was necessary to debrief participants after the voting exercises by probing about characteristics that they did or did not like about the technologies. For instance, participants might vote yes for a technology but then in the debriefing say that it was too expensive for them to afford. This debriefing exercise was an important way for me to re-tally the votes based on the group’s true opinions about the technology in question.

Furthermore, these findings are also not generalizable to other states or districts within India. Udaipur district in particular has a large NGO presence, and the NGO partner in this study, Seva Mandir, has been working in and around the various districts of Rajasthan for decades. The organization itself is well-known and well-respected
across the region, which may not be the case in other areas without a strong NGO presence. Seva Mandir’s extensive work throughout this district speaks to the existing education regarding WaSH practices among the respondents, and could have potentially influenced how some participants responded to the survey and focus group discussions.
5. Conclusion

This study examined household WTP to pay to reduce diarrheal disease risks, as well as what the specific determinants of WTP. The average WTP for a water purification device that could reduce the risk of diarrhea by 50% was $1.03 per person per month. The specific determinants identified were the randomized price levels, and factors like education level and household socio-economic characteristics. In addition, the qualitative work linked the importance of factors such as perceived health improvement and increased convenience on demand. Based on these findings, it is recommended that further research should focus on evaluating household demand before a technology is implemented, so as to increase the chances of long term technology adoption and usage by susceptible communities.
References


