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User preferences and willingness to pay for safe drinking water: Experimental evidence from rural Tanzania

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ABSTRACT

Almost half of all deaths from drinking microbiologically unsafe water occur in Sub-Saharan Africa. Household water treatment and safe storage (HWTS) systems, when consistently used, can provide safer drinking water and improve health. Social marketing to increase adoption and use of HWTS depends both on the prices of and preferences for these systems. This study included 556 households from rural Tanzania across two low-income districts with low-quality water sources. Over 9 months in 2012 and 2013, we experimentally evaluated consumer preferences for six "low-cost" HWTS options, including boiling, through an ordinal ranking protocol. We estimated consumers' willingness to pay (WTP) for these options, using a modified auction. We allowed respondents to pay for the durable HWTS systems with cash, chickens or mobile money; a significant minority chose chickens as payment. Overall, our participants favored boiling, the ceramic pot filter and, where water was turbid, PuR™ (a combined flocculant-disinfectant). The revealed WTP for all products was far below retail prices, indicating that significant scale-up may need significant subsidies. Our work will inform programs and policies aimed at scaling up HWTS to improve the health of resource-constrained communities that must rely on poor-quality, and sometimes turbid, drinking water sources.

1. Introduction

In 2014 inadequate and unsafe drinking water was responsible for over half a million deaths from diarrheal diseases; in Africa 25% of all deaths in children under 5 years of age were attributable to diarrhea (Prüss-Ustün et al., 2014; Fischer Walker et al.,2012). Rural areas of Sub-Saharan Africa suffer from limited access to improved water sources and high risk of fecal contamination in drinking water. Household water treatment and safe storage (HWTS) has been proposed as an intermediate solution to provide safer drinking water and reduce the burden of disease (WHO/UNICEF, 2008; Wolf et al., 2014).

Whether or not HWTS systems are a scalable intervention for poor rural populations is an area of active policy debate (Schmidt and Cairncross, 2009; Schmidt, 2014). Low rates of consistent use have been observed for several types of HWTS systems, (Luby et al., 2008; Brown et al., 2009) and finding the best method to promote adoption and consistent use is an active area of research (Parker Fiebelkorn et al., 2012). In particular, social marketing research has found that consumer preferences and viable price points strongly influence effective demand and the likelihood of consistent use (Evans et al., 2014). This has led to several studies on user perceptions and willingness to pay for HWTS products (Luoto et al., 2012; Albert et al., 2010; Poulos et al., 2012).

This study experimentally investigates which HWTS systems rural households prefer and why they prefer them. We also

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estimate willingness to pay (WTP) for HWTS products, and compare them with user preferences. We do not evaluate water quality effects or health impacts. We assessed preferences and price points for only those HWTS systems that are known to be effective when correctly and consistently used.

We located our study in rural Tanzania, where 56% of the population does not have access to an improved water source (WHO/UNICEF, 2014). The Tanzanian government has concluded that piped and treated water will not be viable for rural areas for some years, and that HWTS should be scaled up as an intermediate strategy (MHSW, 2014). Credible information on which HWTS systems to scale up is critical for any future social marketing and product dissemination (Evans et al., 2014).

We experimentally evaluated user preferences and willingness to pay for six HWTS approaches. The preference for boiling has not been compared to other HWTS preferences in previous research, despite its high global usage relative to other treatment technologies (Rosa and Clasen, 2010; Ahuja et al., 2010; Amrose et al., 2015). We found few journal articles that compared several HWTS products, for either user preferences or WTP (e.g. Luoto et al., 2011, 2012; Albert et al., 2010). The literature on preventative health products indicates that users' willingness to pay, even when they are liked, is generally low; the evidence suggests that unfavorable opinions would be consistent with low valuations (i.e. WTP) and lower usage rates (Luoto et al., 2011; Ashraf et al., 2007; Dupas, 2011).

Based on this research, we went into the field with the following hypotheses:

(H_1) Households prefer boiling to the retail HWTS products.
(H_2) Households' WTP for HWTS products reflects their preferences.

The HWTS market is nascent but not absent in Tanzania. We focused on those HWTS systems that are already available, to assess which have the greatest potential for widespread adoption and sustained use without the need for a completely new supply chain (see below for the selection criteria).

Our study adds four new features to the user preference and WTP literatures on safe drinking water in low-income countries. First, this is the first study we are aware of to compare user preferences for boiling, a non-commercial and common practice, to those for retail-based water disinfection products. Second, we created a simple ordinal preference ranking protocol across many households and many HWTS methods; our protocol is innovative in that it explicitly solicits categorization of HWTS systems into 'like' or 'dislike', in addition to overall rankings. Third, we estimated WTP using a real auction; this is the first study to identify, and (partially) explain, discrepancies between expressed preferences and willingness to pay for HWTS. Fourth, to minimize respondent dropout, we allowed respondents to pay for the durable HWTS products with cash, mobile money or chickens. In this cash-poor rural economy, chickens are often sold when a little extra money is needed. Our work is relevant for social marketing programs and public health policies aimed at scaling up HWTS in resource-constrained communities that must rely on poor-quality, and sometimes turbid, drinking water sources.

2. Materials and methods

2.1. Site selection

We chose one predominantly Muslim, coastal-region district (Kisarawe) and one predominantly Christian, interior-region district (Geita), thus covering a range of cultures and geographies in Tanzania (Supporting Information (SI) Fig. S1). From each district we obtained a list of five "water challenged" villages, i.e., those in which water had to be fetched from unimproved sources, which had had recent outbreaks of waterborne illnesses, and where the median socio-economic status (SES) was similar to that for rural Tanzania. Two villages in each district matched our criteria and had village leaders willing to work with us (SI Fig. S2). Each village was at least a four-hour drive from the other village in the district, minimizing the risk of spillovers during the study. In each case we discussed our research goals and protocols, and the right of households to refuse to participate, with the village leadership.

Our field team included several of the authors and ten local enumerators whom the lead authors trained in survey techniques and ethical research practices. We visited study households in August of 2011 to conduct a baseline survey of household assets, construction material for houses, water access, fuel usage, education and income. We compared the baseline data with Census of Tanzania (2012) averages for all rural households (SI Table S2). The data show that our study villages were slightly better off than rural Tanzania overall. Latrine coverage was close to 90%, suggesting that poor sanitation should not attenuate the beneficial health effects of safe drinking water.

2.2. Sampling strategy

We conducted our own household census in all four villages prior to the baseline survey. We defined a household as a family group that shared meals and lived in the same compound, with one nominal head, i.e. an adult male or female with the authority to make decisions concerning medium-sized household purchases, such as buckets, shoes and clothing. Therefore one compound could accommodate more than one household, such as the families of three adult brothers who shared many activities but made their own spending decisions.

We covered the entire geographic areas of all the villages for the census, attempting to enumerate all of the households. This census was our sampling frame. We randomly selected our sample households, by name, at open meetings in every village, to reassure the residents that our selection process was fair. Our final sample size was 276 households for Geita and 280 for Kisarawe. The samples were large enough to detect a 10% difference across any two HWTS systems in the proportion of households that liked them, at the 95% confidence level (SI Fig. S3). We collected our data over nine months, starting in May of 2012.

2.3. The six HWTS options

Guided by the Tanzanian Ministry of Health, we selected the study HWTS options according to four criteria:

1) *Low cost.* We set the ceiling for the price of consumables at 4% of the median expenditure per capita (Amrose et al., 2015; Hutton, 2012), and the full price of durables at 33% of the median monthly household expenditure (National Bureau of Statistics Ministry of Finance, 2014). This yielded a maximum retail price of TZS 22 (TZS 1590 = USD 1 in 2012) per liter of water treated for consumable HWTS products (assuming 2 L per person per day for drinking); and TZS 57,000 for a durable HWTS product (National Bureau of Statistics Ministry of Finance, 2014).
2) *Commercially available in Tanzania.* The expansion of an existing supply chain is less challenging than the creation of a new product market.