

## Willingness to Pay for Cleaner Water in Less Developed Countries

**3ie Synthetic Reviews – SR 006**  
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## 1. Background

Diarrheal diseases kill around two million children every year. Consequently, the United Nations' Millennium Development Goal of reducing the under-five child mortality rate by two-thirds is only achievable if diarrhea-related mortality can be drastically reduced. To do so, expanding access to safe water will be crucial since unsafe water is a major vector for diarrheal pathogens.

A variety of technologies have been developed to address this problem in areas where piped water from a central supply is not available, such as urban slums or rural areas with dispersed settlements.<sup>1</sup> Point-of-use (POU) water treatment methods including locally-produced ceramic filters, dilute chlorine, solar disinfection, combined flocculation-disinfection systems, and the age-old practice of boiling are intended to make water microbiologically safe to drink. Especially when combined with safe storage containers that prevent recontamination by allowing users to access water without actually touching it (such as by opening a tap instead of using a dipper), POU water treatment methods can substantially improve the quality of drinking water. POU water treatment methods have been shown to reduce diarrhea among children by anywhere between 20 and 70 per cent.<sup>2</sup>

In recent years, a number of reviews have summarized the growing literature on water quality interventions that reduce the burden of diarrheal morbidity and mortality in poor countries. The medical effectiveness of point-of-use water treatment in particular has been well established (Arnold and Colford, 2007; Clasen *et al.*, 2007; Fewtrell *et al.*, 2005). However, reviews and meta-analyses of studies intended to assess biomedical impacts of interventions feature study designs intended to generate high levels of uptake over short periods (accomplished via weekly or daily reminders by fieldworkers). This sort of intensive approach is intended to ensure that take-up of the interventions is high enough to allow health effects to be measured, but such efficacy studies do not reflect the conditions in which interventions are likely to be implemented outside the research study. As noted in White and Gunnarsson (2008), such impact evaluations do not provide actionable guidance to policymakers about how to implement beneficial interventions because they rely on interventions that are too expensive to be sustainable at scale.

In practice, the health benefits of POU water treatment methods will depend on private demand for health and health products, which will ultimately determine whether or not those who could benefit from POU water treatment will adopt and consistently use these methods. Moreover, the cost-effectiveness of such interventions depends crucially on institutional design and delivery mechanisms. In contrast to the science behind POU water treatment, which is fairly well-established, the factors that influence demand for cleaner water are not well understood.<sup>3</sup> Valuation of health, and cleaner water, can

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<sup>1</sup> In this paper, we focus on water quality improvements rather than increases in the available quantity of water, which might also be important for child health. In some cases, such as when a new borehole well is sunk or piped systems are extended to new users, improvements in quantity and quality go hand-in-hand. We include such cases in this paper, but do not focus on willingness to pay for water quantity per se.

<sup>2</sup> The large literature on the epidemiological efficacy of point-of-use water treatment technologies has been summarized by a number of review articles, most recently one under preparation for the International Initiative for Impact Evaluation (Waddington *et al.*, 2009). See also Arnold and Colford (2007), Clasen *et al.* (2007), Fewtrell *et al.* (2005), White and Gunnarsson (2008), and Zwane and Kremer (2007).

<sup>3</sup> A number of theoretical models for understanding the diffusion of new technologies and preventative behaviors provide a helpful framework for thinking about the issues but do not fully address the particularities of the demand for cleaner water.

inform policy decisions about how to increase use rates of these biomedically effective products. This is the subject of this review.

## **2. Objectives**

Our proposed review will expand upon and complement several existing summary articles on the medical efficacy of water quality interventions by focusing on willingness to pay for cleaner water, an outcome that is rarely addressed in the efficacy literature but which is an important determinant of whether or not water quality improvements are likely to result in health gains. Ultimately, absent subsidies from governments or other organizations, interventions to improve water quality will only be sustainable if potential users' valuations of cleaner water is greater than the cost.

A number of papers have considered willingness to pay for water in less-developed countries, but the focus has primarily been on quantity of water rather than quality, though the two are often intertwined as in the case of increasing access to a centralized piped system. Willingness to pay for cleaner water generated by POU water treatment methods has received much less attention, even as there has been increasing enthusiasm about this approach in the development community (WHO, 2002).

This paper will provide the first summary of experimental evidence on willingness to pay for cleaner water in less developed countries. We focus on studies in which prices are randomized and demand is based on real purchase decisions, rather than contingent valuation in hypothetical situations. We draw lessons from the existing literature to point the way forward on this important topic.

## **3. Methods**

### **3.1 Selection criteria**

We include studies of water quality interventions that assess willingness to pay in less developed countries, as defined by the World Bank's list of low- and middle-income countries. We focus on these countries because citizens of high income countries are rarely expected to pay for water quality improvements themselves (other than through taxes). In contrast, in less developed countries governments are often unable, as in the case of dispersed rural settlements, or unwilling, as in the case of informal settlements in urban areas, to pay for cleaner water for their citizens. Point-of-use water treatment systems have been designed to address this need in less developed countries, but in most cases users are expected to bear the costs.

The interventions considered in this review offer households the opportunity to purchase or use various technologies for improving drinking water quality, with exogenous variation in the price of the technology. All methods of improving water quality will be included, ranging from point-of-use technologies such as filtration, chemical treatment (chlorination), solar disinfection, and flocculants to source water quality improvements such as spring protection or the expansion of piped water systems.

The interventions included are intended to affect the proportion of households who choose to purchase or use a water quality improvement technology at different prices, thus making it possible to measure willingness to pay for cleaner water. Therefore, the primary outcome is the willingness to pay. Special attention will be paid to whether or not a price randomization or data collection method could have had direct or secondary effects on willingness to pay estimates. Such effects could be in the form of

courtesy or social desirability bias, which can be caused by putting a household's decisions under unusual scrutiny.

We will include studies that make use of randomized variation in prices (either across groups or across time for a single group, but ideally both), real purchase decisions, and objective measures of use of water quality treatment methods (such as checking for the presence of chlorine in the water or measuring contamination levels in the drinking water supply). A few examples of studies which meet these inclusion criteria are Ashraf, Barry, and Shapiro (2008), Kremer *et al.* (2009), and Devoto *et al.* (2009). We will include any duration of follow-up from the point at which subjects are exposed to random variation in prices. Studies are not required to have a control group *per se*, but there must be at least two different prices to which subjects are randomly assigned. For example, we would include a study that described the results of a distribution of coupons for either 50 per cent or 100 per cent off the market price of a water quality improvement, as long as the coupons were randomly distributed, even if there were no data from a control group who did not receive a discount. This methodology excludes contingent valuation studies, which are based on decisions in hypothetical situations, and discrete choice analyses. Some examples of studies that would be excluded from our analysis on these bases are McConnell and Rosado (2000), Mu, Whittington, and Briscoe (1990), and Jalan, Somanathan and Chaudhuri (2003).

### 3.2 Search

The literature search for this review included four methods of locating relevant studies, including: keyword searches in various academic literature databases, a review of articles addressing the efficacy of different water treatment technologies, contact with researchers in the field to inquire about existing unpublished studies or ongoing work with upcoming results, and an examination of references listed in bibliographies of published works.

#### *Database search*

We will conduct a literature search for papers that measure willingness to pay for water quality improvements in less-developed countries (defined by the World Bank's list of low- and middle-income countries) using experimental or quasi-experimental methods. The databases listed in Table 1 below will be searched using all combinations of the following search terms.

**Table 1: Databases and search terms**

Databases	Search Terms
Cochrane Library Google Scholar IDEAS LILACs Medline PubMed Web of Science	ONE OF: clean water, drinking water, clean drinking water, drinking water quality  AND ONE OF: willingness to pay, willingness-to-pay, valuation, demand

#### *Review papers on water quality improvements*

In addition to the literature search described above, we will access all of the papers on water quality improvements identified for inclusion in an updated synthetic review of diarrhea prevention interventions in less developed countries (Waddington *et al.*, 2009). We will note whether or not any measure of willingness to pay for the intervention was

included as an outcome variable in the analysis, and if so, whether the method of estimating willingness to pay was experimental or non-experimental.

### *Contact researchers*

We will also contact researchers who have published on the topic of water quality improvements in less-developed countries and asked for references on unpublished work, to avoid publication bias in our summary. We will ask researchers to indicate if they or other colleagues were currently working on relevant studies, in order to allow us to incorporate new work which has not yet been published.

### *Cross-check bibliographies*

As a final step, bibliographies of relevant papers uncovered through the first three search steps will be cross-checked for other citations that might also meet the search criteria.

## **3.3 Data collection**

Data collection was determined based on the search method utilized. Paper titles identified through the database searches will be examined for appropriateness by two researchers, with any conflicts resolved by a third researcher. If, through the title examination, the paper is deemed appropriate, then the paper will be downloaded to our shared directory. Papers will then be examined for discussion on whether the study did indeed measure willingness to pay and the method of eliciting WTP (experimental or non-experimental). No further information will be collected from studies using non-experimental methods, such as contingent valuation. If the study used experimental methods, then further data will be collected on the study location, the water quality improvement, sample size (number of households), length of exposure to water quality improvement prior to willingness to pay measurement, any additional details specific to the experimental design, and the WTP results. A process similar to this one will be implemented in cross-checking bibliographies for additional relevant papers.

All papers listed in the abovementioned updated synthetic review of diarrhea prevention interventions in less developed countries, will be assessed for the existence of a WTP component. If a WTP component was included in the study, then it will be noted whether experimental or non-experimental studies were used. Details on WTP from these efficacy studies will be included, such as: study location, water quality improvement, willingness to pay estimation method, sample size (number of households), and length of exposure to water quality improvement prior to willingness to pay measurement.

When contacting researchers in the field, we will ask them specifically for information on unpublished or ongoing experimental studies, indicating that our study would not include contingent valuation studies. When researchers inform us of new results or upcoming working papers, we will ask for permission to cite their preliminary results.

## **3.4 Statistical analysis**

We will carry out a statistical meta-analysis of all included studies where the results are judged to be sufficiently homogeneous. The synthetic review will include annexes with tables on the studies included from willingness to pay evidence from efficacy studies and studies included from willingness to pay evidence from experimental studies. These tables will compare studies based on: study location, water quality improvement,

willingness to pay estimation method, sample size (number of households), and length of exposure to water quality improvement prior to willingness to pay measurement.

## 4. Timeframe

**Table 2: Timeline for submitting deliverables**

Deliverable	Date
Search and application of inclusion criteria	February-March 2009
Extraction of data from included studies	March 2009
Analysis	March 2009
Draft review submitted to 3ie	April 30, 2009
Second draft of review submitted to 3ie	June 30, 2009
Revised draft of review submitted 3ie	October 30, 2009

## 5. Study team

### 5.1 Study team members' background

**Michael Kremer** is the Gates Professor of Developing Societies in the Department of Economics at Harvard University and Senior Fellow at the Brookings Institution. He is a Fellow of the American Academy of Arts and Sciences, a recipient of a MacArthur Fellowship and a Presidential Faculty Fellowship, and was named a Young Global Leader by the World Economic Forum. Kremer's recent research examines education, health, and water in developing countries, immigration, and globalization. He and Rachel Glennerster published *Strong Medicine: Creating Incentives for Pharmaceutical Research on Neglected Diseases*, which won the Association of American Publishers Award for the Best Professional/Scholarly Book in Medical Science in 2004.

**Robyn Meeks** is a doctoral candidate in Public Policy at the Harvard Kennedy School of Government. Robyn's research interests include access to water and sanitation, and, more broadly, environmental and development economics. Robyn has a bachelor's degree in political science from Brown University and an M.E.M. in water resources management from Yale University. As a Fulbright recipient, she researched tariff collection in rural water supply systems in the Kyrgyz Republic. Robyn has consulted for the Energy and Environment Group at the United Nations Development Programme (UNDP), performed research on climate change mitigation and adaptation for the United Nations Framework Convention on Climate Change (UNFCCC) and the World Bank, and interned at Resources for the Future.

**Edward Miguel** is associate professor of economics and director of the [Center of Evaluation for Global Action](#) at the University of California, Berkeley, where he has taught since 2000. He earned S.B. degrees in both economics and mathematics from MIT, and received a Ph.D. in economics from Harvard University, where he was a National Science Foundation Fellow. Ted's main research focus is African economic development, including work on the economic causes and consequences of violence; the impact of ethnic divisions on local collective action; and interactions between health, education, and productivity for the poor. He has conducted field work in Kenya, Sierra Leone, Tanzania, and India. Ted is a Faculty Research Associate of the National Bureau of Economic Research, Associate Editor for the *Quarterly Journal of Economics*, *Journal of Development Economics* and *Review of Economics and Statistics*, recipient of the 2005 Alfred P. Sloan Fellowship, and winner of the 2005 Kenneth J. Arrow Prize awarded annually by the International Health Economics Association for the Best Paper in Health Economics.

**Clair Null** is assistant professor of global health in the Rollins School of Public Health at Emory University. She received her Ph.D. in Agricultural and Resource Economics from the University of California, Berkeley, where she was a National Science Foundation Fellow, in 2009. Prior to graduate school, she was a Research Assistant in the Emerging Markets Section at the Federal Reserve Board of Governors in Washington, DC. As a development economist, her research interests include willingness to pay for water and sanitation services, and the health impacts of low-cost technologies for improving water, sanitation, and hygiene.

**Alix Peterson Zwane** is a Program Officer in Global Development at The Bill and Melinda Gates Foundation. Prior to her work at the Gates Foundation, Alix managed the health and water component of a larger initiative at google.org, the philanthropic arm of Google Inc, which works to use information to improve the quality of public services for the poor. Zwane was also previously a member of the department of Agricultural and Resource Economics at UC at Berkeley, where she performed randomized impact evaluations of water and health interventions. She received her PhD in Public Policy from Harvard University in 2002.

## 5.2 Experience specific to synthetic review

- Content: Kremer, Miguel, and Zwane have been researching and writing on related topics for over five years, contributing a wealth of knowledge about water quality improvements in less developed countries. Meeks has a master's degree in water science, policy, and management and is currently writing a dissertation on access to water in less developed countries. Null's dissertation also included a chapter on the topic.
- Systematic review methods: Kremer and Zwane have prior experience writing a systematic review.
- Statistical analysis: Kremer, Miguel, Null, and Zwane have graduate degrees in economics, whereas Meeks is working towards a degree in public policy. Both of these fields require extensive training in statistical methods.

## 6. Conflict of interest

Kremer, Miguel, Null, and Zwane are affiliated with the Kenya Rural Water Project, a series of randomized interventions to study cost-effective ways of preventing diarrhea by improving water quality. Results from the Kenya Rural Water Project are relevant to the topic of the review and will be included in the analysis.

Kremer and Zwane have previously published a review article on the related topic of cost-effective strategies to prevent childhood diarrhea (Zwane and Kremer, 2007).

## 7. References

- Ashraf, N., J. Berry, and J. Shapiro. 2008. "Can Higher Prices Stimulate Product Use? Evidence from a Field Experiment in Zambia," [American Economic Review](#), forthcoming.
- Arnold, B. and J. Colford. 2007. "Treating Water with Chlorine at Point-of-Use to Improve Water Quality and Reduce Diarrhea in Developing Countries: A Systematic Review

and Meta-Analysis," *American Journal of Tropical Medicine and Hygiene* 76(2): 354-364.

Clasen, T., W. Schmidt, T. Rabie, I. Roberts, and S. Cairncross. 2007. "Interventions to Improve Water Quality for Preventing Diarrhoea: Systematic Review and Meta-Analysis," *British Medical Journal* 334: 782-91.

Devoto, F., E. Duflo, P. Dupas, V. Pons. 2009. "Happiness on Tap: The Demand for and Impact of Piped Water in Urban Morocco," working paper.

Fewtrell, L., R. Kaufmann, D. Kay, W. Enanoria, L. Haller, and J. Colford. 2005. "Water, Sanitation, and Hygiene Interventions to Reduce Diarrhoea in Less Developed Countries: A Systematic Review and Meta-Analysis," *Lancet Infectious Diseases* 5: 42-52.

Jalan, J., E. Somanathan, and S. Chaudhuri. 2003. "Awareness and the Demand for Environmental Quality: Drinking Water in Urban India," working paper:  
<http://www.isid.ac.in/~planning/workingpapers/dp03-05.pdf>

Kremer, M., J. Leino, E. Miguel, and A. Zwane. 2009b. "Spring Cleaning: Rural Water Impacts, Valuation, and Institutions," NBER working paper 15280:  
<http://www.nber.org/papers/w15280>

Waddington, H., B. Snilstveit, H. White, L. Fewtrell. 2009. "Water, Sanitation, and Hygiene Interventions to Combat Childhood Diarrhoea in Developing Countries," Synthetic Review 001, International Initiative for Impact Evaluation, New Delhi.  
<http://www.3ieimpact.org/admin/pdfs2/17.pdf>

White, H. and V. Gunnarsson. 2008. "What Works in Water supply and Sanitation? Lessons from Impact Evaluations," Document of the World Bank.

Zwane, A. and M. Kremer. 2007. "What Works in Fighting Diarrheal Diseases in Developing Countries? A Critical Review," *World Bank Research Observer* 22: 1-24.