Promoting Latrine Use and Improving Child Health: Design and Baseline Findings from a Randomized Evaluation of a Community Mobilization Campaign in Bhadrak, Orissa

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ABSTRACT

Objective: To present the study design and baseline findings of a randomized controlled intervention to decrease child morbidity and mortality associated with diarrhea by increasing the demand for and use of individual household latrines in the state of Orissa, India.

Design: Cluster-randomized controlled trial with repeated measures on households. The sample included 40 representative villages from a sampling frame of 1112 villages in the district of Bhadrak. Under random assignment, 20 villages received an intensive community social mobilization (CLTS) campaign and the remaining villages served as controls. Data collection from approximately 25 households per village was secured through the use of local enumerators trained by our research staff. Across the 40 villages, 1086 households (treatment = 534, control = 552) were surveyed; the same set of households will be surveyed post-intervention.

Setting: Chandbali and Tihidi blocks, Bhadrak district, Orissa India, 2005.

Participants: Respondents who self-identified as the primary care giver of a child below the age of 5 years provided data for the household survey. Key informants (*i.e.*, village elders, teachers) provided information on village infrastructure and characteristics.

Results: Baseline findings suggest that randomization successfully distributed potential confounders across experimental conditions; some differences across condition are identified and these will be controlled for analytically in the impact analyses.

Conclusions: The Orissa evaluation will provide important information on the effectiveness of information and education campaign efforts to alter the demand for individual household latrines and promote household and community sanitation and hygiene practices.

INTRODUCTION

Inadequate water and sanitation infrastructure coupled with unsafe hygiene behaviors are collectively responsible for high diarrhea incidence, especially in children (Hughes et al. 2001, Wang 2002, WHO 2002). The most recent data available suggest that Orissa has one of the highest infant mortality rates (IMR) as well as diarrhea prevalence among major Indian states with an IMR of 81 per 1000, under-five mortality of 104 per 1000, and diarrhea prevalence of 28 % for children under-3 years (ORC 2000). A recent meta-analysis by Fewtrell et al. (2005) found that five types of interventions (hygiene education, water supply improvements, water quality improvements, sanitation, and multiple interventions) can reduce diarrhea prevalence in children, with relative risk estimates ranging from 0.63 to 0.75. Nevertheless, many questions still persist, including on the effectiveness of sanitation interventions in particular, and mechanisms for convincing households to build and use toilets.

The Government of India has adopted a nationwide Total Sanitation Campaign (TSC) which is intended to improve sanitation conditions throughout the country. Nevertheless, sanitation coverage remains low to date – in India as a whole, less than 25% of the population has access to safe water and sanitation (DDWS 2004), and this is less than 10% in the state of Orissa (ODS 1998-99) – the location of our study. These low levels of sanitation may contribute to poor health outcomes and high child mortality (Wang 2002, Murray and Lopez 1996).[2] Several key knowledge gaps limit our understanding of these persistent sanitation and health challenges, thereby limiting current efforts to overcome these challenges and promote better sanitation, health, and development in Orissa and beyond.

What do we aim to achieve in this study?

This paper presents the study design and baseline findings of a community-level randomized controlled intervention to increase the demand for and use of individual household latrines (IHL), and thus, decrease child morbidity in rural Orissa, India. The study is designed to address several knowledge gaps regarding persistent sanitation and health challenges as follows.

First, the study provides important information on the links between sanitation improvements and health outcomes. Fewtrell et al. (2005) identified only four studies conducted between 1970 and 2003 that examined the effect of sanitation interventions on health (diarrhea or cholera) outcomes in developing countries. Of these four studies, only one (Daniels et al. 1990) was considered to by of good quality by

[2] For example, Luby et al. (2006) show that efforts to raise awareness of the association between hand and water contamination and poor health outcomes result in significantly less diarrhea (50% – 65%) compared to persons living in control neighborhoods. Similar findings have been reported from programs in peri-urban and rural settings (Quick et al. 2002, Crump et al. 2005)

the meta-analysis team. While the Daniels et al. study did find that latrine installation significantly reduced diarrhea rates in the study area (rural Lesotho), Fewtrell et al. (2005) highlight the need for additional studies examining sanitation interventions in different contexts.

Second, the intervention we study employs a unique combination of social mobilization techniques aimed at generating demand for sanitation and motivating behavior change at the household level. While the need for these "participatory" and "community-based" approaches to development is now well accepted (e.g., Cairncross 2003), there is little rigorous measurement of the effectiveness of community-based approaches (Mansuri and Rao 2004). The design of this study allows us to evaluate the impact of one community-based intervention package on sanitation and health outcomes.

Third, the infectious nature of diarrheal diseases (and the associated externalities) suggests that households may not find it in their own self interest to engage in socially optimal prevention (and cure) if they believe they can "free ride" on the contributions of others (Beach et al. 2006). As Gersovitz and Hammer (2003) argue, prevention and infection externalities are important in infectious disease transmission. Behaviors, such as the adoption of preventive practices, that are independent of the epidemiological channels can help blunt (or exacerbate) the negative externalities and these behaviors are, in turn, dependent on preferences as well as the availability of information and education on hygiene. Unfortunately, there are no known rigorous econometric estimates of the nature and extent of these externalities. We can estimate these directly by using detailed data on knowledge, prevention, and infection that is collected at the household and community levels at different points in time.

Fourth, by employing one of the most rigorous impact evaluation methods (a randomized cluster trial), we respond to recent calls for careful and systematic assessment of interventions for economic development (Duflo and Kremer 2004). In the water and sanitation sector in particular, there have been no peer-reviewed rigorous scientific impact evaluation that utilize some mix of control groups, baselines, and covariates to establish the counterfactual scenario and permit the estimation of program impacts (McKenzie and Ray 2005, Poulos et al. 2006).

Finally, we use the results of this study to shed light on the drivers of households' latrine adoption decisions. Notwithstanding significant global attention on household water and sanitation behaviors, there is astonishingly little formal conceptual modeling by economists of seemingly mundane, universal and routine (daily) behaviors. We sketch a theory of health- and sanitation-related behavior change, highlighting a number of factors that may affect the perceived costs and benefits of adopting a new behavior. The model is relevant to a general class of choices made by households to reduce their exposure to environmental risks such as water contamination through microbial pathogens and air pollution (indoor and ambient), which are blamed for some of the most pernicious health problems - malaria, diarrhea, ARI - in the developing world (Smith et al. 1999). The infectious nature of these diseases (and the associated

public good problem) creates the rationale for public policy analysis and the design and use of social incentives such as the social mobilization campaign in Bhadrak, Orissa. We explain how the intervention employed in this study incorporates aspects of this theory, and use the theory to analyze the impacts of this campaign.

CONCEPTUAL FRAMEWORK

A Shift from Supply-Driven to Demand-Driven Development

Despite decades of donor and government financed infrastructure to improve water and sanitation conditions, many rural households in developing countries lack adequate coverage. Some have concluded that ownership and investment (*i.e.*, demand) by the local population is needed if a program is to be sustainable. This sustainability factor has long been overlooked in development because supply-driven interventions have tended to measure success in terms of program outputs (*e.g.*, latrines built), rather than in terms of project impact (*e.g.*, reduction in open defecation) [Kar 2003].

Accordingly, reform efforts in water and sanitation policy have attempted to remedy coverage and sustainability problems by promoting bottom-up, demand-driven programs. Unlike the previous generation of development projects, demand-driven efforts are based on the assumption that the keys to increasing program coverage include effective behavior change strategies to increase program adoption and community empowerment efforts to increase sustainability. These campaigns have been effectively employed in developing countries (Quick 2003, Rowland et al. 2002, Mong et al. 2001) and offer economic advantages in increasing coverage of government sponsored public health initiatives to economically and geographically marginalized populations (Kikumbih et al. 2005, Kar 2003), for example, describes a community-led total sanitation effort in Bangladesh that employed children as change agents and used recognized diffusions principles (Barker 2004, Oldenburg et al. 1997, Dearing 2004) to increase coverage and acceptance of key program goals. Quick (2003) reports on water treatment efforts in three African nations; these efforts included individual behavior change and community mobilization and resulted in meaningful improvements in safe water handling practices.

The Theory of Household Behaviors

Demand-driven programs recognize that health behaviors are driven by value expectancy (Strecher 1997). They include components designed to influence household demand by altering the structure of costs and benefits from the perspective of the end user. If local stakeholders and community members do not recognize the benefits of improving basic water safety and hygiene, if they do not perceive themselves as capable of executing the intended behavior, or if they view costs and barriers as too high, they will be less likely to embrace program activities. In order for this explanation to have any

practical meaning or predictive power, we need a better understanding of the "benefits" and "costs" that households consider. Thus, this study is guided by a generalizable theory of health- and sanitation-related behavior change, which is grounded in economic theory (utility maximization subject to constraints) and informed by psychological theories of behavior change (non-market aspects of sanitation improvements, including dignity, privacy, and security). Appendix A presents a detailed exposition of this theory.

Based on this theory and its predictions regarding the factors that affect the perceived costs and benefits of adopting an IHL (as well as hygiene behaviors), we hypothesize that the demand for IHL will increase where:

1. inputs to IHL construction, including time and materials, are subsidized
2. village residents' technical knowledge regarding IHL construction is enhanced to improve the quality of IHL
3. non-health aspects of IHLs such as dignity, privacy, and security are perceived by village residents
4. health impacts of IHL are well understood by village residents
5. economic benefits of improved health are well understood by village residents (e.g., fewer lost work days and lost wages due to illness or caregiving responsibilities, increases in expected earnings for children)
6. village residents' expectations about the behavior change of others in the community

The theory also guides the data collection strategy by identifying and describing how the intervention is expected to affect household preferences. While the theory predicts that the health benefits will be borne largely by children, it predicts that the non-health benefits will be borne largely by women.

The Government of India's Total Sanitation Campaign

The Government of India developed the Total Sanitation Campaign (TSC) in response to studies indicating that obtaining a private latrines was associated with an individuals' attitudes regarding the value of ownership (Ministry of Rural Development 2004). The TSC was developed to be a demand-responsive, 'community led' and 'people centered' reform program that would be implemented by state governments such as the Government of Orissa (GoO). This approach has an empowerment focus that acknowledges the importance of individuals and communities in selecting and achieving goals. The strategy addresses all sections of the rural population, includes a wide range of community partners, and provides economic incentives to meet program and community needs. Current program efforts emphasize the development of information, education, and communication (IEC) activities to impact attitudes and knowledge relating sanitation, safe water, and hygiene to health. According to the logic of the program, increasing awareness of the connection among these health-related factors will lead to increased demand

for sanitary facilities. TSC also acknowledges the role of small subsidies, particularly to the poorer segments of the population, in encouraging adoption of behaviors (e.g., construction and use of IHLs). For example, the typical cost of construction for the type of latrine (off-pit) promoted under this campaign was Rs. 1500 (about US$30), of which households below the poverty line (BPL) were only required to pay Rs. 300 (about US$6).

GoO has a particular interest in the potential for TSC efforts to encourage the uptake of IHL and to reduce open defecation practices (UNICEF 2004, GoO 2004). It is believed that the success of the TSC and the increase in IHL coverage will lead to substantial reductions in the infant mortality rate related to diarrhea. To help it plan, the government piloted a version of the Total Sanitation Campaign of the Government of India in the 20 rural villages in the district of Bhadrak which is our intervention or treatment.

THE INTERVENTION: COMMUNITY-LED TOTAL SANITATION

The "intensification" of the TSC campaign draws many ideas from a model of "Community-led Total Sanitation" (CLTS) developed by Kamal Kar in Bangladesh (Kar 2003). Following a larger trend in development programs, the CLTS intervention relies on generating demand for improved sanitation through changing the "software" of knowledge, attitudes and practices, rather than simply providing latrine "hardware." Because Bhadrak's local government in the water and sanitation mission is comprised of engineers with little experience in these "software" activities, Delhi-based Knowledge Links was brought in to draw on its experience with CLTS and provide technical assistance to the Bhadrak intervention.

According to Kar (2003), the CLTS approach focuses on "empowering local people to analyze the extent and risk of environmental pollution caused by open defecation." More crudely, one Knowledge Links staff member explained that the approach used in Bhadrak boiled down to "getting people to realize that they are eating each others' shit." Knowledge Links believes that creating this kind of visceral experience for people is essential for affecting lasting behavior change. They argue that having this knowledge is not enough to motivate lasting behavior change. Instead, the CLTS approach seeks to generate strong, emotional responses at the community and individual level, culminating in a community-wide resolve to end open defecation by a community-defined target date.

According to the Knowledge Link Report, three main activities or CLTS "tools" were selected to form the core of the sanitation intervention in the study villages:

1. Core fecal count (i.e., calculating the volume of fecal material accumulated in a village)
2. Walk of shame (i.e., a community walk to identify current conditions)

3. Defecation mapping (i.e., understanding the spatial distribution of feces)

These tools were invariably preceded by repeated small 'focus group' discussions. Additionally, depending on community interests, technology options and the costs of diarrheal illness were also discussed. Indeed, the nature of the community-based, interactive intervention dictated that the specific content of the campaign differed from village to village. However, a similar protocol was followed across the 20 intervention villages and the end goal -- self-analysis of the sanitation situation leading to community consensus to end open defecation -- was the same. Knowledge Links worked with district government and village water, sanitation, and health committees (VHWSCs), formed as part of the intervention process, to implement the CLTS activities. Village production centers (PCs) were also established to provide the materials needed for latrine construction. Local NGOs served as "implementing agencies" in each village, and were often in charge of carrying out latrine construction.

In terms of the theory of latrine adoption outlined in the previous section, the CLTS intervention conducted in Bhadrak provides an exogenous source of variation affecting each of the broad factors we identified as potentially impacting demand for latrines (see Figure 1, a logic model of the intervention, for further clarification). First, CLTS subsidizes materials and labor for latrine construction. These subsidies for households below the poverty line are intended to relax the budget constraint and increase uptake by poor households, although we can interpret Knowledge Links' concern about subsidies as a fear of creating an endowment effect. Second, the campaign provides technical know-how to guide household construction of IHL. The supply of both materials and expertise are increased through production centers and NGOs in the villages. Third, the campaign places much emphasis on the non-health benefits of IHL use, such as dignity and privacy for women. Fourth, the campaign targets households' knowledge of the health risks associated with open defecation. While this intervention does not focus on "germ theory" education per se, providing other kinds of knowledge—for example, awareness of the total amount of feces in the village—is an essential part of the campaign.

Finally, CLTS attempts to budge social norms: essentially, CLTS is an attempt to move communities from one social norm (open defecation) to another (universal latrine use). To promote this new norm, CLTS motivators focus on increasing the perceived benefits of latrine use by emphasizing privacy and dignity as important values, and inducing individuals to feel ashamed when they violate this new norm. Importantly, the intervention explicitly targets villages, rather than individual households, and the stated goal of CLTS is to generate a community-wide agreement to end open defecation. Bringing village members together, establishing this common goal, and promoting a new set of norms that reinforce this goal, may allow households to overcome their collective action problem. Furthermore, CLTS encourages villages to establish systems for punishing "free-riders." Punishments can involve

monetary fines or social sanctions such as mocking or even throwing stones at those who continue to practice open defecation.

Thus, the focus of the CLTS intervention employed in Bhadrak addresses a broader set of barriers to latrine adoption than those considered by most previous campaigns, which tended to include more narrowly defined information campaigns as well as "supply-push" measures. The model outlined in the previous section emphasizes that while these knowledge and supply-side considerations may be necessary conditions for latrine adoption, they are not sufficient. In many cases, social norms and collective action problems present an additional set of barriers that must be addressed. It is this set of barriers that is squarely targeted by the CLTS intervention in Bhadrak.

METHODS

Overview of the Study Design

We applied a cluster-randomized design to assess the impact of the CLTS campaign on IHL coverage in the state of Orissa. In this experimental framework, villages rather than individuals are randomly assigned to treatment and control conditions, while the individuals within the villages remain the primary unit of observation. This is considered to be the best experimental design available whenever the evaluator wants to assess a program that operates at the group level, manipulates the social or physical environment, or cannot be delivered to individuals (Murray 1998, Donner and Klar 2000). As we are interested in whether IEC impacts individual behavior, the primary analyses for this study will evaluate a repeated-measures cohort model using a difference-in-difference (DID) estimator. Our evaluation will measure two primary outcomes: (a) uptake of IHL in response to the IEC intervention; and (b) change in reported rate of diarrhea. The study protocol was approved by several authorities including the Institutional Review Board at RTI International, an external technical oversight group comprised of leading public health agencies (*e.g.*, U.S. Centers for Disease Control and Prevention, the World Bank, UNICEF, and Indian Council of Medical Research) and a local steering committee from the Office of the Secretary of Rural Development in Orissa. Throughout the design stage of this study, the evaluation team worked closely with GoO as well as the IEC campaign implementation team to ensure consistency and coherence across all aspects of the study, including integrity of the design and measurement.

Sample Size Estimation

Sample size calculations indicated that 40 villages with 25 eligible households per village would provide sufficient statistical power (*i.e.*, 80% or greater) to identify meaningful differences between treatment and control villages on the primary outcome of prevalence of diarrhea among children younger

than five years. We assumed a base rate of 25% and an anticipated program effect of 0.30. Moderate attrition was considered and a design effect of 2.0 was introduced to account for variance inflation.

Sample Selection

Within the state of Orissa, the coastal district of Bhadrak (see Figure 2) served as our study area for three reasons: (1) Bhadrak still has a sufficiently large number of blocks and villages without any TSC related interventions; (2) the use and maintenance of latrines in the area remains unsatisfactory despite adequate water availability; and (3) the GoO indicated that no special water, sanitation or hygiene programs would be implemented in 'control' villages during the study period.

Within Bhadrak, we established a sampling frame of 1112 villages, excluding those with less than 70 or more than 500 households to ensure that included villages would be similarly 'rural' and would provide enough households with at least one child under the age of five. We also considered measures to reduce the potential of spillover effects. For example, we grouped the villages by panchayat[3] and selected one village per panchayat. Next, we spatially mapped all villages in the sampling frame and removed from the selection process contiguous villages. Next, we selected villages that were accessible via roadways and avoided areas where political issues could affect survey implementation. The final sample frame was of 490 villages from which we randomly selected 40 villages, and randomly assigned 20 of them to the "treatment" group and the rest served as "controls." Figure 3 shows a map of the study area and the location of our treatment and control villages.

Data Collection

Instrument Design. We developed the survey instruments in three stages. First, we developed a preliminary household survey instrument based on existing survey instruments (ORC 2000, Grosh and Glewwe 2000, GoI 2005, Pattanayak et al. 2001, Pattanayak et al. 2004), literature reviews of various WSH studies, and inputs from local advisors. We developed the community questionnaire based on the household questionnaire and information gathered during previous field trips. Village-level information is collected on WSH related projects, other community-based projects, land use, socioeconomics, and village institutions in the community questionnaire. Second, we finalized the household and community questionnaires through focus group discussions with selected individuals, key informants, and households. Third, we pre-tested the household and community questionnaires in the field to identify any problems with the content, length, and flow of the instrument.

For the purposes of interpretation, we created "knowledge scales" to assess respondents' understanding of the causes, symptoms, and danger signs of diarrhea. For dangers signs of diarrhea, an open ended question asked respondents to report all know indicators (we find that respondents listed 0-3

[3] Panchayats are groups of about 3-6 villages that are linked administratively and interact frequently.

danger signs). A similar approach was employed to assess knowledge of symptoms of diarrhea (range = 0–6). For causes of diarrhea, respondents were queried (agree or disagree) on a set of 12 potential causes. Of the 12 items, eight items represents valid causes of diarrhea and the remaining four items were distracters. The scale score for causes of diarrhea was calculated by summing the number of valid causes correctly identified and subtracting one point per distracter item endorsed (range = 0–8).

Survey Implementation. We worked with an international survey organization, with substantial local experience and presence, to recruit and train approximately 30 local enumerators, supervisors, and water quality personnel, all of them with at least a bachelor's degree and fluent in the local language. The survey was implemented by three teams of six members; each team consisted of 5 enumerators and a supervisor. One field executive supervised all three teams. A listing and mapping team identified the eligible households (< 5 year old children) within the 40 villages prior to the survey. From each village, supervisors of each team randomly selected 28 households from the sampling frame generated by the mapping and listing process. At each household, enumerators interviewed the primary care giver (usually a mother) for children under 5 years whenever possible. This was done to ensure the most accurate information on child health and child sanitation and hygiene practices. Survey teams sent completed questionnaires to trained editors who scrutinized questionnaires prior to data entry. Validity and accuracy were maintained through spot checks, range checks, consistency checks, and skip pattern checks.

We also collected household and community water samples to test for total coliform and escheria coliform (E. coli) contamination. We collected water samples from approximately 50% of the surveyed households selected randomly and up to 10 samples from in-use community water sources. Samples were collected, stored and transported in iceboxes in a cycle of less than 24 hours. All sampled were transported to a lab in Kolkata that used a membrane filtration method to test these water samples using a 1 ml volume and using CHROMagar media to culture the bacteria colonies.

BASELINE RESULTS

A total of 1086 households were surveyed, 534 from the treatment villages and 552 from the control villages. As Table 1 indicates, treatment and control groups are similar in terms of most demographic characteristics. Following our intention to interview primary caregivers of young children, the majority of respondents were female (94%). The religious affiliation of the majority of households was Hindu (97%) and slightly more than half of the respondents report that they live below the poverty line (58%).

Table 2 reports attitude and knowledge variables for villages in the treatment and control groups. Survey items assessed perceptions of cleanliness and safety, attitudes about future improvements, interest

in building private latrines, as well as knowledge relating to diarrhea. No significant differences between households in treatment and control villages are evident. Across treatment and control villages an average of 40% of respondents endorsed a statement indicating the village was 'very dirty.' Similar levels of satisfaction with the current sanitation situation were reported in both treatment and control villages, with 67% of respondents 'completely dissatisfied' with current practices. Knowledge related items assessing key symptoms of diarrhea, treatment of diarrhea, and causes of diarrhea reveal no systematic differences between households in the two intervention conditions.

Table 3 compares base rates of key hygiene practices and community involvement. Water safety, garbage disposal, waste water disposal, and handwashing practices of both children and adults are similar in treatment and control village. Community participation rates are similar across experimental conditions, with slightly more than one-third of household (36%) participating in a Gram Sabha (village council) meeting. Community participation measures reflect that involvement in public sanitation efforts (*e.g.*, helped sweep streets) are generally low and similar in treatment and control villages.

However, significant differences between treatment and control villages are evident for defecation practices and diarrhea prevalence. Households in control villages report less open defecation and, obviously, a greater proportion of IHL usage than households in treatment villages. Twenty-eight percent of the under 5 children in the treatment villages experienced diarrhea 2 weeks prior to the survey whereas 24% in the control villages.

Other community level indicators reported in Table 4 indicate similarity between treatment and control villages with regard to number of under 5 children, average house and farmland values, water consumption, water quality problems, awareness of TSC, assistance under public schemes or programs, and village services. However, treatment villages do appear to be slightly "worse off" along a few dimensions, such as distance from all-weather roads and ownership of consumer durables like TVs and cell phones.

DISCUSSION

In this section, we first discuss some of the methodological implications of the baseline results and how our study design can address these issues. Then, we explore how well the study is poised to address its overall objectives.

The results of the baseline survey suggest that on the whole, randomization was successful in distributing many of the potential confounding factors that may influence the impact analysis. Respondents are similar across treatment and control villages in terms of household demographics, as well as knowledge, attitudes, and practices related to hygiene and sanitation.

Our findings also reveal two important differences across treatment and control groups that randomization could not balance. First, the outcome of interest – level of IHL ownership and use – is lower is treatment group compared to that in the control group. Second, the main indicator of health impact – under 5 diarrhea rate – is lower in the control villages compared to that in the treatment villages. Therefore, through simple luck of the draw it appears that the baseline situation in treatment villages was slightly worse than in control villages according to a few key indicators prior to the intervention.

Our study collected an extensive baseline data so that these pre-existing differences can be controlled for in estimating program impacts. We use a repeated measures methodology with a difference-in-difference estimator of program effects that can subtract out any baseline differences in the treatment and control villages (Maris 1998)

The baseline results indicate that the study is well poised to provide a rigorous answer regarding the effectiveness of a demand-driven sanitation sector reform effort. The framework of the design includes cluster randomization and overcomes a number of limitations identified by Fewtrell as well as our own review of the extant literature. These limitations include: (a) accounting for baseline diarrhea rates and pre-intervention behaviors, (b) the inclusion of control groups, (c) explicit examination and control for confounders, and (d) detailed reporting and presentation of results. The baseline results specifically indicate that the study can answers to the following knowledge gaps we identified in the introduction.

First, the study provides important information on the links between sanitation improvements and health outcomes. Although this objective will be better met when the endline data is available, even the simple comparison in Table 3 shows that control villages have higher IHL use, less open defecation, and lower rates of diarrhea compared to the treatment group.

Second, the CLTS intervention we study employs a unique combination of social mobilization that generates ‘demand for or uptake of’ the toilets at the community level and motivating behavior change at the household level to increase the ‘use’ of the toilets.

Third, we identify that households may not find it in their own self interest to engage in socially optimal prevention (and cure) because they can “free ride” on the contributions of others.

Finally, we use the results of this study to shed light on the drivers of households’ latrine adoption decisions. The results of the baseline survey identify current attitudes and practices regarding hygiene and sanitation. For example, costs of IHL seem to be the major constraint to uptake of this intervention. Most households that defecate in the open report they have no other defecation option and that the biggest constraint to using an IHL is expense. Additionally, when households that say they want to build an IHL are asked why they have not done so, most say cost. However, it may be the case that households are overestimating the true monetary costs of IHLs. Our data indicate that households with an IHL

overestimate the true costs by as much as Rs. 4000. And yet, even with accurate information many people still would be unlikely to build a private latrine without financial assistance as they believe the government has a responsibility to provide sanitation facilities to households, or at least help subsidise the costs of these facilities.

While cost appears to be a major factor, discussions with key informants also suggest that cheap private latrines can be more of a burden to a household, and can have greater negative health consequences than alternative practices. Although most households that report owning a latrine have built a permanent structure, ventilation within an IHL is rare. We have not yet analyzed the relationship between quality of latrines, their level of use, and the health effects in the study area. Given the prevalence of poor quality toilets and the fact that usage rates by men and children are low, it is possible that households have a negative perception of IHL because of the proliferation of poor quality toilets in their villages. This type of negative perception can decrease demand within the population and usage rates if poor quality latrines are built.

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Figure 1. Logic Model of Program

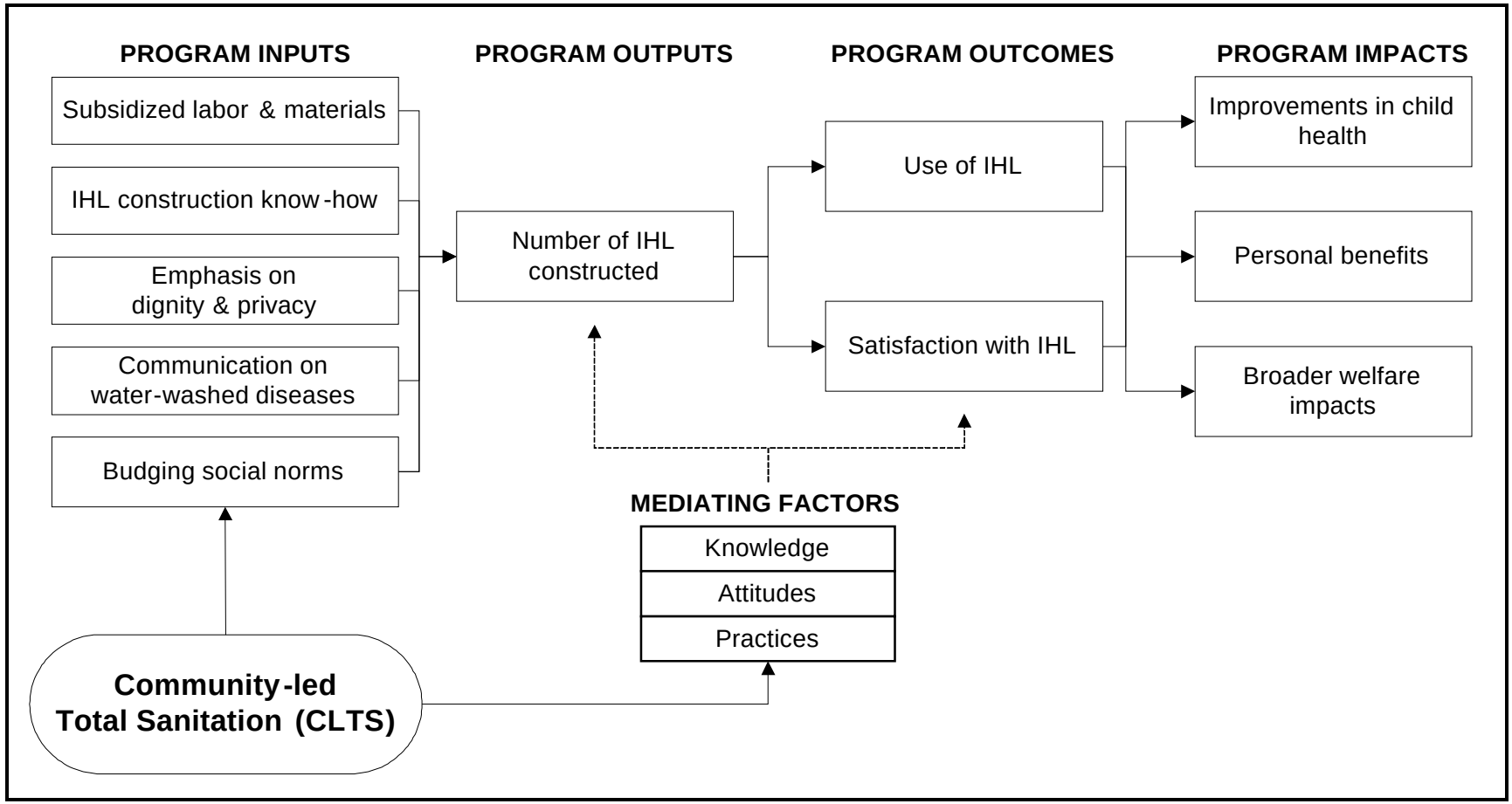

Figure 2. Map Showing Location of Bhadrak District

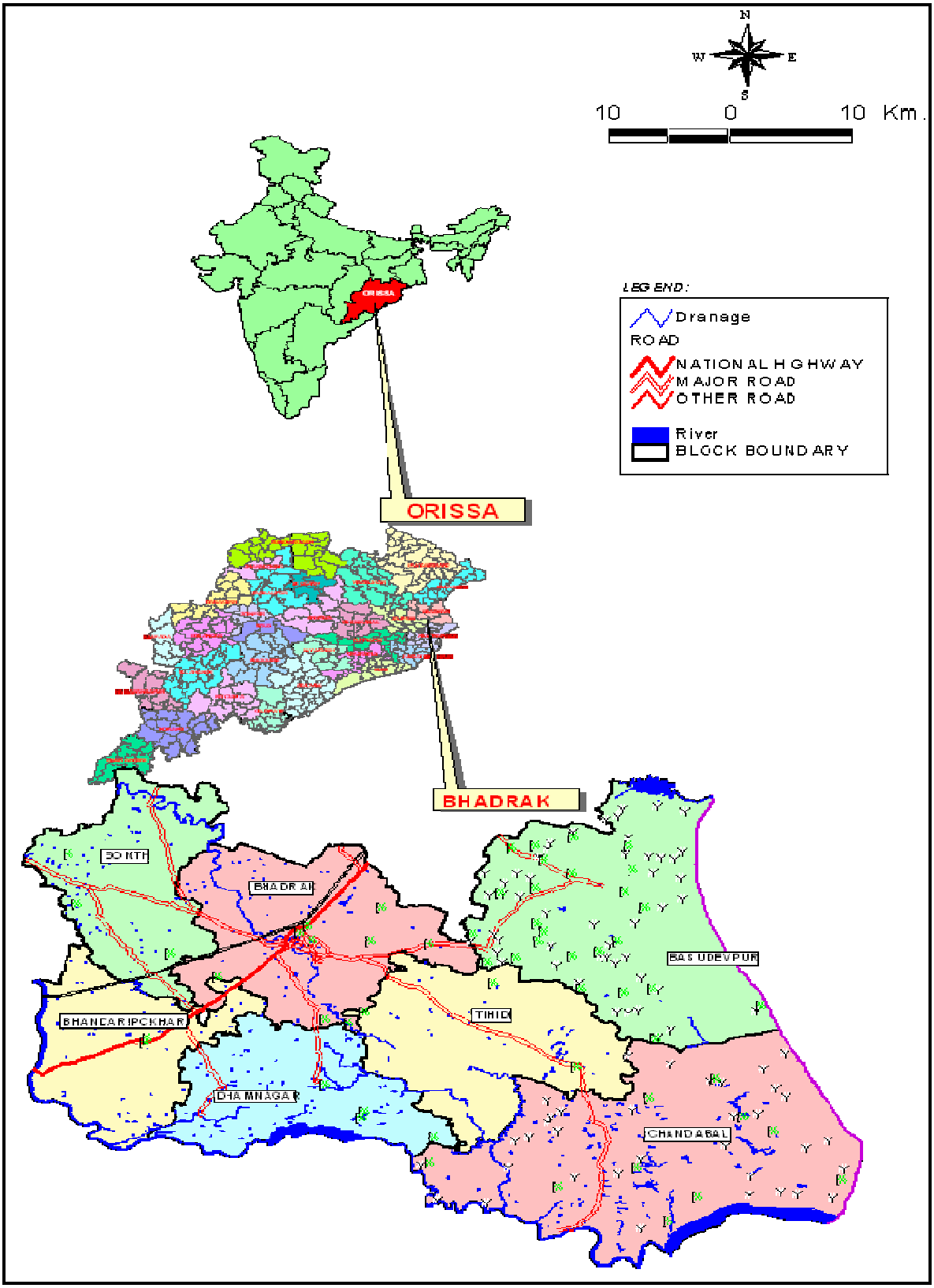

Figure 3. Location of Treatment and Control Villages in Tihidi and Chandbali Blocks, Bhadrak, Orissa

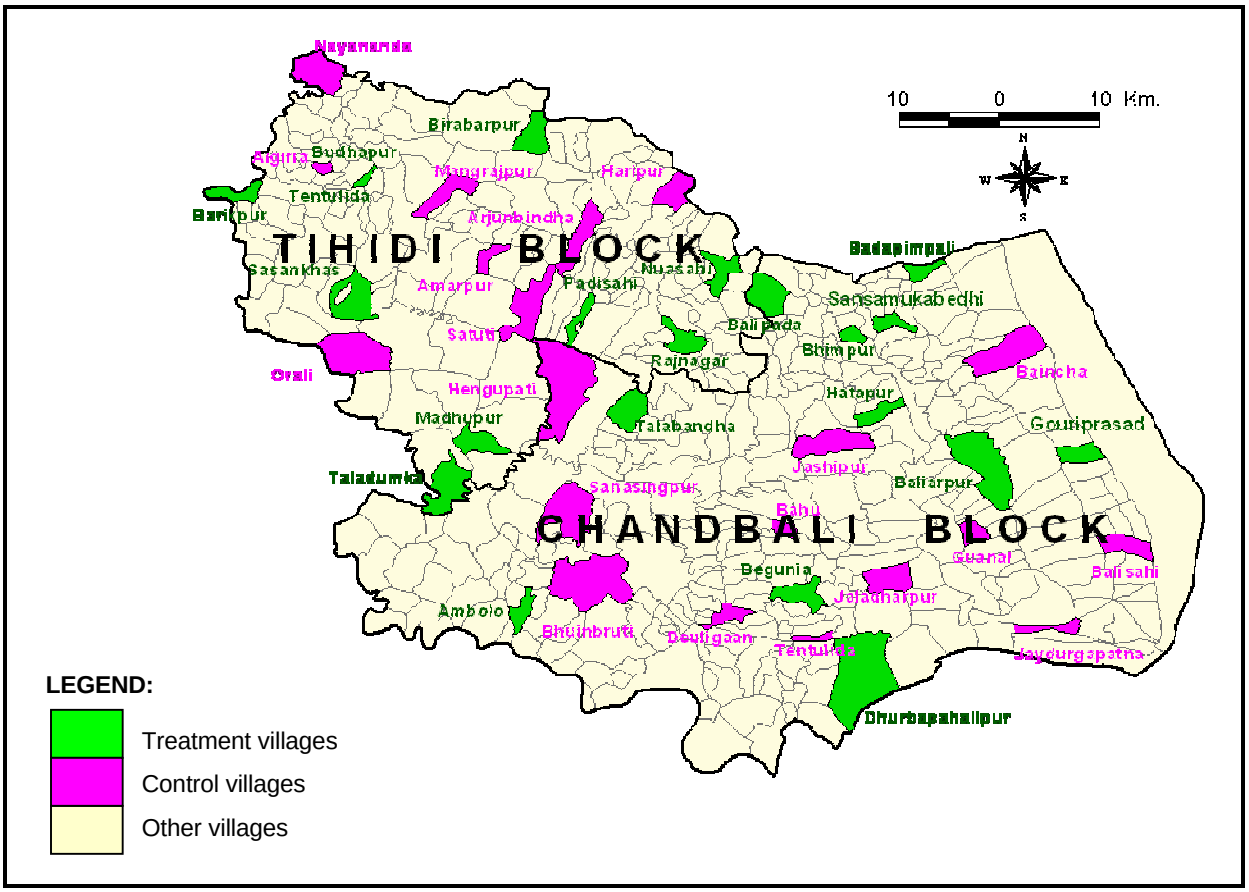

Table 1. Demographic Characteristics of Respondents and Households in Treatment and Control Villages

Variable	Overall (mean) N=1086	Treatment Village N=534	Control Village N=552	p-value*
Respondent information				
Female	93.55%	93.26%	93.84%	0.870
Age	29.39	29.25	29.52	0.661
Household information				
Religion				
Hindu	96.87%	96.25%	97.46%	0.616
Muslim	2.30%	3.56%	1.09%	0.372
No Religion	0.55%	0.19%	0.91%	0.166
Government assigned caste				
Open / general	39.96%	35.77%	44.02%	0.293
Scheduled Castes (SC)	26.98%	27.72%	26.27%	0.796
Other Backward Classes (OBC)	26.43%	29.03%	23.91%	0.387
Scheduled Tribes (ST)	1.10%	1.50%	0.72%	0.243
Below poverty line	58.20%	56.18%	60.14%	0.462
Currently have IHL	9.39%	5.99%	12.68%	0.030
Open defection	91.25%	94.94%	87.68%	0.008
% households reported a case of diarrhea in past 2 weeks				
Adults	10.99%	10.75%	11.23%	0.710
Children under 5	30.81%	32.40%	29.24%	0.401

*Statistical tests assessed the difference between treatment conditions, measured among households nested within villages

Table 2. Knowledge and Attitudes Regarding Health and Hygiene

Variable	Overall (mean) N=1086	Treatment Village N=534	Control Village N=552	p-value*
Village cleanliness				
Village is very clean	2.30%	1.87%	2.72%	0.554
Village is clean	6.63%	5.62%	7.61%	0.365
Village is somewhat dirty/clean	35.27%	32.58%	37.86%	0.336
Village is dirty	15.47%	15.36%	15.58%	0.950
Village is very dirty	39.87%	44.01%	35.87%	0.129
Satisfaction with sanitation				
Completely dissatisfied	66.57%	72.28%	61.05%	0.011
Somewhat dissatisfied	15.93%	15.17%	16.67%	0.555
Satisfied	17.22%	12.17%	22.10%	0.01
Most important community improvement in next 10 years				
New roads	58.66%	62.92%	54.53%	0.282
Household water supply	9.48%	6.93%	11.96%	0.149
Sanitation & hygiene improvements	6.72%	5.43%	7.97%	0.264
Women do not have privacy during defecation	32.14%	33.52%	30.80%	0.805
Women are not safe during defecation				
During the day	34.25%	33.71%	34.78%	0.364
At night	30.02%	29.96%	30.07%	0.522
Diarrhea knowledge**				
Symptoms of diarrhea (range 0 - 6)	2.19	2.18	2.21	0.546
Causes of diarrhea (range 0 - 8)	6.26	6.28	6.24	0.729
Danger signs of diarrhea (range 0 - 3)	0.42	0.40	0.44	0.366
Treatment of diarrhea				
Give oral rehydration salts/solution (ORS)	89.69%	90.07%	89.31%	0.602
Breast-fed during diarrhea	58.47%	58.05%	58.88%	0.782
Building a private latrine				
% who would like to	77.99%	82.58%	73.55%	0.183
% who say it is cost prohibitive	66.76%	69.10%	64.49%	0.934
Responsible for improving sanitation				
Family	59.48%	57.87%	61.05%	0.568
Government	32.60%	32.21%	32.97%	0.894
Who should bear burden of cost				
Family	28.45%	24.72%	32.07%	0.124
Government	52.49%	53.37%	51.63%	0.706
% households willing to cost share	47.51%	44.94%	50.00%	0.341

*Statistical tests assessed the difference between treatment conditions, measured among households nested within villages.

**Diarrhea knowledge scales were constructed by asking respondents to agree or disagree with items related to each domain.

Table 3. Key household variables in treatment and control villages

Variable	Overall (mean) N=1086	Treatment Village N=534	Control Village N=552	p-value*
Waste Safety Practices				
Use pots to store water	53.13%	56.18%	50.18%	0.414
Use buckets/vessels to store water	71.64%	68.91%	74.28%	0.435
Boil or treat drinking water	11.23%	9.36%	13.04%	0.192
Defecation Practices				
% who defecate in open	91.16%	94.76%	87.68%	0.011
% who use an IHL	9.39%	5.99%	12.68%	0.030
Garbage disposal				
Dump garbage outside of house	68.32%	67.60%	69.02%	0.794
Uses compost in field or yard	25.05%	27.72%	22.46%	0.199
Wastewater disposal				
Throws in backyard	47.05%	46.07%	48.01%	0.705
Flows outside the house	23.39%	24.16%	22.64%	0.660
Adult handwashing practices				
Report of 5 critical times**	2.92	2.98	2.86	0.578
Child handwashing practices				
Reported of 2 critical times**	1.43	1.42	1.43	0.709
Community Participation				
Attended a Gram Sabha meeting	36.19%	34.46%	37.86%	0.540
Helped sweep streets	7.92%	8.99%	6.88%	0.395
Helped clean water sources	8.66%	9.93%	7.43%	0.474
Helped clean drains	7.73%	8.80%	6.70%	0.351
% who own TV	14%	10%	18%	0.000
% who own cell phone	1.9%	1.1%	2.6%	0.000
Household drinking water quality				
Total coliform	107	101	112	0.302
E. coli	10.8	10.4	11.2	0.805

*Statistical tests assessed the difference between treatment conditions, measured among households nested within villages

**Respondents indicated whether they typically wash hands prior to, or following, certain events (*i.e.*, after defecating, before preparing food)

Table 4. Key community-level variables in treatment and control villages

Variable	Overall (mean) N=40	Treatment Village N=20	Control Village N=20	p-value
Mean # households per village	189	166	211	0.119
Number of children under 5 in the sample	38	39	38	0.607
Percent of households below the poverty line	57.52%	59.17%	56.07%	0.793
Average daily wage rates				
During dry season (Rs.)	42	43	41	0.547
During rainy season (Rs.)	46	48	45	0.544
Value of arable/farm land (Rs.)	43,248	50,622	35,875	0.335
Average house value (Rs.)	31,740	29,880	33,600	0.599
Water consumption (liters per capita per day [lpcd])				
1-10 lpcd	10.00%	5.00%	15.00%	0.297
11-20 lpcd	15.00%	10.00%	20.00%	0.377
21-30 lpcd	5.00%	5.00%	5.00%	1.000
31-40 lpcd	2.50%	5.00%	0.00%	0.317*
Over 40 lpcd	67.50%	75.00%	60.00%	0.312
Water quality problems				
Nitrate	2.63%	5.26%	0.00%	0.317*
Salinity	58.97%	57.89%	60.00%	0.894
Iron	47.37%	38.89%	55.00%	0.321
Bacteriological contamination	5.26%	5.26%	5.26%	1.000
Other harmful minerals (naturally present)	2.70%	5.56%	0.00%	0.304*
Community has levied charges for water use	2.70%	5.56%	0.00%	0.304*
Have a village water and sanitation committee (VWSC) / paithana committee	5.00%	10.00%	0.00%	0.152*
Aware of TSC	12.50%	10.00%	15.00%	0.676
Whether households in the village that receive assistance from the following programs				
Integrated Rural Development (IRDP)	27.50%	25.00%	30.00%	0.723
National Rural Employment Program (NREP)	5.00%	5.00%	5.00%	1.000
Training Rural Youth for Self Employment (TRYSEM)	7.50%	5.00%	10.00%	0.550
Employment Guarantee Scheme (EGS)	15.00%	20.00%	10.00%	0.377
Development of Women and Children of Rural Areas (DWACRA)	7.50%	5.00%	10.00%	0.550
Indira Awas Yojana (IAY)	70.00%	60.00%	80.00%	0.168
Sanjay Gandhi Niradhar Yojana (SGNY)	2.50%	5.00%	0.00%	0.317*
Housing under other government scheme	30.00%	20.00%	40.00%	0.168
Ganga Kalyana-Irrigation Borewell Scheme	5.00%	0.00%	10.00%	0.152*
Sector reform programme (water supply)/Swajaldhara	5.00%	0.00%	10.00%	0.152*
Mills/small scale industries (M/SSI)	2.50%	0.00%	5.00%	0.317*
Credit cooperative society (CCS)	40.00%	40.00%	40.00%	1.000
Agricultural cooperative society (ACS)	45.00%	40.00%	50.00%	0.525
Fishermen's cooperative society (FCS)	12.50%	5.00%	20.00%	0.159
Milk cooperative society (MCS)	7.50%	5.00%	10.00%	0.550
Literacy program	27.50%	30.00%	25.00%	0.723

Variable	Overall (mean) N=40	Treatment Village N=20	Control Village N=20	p-value
Health program	7.50%	10.00%	5.00%	0.550
Family planning program	60.00%	60.00%	60.00%	1.000
Village Services				
No drainage facilities	92.50%	90.00%	95.00%	0.550
Electricity	57.50%	60.00%	55.00%	0.749
Receive NGO assistance	2.50%	5.00%	0.00%	0.317*
Have a health centre	5.00%	5.00%	5.00%	1.000

*Results based on the Wilcoxon rank-sum test, which is also know as the Mann-Whitney two-sample statistic.

APPENDIX A. THE SIMPLE ANALYTICS OF DEMAND FOR TOILETS

The purpose of this study was to measure the impact of an intensive sanitation-promotion campaign, and to gain a better understanding of "what works" to encourage uptake of individual household latrines (IHLs). In order to address this question, it is helpful to outline a basic theory of latrine adoption. A simple economic explanation of households' decision to adopt latrines, or any other good, is that households will decide in favor of adoption when the perceived benefits of latrine use outweigh the perceived costs. Of course, in order for this explanation to have any practical meaning or predictive power, we need a better understanding of the "benefits" and "costs" that households consider.

The conceptual underpinnings of toilet demand are a special case of utility maximization theory—the household production model. This section presents a stylized model of toilet demand as the outcome of a process of utility maximization by households facing budget, time, and production constraints. Following Pattanayak et al. (2005), and Pattanayak and Whitehead (2006), we adapt the averting behavior models (also called defensive expenditure or coping costs models) described in Dickie and Gerking (1991). Furthermore, drawing on Udry's (2003) suggestion for iterating between theory and fieldwork in model formulation, we also draw on field observations and interviews with policymakers and village members in our study location to clarify this model. We treat the construction and use of IHLs as a type of averting activity that is conceptually equivalent to the self-insurance and self-protection idea in Ehlrich and Becker (1972). Thus, IHLs can be considered as one among a portfolio of utility yielding technologies (or input mixes), which also include construction and use of wells and rainwater harvesting schemes; safe handling and treatment of drinking water; handwashing; and medicines, doctor visits, and hospital care. To keep things simple, we focus on IHLs and not the entire vector of averting behaviors.

Constrained Utility Maximization[4]

Under this logic, households "produce" utility-yielding services such as health by combining their labor, money, capital, and environmental inputs. Consider the following stylized model that briefly summarizes the theory underlying coping costs. A typical household maximizes utility by allocating its time and income budgets to leisure (T1), health (S), and a composite consumption good (Z), for example, money. Health is measured by the number of days household members are sick. This utility is conditional on preference parameters (?) that characterize the shape of the utility curve, usually proxied by socioeconomic data. Although we are using a stylized static model of a self-interested individual (or

[4] See Larson and Gnedenko (1998), McConnell and Rosado (2000), Larson and Rosen (2002) and Dasgupta (2004) for other examples of this type of micro-econometric modeling applied to environmental risks in developing countries.

unitary household), ? can be conceived of as a place holder for common aspects of preferences such as discount rates (*i.e.*, inter-temporal tradeoffs), risk aversion, and other-regarding behaviors (e.g., altruism).

Utility is maximized subject to two constraints. First, the household faces a health production function that is twice-differentiable, continuous, and convex. Health (H) depends on environmental quality (Q) and the extent of coping (a). Q is a vector of water quality (i.e., free of biological and chemical contaminants that cause sickness) and quantity (i.e., daily access to a minimum volume of water) elements. Of course, in order for Q to enter the production function, households must be aware of the links between poor sanitation and health. Interviews with village members indicated that most people were aware of the links between open defecation and diseases like diarrhea, typhoid, and cholera, and in the baseline survey we conducted prior to the sanitation intervention, over 90% of household respondents cited open defecation as a cause of diarrhea.[5]Here we are using a rational expectations formulation of how risks are perceived and acted upon; that is, or economic agents accurately identify, estimate and forecast disease risks. However, this approach is not central to our analysis and, as will be revealed in the discussion of the data, we certainly have a wealth of information on knowledge and attitudes to develop alternative approaches to risk perceptions.

Q depends on public policies (G) such as the expansion of infrastructure networks and hygiene education campaigns. Q also obviously depends on the extent of averting behaviors in the community (A). For example, open defecation contributes to poor water quality, and flies may transmit openly available fecal matter to food and drinking water sources.[6] If the community water is not potable, reliable, or sufficient, then households must engage in a greater amount and possibly wider variety of averting behaviors - *a*. These averting goods and services depend on time (T2) and material (M) inputs. Water quality and therefore household use also depend on the household's technical know how (K), for example, about the optimal location and pit depth of IHLs and the design and materials used to aerate the structure, while sealing for water contamination. However, *a* is not a perfect substitute or complement for Q.

The resulting averting good, e.g., IHL, can also contribute directly to household utility, i.e., not through the health pathway. For example, women may benefit from the privacy, security and convenience

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[5] Several previous sanitation campaigns focused on educating households on this "germ theory," believing that this was a key barrier to latrine adoption. However, these campaigns often failed to motivate behavior change (Kar, 2003). In our study area it does not appear that this knowledge is an important barrier to latrine adoption.

[6]To the extent that health risks operate through these community-level pathways, the actions of any individual household will have only a small impact on expected health outcomes. In this case, averting behaviors act as a contribution toward a public good of "village cleanliness," with the associated problems of free-riding and collective action. Moreover, IHL use itself may be perceived to entail health risks, for example, if many of these are inappropriately located very close to wells.

afforded by an IHL, instead of having to wake up early in the morning, walk long distances, and always travel and defecate in the company of other women. For example, Jenkins & Curtis (2005) studied the motives for latrine construction in rural Benin, and found that "prestige" and "well-being" goals, such as identifying with the urban elite or increasing convenience and comfort, played a more important role than avoidance of fecal-oral disease transmission per se. Similarly, in interviews with village members in Bhadrak, "privacy," "dignity," and "convenience" were often mentioned as reasons for building or wanting to build latrines. Other people cited disadvantages of latrine use, such as bad odor or presence of flies and mosquitoes.[7] Many of these psychic benefits (or costs) of IHL use are socially defined and dependent on community customs, culture, and beliefs. We would expect peer reference groups to have a strong influence on households' desire for things like privacy, and the notion that using a latrine is more "dignified" than practicing open defecation is a social construct. To the extent that these factors play a role in households' adoption decisions, we would expect these decisions to be characterized by social interactions (Manski 1993, Moffitt 2001, Brock & Durlauf 2001).

Second, households face a budget constraint: expenditures on consumption items (Z and T1) and household production inputs (T2 and M) must be no greater than the sum of exogenous and earned income (E). Earned income is limited by the total amount of time available to the household (T), which is spent on leisure (T1), coping (T2), or being sick (S). All prices are normalized by the price of Z. Without loss of generality, we assume that the time constraint and the health production constraint are binding and therefore use a full income constraint below. The Lagrangian for this problem (l) is presented in Equation 1, where μ and ? are Lagrangian multipliers that represent the marginal utility of income and averting behavior.

$$\begin{aligned} l_{T_1,T_2,Z,M,\lambda,\mu} \quad &= \quad Max \quad U[T_1, Z, S(a, Q\{G, A\}), a; \theta] \\ &- \lambda[f(a, T_2, M; K)] + \quad \mu[E + w(T - S - T_1 - T_2,) - p.M - Z] \end{aligned} \tag{1}$$

The first-order conditions of this utility maximization are presented in Equations 2 to 8.

[7] A few people we spoke with said that open defecation was a tradition, even something they enjoyed doing. In one village, a man told us that, "If it was good enough for the Maharajas, it's good enough for me." In another village, women said that going out together in the evenings for open defecation gave them a chance to spend time together and gossip. These statements suggest that there may be psychological costs associated with breaking with tradition and establishing a new practice.

$$\begin{bmatrix} l_{T1} \\ l_Z \\ l_a \\ l_M \\ l_{T2} \\ l_\lambda \\ l_\mu \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} U_{T1} - \mu \cdot w \\ U_Z - \mu \\ U_a + U_S.S_a - \lambda \cdot f_a \\ -\lambda f_M - \mu \cdot p \\ -\lambda f_{T2} - \mu \cdot w \\ f(a, T_2, M) \\ E + w(T - S - T_1 - T_2,) - p.M - Z \end{bmatrix} \Rightarrow \begin{bmatrix} T_1 *(p, w, \theta, K, E, Q[G, A]) \\ Z *(p, w, \theta, K, E, Q[G, A]) \\ a*(p, w, \theta, K, E, Q[G, A]) \\ M *(p, w, \theta, K, E, Q[G, A]) \\ T_2 *(p, w, \theta, K, E, Q[G, A]) \\ \lambda *(p, w, \theta, K, E, Q[G, A]) \\ \mu *(p, w, \theta, K, E, Q[G, A]) \end{bmatrix} \mathrm{K} \begin{pmatrix} 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \\ 8 \end{pmatrix}$$

Simultaneous solution of the first-order conditions of this Lagrangian determines optimal consumption of S, Z, and T1 based on the optimal amount of a. In essence, time and money are allocated so that marginal opportunity costs are equal to marginal utility of consumption generated by these efforts.

T1, Z, M, T2, and the resulting levels of S and a can thus be described as a function of opportunity cost of time (w), price of averting inputs (p), preference proxies such as exogenous household characteristics (?), technical know how (K), exogenous income (E), and government policies (G) and community averting behavior that determine environmental quality (A)—all exogenous to the household.

For three reasons, we follow Wolfe and Behrman (1982) in presenting a reduced-form characterization of optimal choices in Equations 2 through 8 (instead of a structural representation). First, the choice of functional form for a structural representation of all epidemiologic and economic functions would be arbitrary. Second, the resulting analytical expressions would be sufficiently complex that the signs of most partial derivatives would be indeterminate without very specific information not only about the functional forms but also about the magnitudes of all of the parameters. Finally, without good measures of pain and suffering, especially in monetary terms, we do not have the data to estimate the complete system. By relying on a reduced-form model, we are essentially following all the prior empirical studies on averting behaviors related to inadequate and contaminated water supply (see Pattanayak et al. [2005] for the full list of papers).

However, we are interested in a better understanding of the determinants of *a* (i.e., IHL) than is represented in equation 4. To better interpret this Marshallian equi-marginal condition, we can re-write it as equation 4a.

$$U_a + U_S.S_a = \lambda \cdot f_a \qquad (4a)$$

The left hand side represents the marginal benefits of constructing and using IHLs – these include psychic benefits (safety, privacy, convenience) and health effects. To get a clearer intuition for the costs, we can totally differentiate equation 7 to obtain 7a, which is essentially the marginal production of averting goods through more time and materials.

$$-f_a = f_{T2}.a_{T2} + f_M.a_M \qquad (7a)$$

Re-writing equations 5 and 6, as 5a and 6a

$$f_M = -\frac{\mu \cdot p}{\lambda}$$

$$f_{T2} = -\frac{\mu \cdot w}{\lambda} \qquad \text{(5a, 6a)}$$

and replacing fT2 and fM in 7a, and the replacing for fa in 4a, we get 4b.

$$\frac{U_a + U_S.S_a}{\mu} = w \cdot a_{T2} + p \cdot a_M \qquad \text{(4b)}$$

Now the marginal benefits are written in money terms (by normalizing by the marginal utility of money) and the marginal costs are the marginal productivity of time and materials in IHL construction and use in terms of their opportunity cost. Equation 4b represents the classical Marshallian interior solution: household will invest time and money in building and using IHLs up to the level that the costs are equal to the perceived psychic and health benefits of IHL.

Some Predictions

As Pattanayak et al. (2005) illustrate, this model can also be used to derive a micro-economic measure of the value of improved Q as the sum of four economic concepts - coping expenditures, cost of illness, opportunity costs of lost work days, and monetary value of pain and suffering. This derivation of the willingness-to-pay (WTP) for improving Q (e.g., reducing community microbial contamination) is based on a comparative static analysis of coping activities attributable to inadequate and poor quality water. Thus, it is relevant to a technology such as IHL, which can improve Q by diminishing household exposure to microbial contamination.

Prior to the sanitation intervention, latrine coverage was quite low in the 40 villages we study in rural Bhadrak. Overall, less than 10% of surveyed households had latrines. Based on the model outlined here, what can we say about the potential reasons for this initially low level of adoption? Moreover, what are the model's recommendations for increasing households' demand for latrines? Following Pattanayak et al. (2005), we can conduct comparative static analysis with equation 4b to understand how demand for IHL would respond to the constituents of the marginal benefits and costs, for example, by taking total derivatives of Equation 4b with respect to say K – an shift in technical know how through an exogenous training and information campaign of the kind discussed in this paper. Instead, perhaps an intuitive explanation of some key policy-amenable drivers is sufficient. Demand for IHL will expand if:

1. time and materials are subsidized
2. technical know how is enhanced to improve the quality of IHL
3. non-health aspects of IHLs such as dignity, privacy, and security are clarified and perceived

4. health impacts of IHL are well understood
5. economic benefits of improved health are well understood by village residents
6. social norms shift (in favor of IHLs)

This last prediction needs some further clarification. If households know about the potential benefits of latrine use and have the ability to adopt this technology, another important factor influencing household decisions will be the expected actions of other households. If households place a high value on village cleanliness, they face a typical public goods problem where the expected benefits of individual action may be quite low since each household has an incentive to free ride. *Social norms* may help to overcome the collective action problem (Sethi & Somanathan 1996) by establishing a set of common expectations about others' actions. However, persistent social norms that, for example, establish open defecation as the "accepted" practice may act as additional barriers to latrine adoption, especially where households have a strong preference toward conformism.