An evaluation of the sustained impacts of a sanitation campaign in rural India

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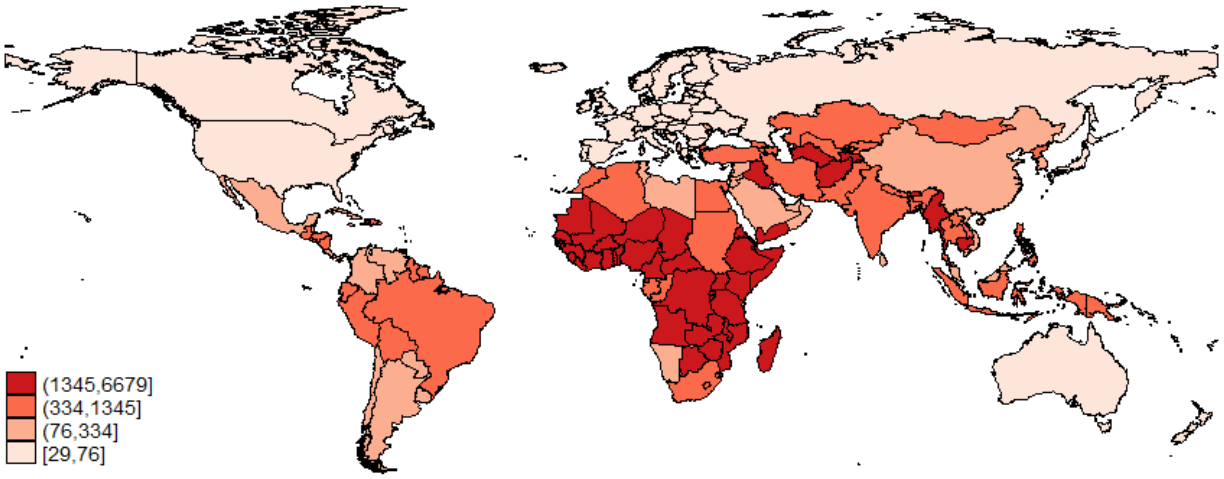
POLICY QUESTION

Does a social mobilization and subsidies program in Orissa, India generate sanitation and child health outcomes that are sustained over time?

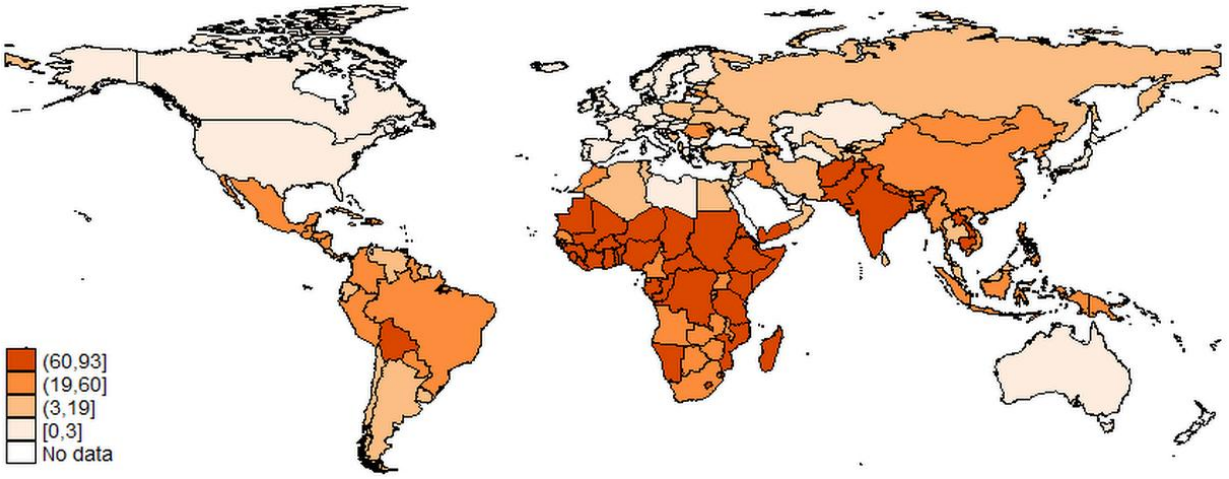
INTRODUCTION

Poor water and sanitation facilities and unhygienic practices contribute to millions of child deaths every year. Around the world, an estimated 1.5 million children under five die each year from diarrhea (UNICEF 2009), and many others suffer from malnutrition and disease caused by water-borne diseases. Lack of access to safe sanitation is a key contributor to high rates of diarrhea. As figure 1 shows, many of the countries with the highest annual DALYs (disability-adjusted life years) attributable to diarrhea also have large shares of their populations lacking access to improved sanitation facilities.

FIGURE 1. COUNTRIES AND THEIR ANNUAL DIARRHEA DALYs (2000)



COUNTRIES AND THE PROPORTIONS OF THEIR POPULATIONS NOT USING IMPROVED SANITATION (2000)



India is perhaps the worst affected country. Annually, over half a million children die of diarrhea in India; 46% of children under five are malnourished (Boschi-Pinto et al. 2008). Across rural and urban India, one of the main causes of widespread diarrheal diseases is open defecation, practiced by around 638 million people who lack improved sanitation facilities (WHO/UNICEF JMP 2010). Over half of the world's open defecation occurs in India.

In 2005-06, a team from RTI International, the World Bank and the government of Orissa conducted a randomized sanitation campaign in rural Orissa (Pattanayak et al. 2009). 20 villages were randomly chosen to receive the intervention, while 20 villages served as controls. The campaign was based on the community-led total sanitation (CLTS) methodology now favored by the World Bank and UNICEF, and drew on strategies to increase household latrine adoption by inducing emotional responses to open defecation. Below-poverty line (BPL) families received subsidies to construct latrines, consistent with India's Total Sanitation Campaign.

The study found that latrine ownership increased significantly in villages that received the intervention ('treatment villages'), even among families that did not get subsidies. Ownership levels were unchanged in control villages. Anecdotal evidence from similar CLTS programs in other parts of the world suggests encouraging results immediately after the programs are completed. However, few longitudinal studies have assessed the sustainability and persistence of behavior changes and health gains. In order to contribute to this underdeveloped field of research, Duke University and CTRAN Consulting (Bhubaneswar, Orissa) conducted a survey in July-August 2010 to collect data about sanitation behavior and child health from the same households in Orissa that had participated in the World Bank campaign in 2005-06.

This paper presents an analysis of the results of the 2010 survey to examine the sustainability of the gains in sanitation behavior and health observed immediately after the CLTS campaign ended. First, I present a review of the literature on the health effects of sanitation campaigns, and also the sustainability of impacts seen after water, sanitation and hygiene programs are completed. Second, I describe the randomized intervention that was carried out in Orissa and the 2010 survey. Third, I outline the empirical models used to estimate the effects of the campaign on sustained sanitation behavior and health. Fourth, I present the findings of the study. Finally, I discuss the observed effects and present potential policy implications for governments and international organizations working in the sector.

LITERATURE REVIEW

The salutary effects of improved sanitation are widely acknowledged. In an online poll conducted in 2007 by the British Medical Journal on 'the greatest medical advance since 1840', over 11,000 people voted 'the sanitary revolution' to victory (Ferriman 2007). The United Nations has declared as a Millennium Development Goal the halving, by 2015, of the proportion of people without sustainable access to safe drinking water and basic sanitation. Much research has been conducted into the health benefits of interventions that combine sanitation with improved water supply and hygiene (Fewtrell et al. 2009).

Yet there is surprisingly little rigorous research about the effects of the provision solely of better sanitation. Reviews of studies on the impacts of better sanitation have found little to go on. Esrey et al. (1991) used five studies to estimate that sanitation had a median morbidity reduction for diarrhea, trachoma and ascariasis of 36%. Other authors went on to challenge this conclusion on methodological grounds, arguing that Esrey's review looked only at observational studies that were prone to confounding (since households that choose to have better sanitation could also have better overall hygiene). Yet this number is still widely used.

In another review, Fewtrell et al. (2005) looked at over 2000 published studies on water, hygiene and sanitation interventions to reduce diarrhea in developing countries, but found only four studies on sanitation which met quality standards and only two which could be used in a meta-analysis. Most studies either ignored baseline diarrhea rates or hygiene behaviors prior to the intervention, or lacked a valid control group. Fewtrell (2005) estimated that sanitation interventions reduced diarrheal disease by 32%.

One of the studies Fewtrell examined was Azurin et al. (1974), which used data from a field study on four communities in a Philippine city to examine the impact of better sanitation on cholera rates. Azurin said improved sanitation could reduce cholera incidence by up to 68%. The second study, Daniels et al. (1990), examined the impact of latrine installation and hygiene education on households in Lesotho using a case-control design, and estimated that children under five in households with latrines could have 24% fewer diarrhea episodes than those in households without latrines.

More recently, Clasen et al. (2010) conducted a review of interventions 'to improve disposal of human excreta for preventing diarrhea'. This review, which outlined the influential Cochrane protocol for future meta-analyses, also commented on the paucity of research on the role of sanitation in reducing diarrhea. It restricted its focus to randomized, quasi-randomized and non-randomized controlled trials, and identified 13 studies from six countries which studied the effects of improved sanitation.

However only five of these studies involved sanitation-only interventions and of them, four were in country – China – and one was a study conducted in 1957 in the United States. The Cochrane review said 11 of the 13 studies had concluded that their interventions reduced diarrheal rates. But the authors chose not to calculate a pooled estimate of effect, noting that

the wide variation in interventions, settings and methodologies made any such estimate unsound and misleading.

The lack of strong evidence about the effectiveness of sanitation in combating diarrhea is also highlighted in Cairncross's (2010) review of water, sanitation and hygiene interventions. In looking for relevant studies of the effects of sanitation, the authors say, "our initial attempt at this review nearly foundered." The authors were, at first, only able to find studies which involved sanitation as one of the components of a broader intervention. Further research led them to the four Chinese articles mentioned earlier, and one before/after trial in Brazil.

One other study that examines this issue (but is not mentioned in the reviews quoted above) is Dickinson and Pattanayak (2011) which uses data from the same surveys that this paper studies. This paper is discussed in more detail subsequently.

The lack of research into sanitation impacts is unsurprising, to an extent, because the provision of latrines is a costly exercise. Randomizing large-scale sanitation programs involves considerable public investment. However, as Clasen et al. (2010) points out, the dearth of reliable evidence could hinder progress towards the MDG target for sanitation. There is therefore an urgent need for rigorous experimental research in this field.

Almost as rare an area of research is the longevity of the health gains seen in sanitation interventions. Some studies in other sectors which investigate the persistence of intervention impacts have found favorable results. Balasubramanya et al. (2010), for instance, looked at whether a 2003 campaign that tested and painted arsenic-contaminated tubewells in rural Bangladesh encouraged permanent switching to 'safe' wells, by revisiting 1700 treatment households in 2008. The study found that not one of the households that switched wells in 2003 had returned to an unsafe well. Further, another 18% of households with unsafe wells had also switched wells in the interim.

Another relevant study is Whittington et al. (2009), which analyzed the performance of community-managed rural water supply systems in 400 rural communities in Peru, Bolivia and Ghana 3-12 years after they had been set up. The study found that despite many village water committees being in poor financial shape, over 90% of rural water supply projects were still working, and almost all households in the communities were drawing at least some of their water from the systems.

Several studies on water, sanitation and hygiene have reported favorable behavioral and health effects immediately after the campaigns have ended. Research into the middle and long-term duration of these effects, however, is sparse, even though authors have pointed out that many households discontinue their new behavior with time. Waddington et al. (2009), in a meta-analysis, found only five follow up studies which examined the sustainability of reduction in diarrheal illness more than a year after the initial interventions ended. Only one of them – Hoque et al. (1996) - involved sanitation.

Hoque discussed the persistence of behavioral change and health gains six years after the implementation of a hygiene and sanitation project in Mirzapur, Bangladesh. In the intervention, households received extensive hygiene education, a pit latrine for almost every family, and a tubewell for every five families to provide access to less contaminated groundwater. Water use and defecation practices improved in the treatment households immediately after the intervention, and children experienced 25% fewer episodes of diarrhea than children in the control area.

Six years later, the researchers found that the benefits had stuck. The use of tubewell water had fallen from 88% to 66%, but was still higher than the control villages' rate of 5%. Four in five treatment households still used their latrines (only slightly less than the 87% immediately after the intervention), which was far higher than the 8% in the control area. The authors attributed the continued effects to the good maintenance of tubewells and latrines, and the easy availability of spare parts close to the intervention site.

Further research into the impacts of sanitation-only interventions on health, and the persistence of behavioral change and health gains, will contribute to our understanding of how well such campaigns work and how long their effects last. This paper seeks to contribute to this under-explored field of research by looking at the persistence of sanitation improvements and health outcomes four years after the completion of a sanitation intervention in Bhadrak, Orissa.

CLTS CAMPAIGN IN BHADRAK, ORISSA

The data for this paper was collected from three surveys conducted in rural Orissa, India, over a period of five years from 2005 to 2010. In 2005-06, a team from RTI International, the World Bank and the government of Orissa carried out a randomized sanitation campaign in 40 villages in Bhadrak, Orissa (Pattanayak et al. 2009). Orissa is one of India's poorest states (OPHI 2010), and has the second highest infant mortality rate in the country (GOI 2009).

Two adjacent blocks in Bhadrak district were chosen to be the intervention sites since the Indian government's Total Sanitation Campaign - aimed at changing attitudes to sanitation in rural households - had not been implemented in several areas in the region, latrine coverage was low, and most villages were accessible by road (Dickinson and Pattanayak, 2011). The campaign assessed 413 villages for eligibility, according to whether they had between 70 and 500 households (to ensure homogeneity), they were not in the same panchayat (one village was chosen per panchayat to avoid spillover effects), and they were not adjacent to each other (to avoid spillover effects).

Of the 40 selected villages, 20 were then randomly assigned to be the treatment group, while the others served as controls. In August 2005, a mapping team listed through household surveys all the households in the chosen villages which had at least one child under five years of age. From each listed village, 28 households were chosen at random to make a total of 534 treatment households and 552 control households. Baseline data was then collected using household surveys. The quality of drinking water at the most commonly-used source in each village was tested for the presence of coliform and E.coli bacteria, which would indicate fecal contamination.

Between February and May 2006, the intervention campaign was carried out in the treatment villages. The campaign was based on the community-led total sanitation (CLTS) methodology, which attempted to increase household latrine adoption by arousing disgust and shame at the practice of open defecation. Families below the national poverty line received subsidies to construct latrines: they had to pay only 300 rupees ($6) for the off-pit toilets that were promoted through the campaign, while other (above poverty line, or APL) families paid around 2000 rupees ($43). Village latrine production centers were set up to produce and provide materials for latrine construction locally. Local NGOs worked in each village to construct the latrines – for which they were later compensated by the government - and set up community sanctions against open defecation in the form of fines, taunting and social sanctions.

In August and September of 2006, a post-intervention survey was conducted in the treatment and control villages to gauge the impact of the campaign on sanitation behavior and related health and welfare outcomes. The survey found that latrine ownership had increased by 30% in treatment villages relative to controls, even among families that did not receive subsidies. Latrine use increased by 20%. Detailed results have been published in Pattanayak et al. (2009) and Dickinson and Pattanayak (2011). The impact on child diarrhea was not significant, but the

campaign improved children's nutritional status, measured through their height and arm circumference.

To assess the persistence of the gains seen in the follow-up survey, Duke University and CTRAN Consulting (Bhubaneswar, Orissa) conducted a survey in July-August 2010 which collected data about sanitation behavior and child health from the households that had participated in the campaign in 2006. The survey was conducted in the same months as the previous surveys on account of the high seasonality of diarrhea, which peaks in the monsoon season between July and September. The attrition rate was a low 2%, and was primarily because of families moving out of their villages.

Since many of the children surveyed in 2005 and 2006 were likely to be over five years of age in 2010, village-level diarrhea prevalence was measured through a shorter survey administered to one household neighboring each target household. The survey included questions on diarrhea prevalence, education, asset ownership, poverty status and community/peer monitoring. Water quality tests for fecal contamination were also carried out at the community water source.

The primary survey contained closed-ended questions split into eight sections to measure (i) the respondent's age, gender, education and family's BPL status, (ii) the respondent's knowledge of diarrhea transmission, (iii) the nutritional status of all children under ten, by measuring height, weight and mid-upper arm circumference, (iv) the diarrhea prevalence among children under five, (v) household sanitation practices, including open defecation/use of individual household latrines, (vi) exposure to other sanitation-related interventions, (vii) the levels of community and peer monitoring of sanitation practices, and (viii) the household's socio-economic profile.

The survey data was collected by 12 trained enumerators, who had all either completed college or were undergraduate students. Surveys were carried out in Oriya, the language most commonly spoken in Orissa. The surveys were pre-tested in the village of Parabil, which was neither a treatment nor a control village, but met the criteria that had been originally used to screen villages. The study protocol was approved by the Institutional Review Board at Duke University (FWA No. 00000265). The data was analyzed using the statistical package, Stata/SE 11.1 (Stata-Corp LP).

CONCEPTUAL MODEL

This paper measures the impacts of the CLTS campaign by focusing on three indicators: latrine adoption, height-for-age and weight-for-age measures of children who were below five at the time of the intervention, and diarrhea rates for children under five.

Latrine ownership in itself is an important indicator of improvements in household sanitation. In health production function models, it is viewed as an 'averting behavior' that is an input into household health (Pattanayak and Pfaff 2009). Transtheoretical and social cognitive models of behavior change suggest that the 'treatment effect' of public health interventions extend beyond the duration of the intervention itself (Glanz and Bishop 2010). Personal factors, environmental influences and behavior interaction can cause households to adopt latrines months or years after an intervention ends, and this behavior change can justifiably be attributed to the intervention.

To estimate the 'treatment effect' of the campaign on the ownership of latrines in treatment villages, I use a differences-in-differences (DID) estimator, which looks at the differences in latrine ownership in treatment and control villages in 2010 and 2005. Since latrine ownership in households in the same village is likely to be correlated, I adjust the standard errors using the 'cluster' command in Stata 11. I also include variables which were not balanced between treatment and control villages at baseline. I estimate the effects separately for BPL and APL families, which were exposed to different components of the intervention. Since the treatment was directed at entire villages, I cluster standard errors at the village level.

Additionally, I also examine the determinants of continued latrine ownership and use, which constitute averting behaviors. The decision to use a latrine is driven by a host of household and community-level factors, including the price of materials, knowledge of the health benefits involved, perceptions of the intervention's non-health benefits, and community-averting behavior (Pfaff and Pattanayak 2009). To identify the drivers of late adoption of latrines, I use a structural model that takes these factors into account.

I measure the effect of the treatment on child health in several ways. First, I compare the individual nutrition status in 2006 of children who were under five then, with their present nutritional status - assessed through anthropometric measurements of HAZ (height-for-age) and WAZ (weight-for-age). Low height-for-age and weight-for-age measurements among children are indicators of malnutrition. I normalize individual children's HAZ and WAZ using WHO growth standards to produce z-scores measuring deviation from the mean measurements for children of the same age and gender. To do so, I used the publicly-available Stata macros available on the WHO website.

I measure the effect of the campaign on diarrhea prevalence differently, since diarrhea is more likely to afflict younger children. Also, diarrhea is likely to be affected by village-level factors like rates of open defecation. I therefore estimate rates of village-level diarrhea prevalence in children under five using responses from both the households that were identified in 2005 and

their neighboring households, surveyed for the first time in 2010. This method ensures that I have a larger, effectively random, sample to draw from to estimate diarrhea rates. I then compare the village-level diarrhea rates in 2010 to those in 2005, to get an estimate of the effect of the campaign.

To strengthen my analysis, I also measure the impact of the campaign on diarrhea by comparing diarrhea rates at the household level. I do so by first comparing for each household the proportion of children under five who had an episode of diarrhea in the two weeks prior to the survey in 2005, to the same proportion in 2010. I also compare households by whether they reported any cases of child diarrhea in 2005, to whether they did so in 2010.

This analysis will give an estimate of the intent to treat, or the effectiveness of the campaign in affecting diarrhea levels. However policymakers may also want to know the effect of actual latrine ownership on certain outcomes. Since there are households in treatment villages which did not construct latrines (and those in control villages which did), there is, in a sense, only partial compliance with the treatment. The true effect of latrine adoption on individual households may therefore be misestimated.

To measure the impact of the 'treatment on the treated', ordinary least squares (OLS) regressions will be inadequate, because the factors that affect latrine adoption may be endogenous and also affect diarrhea prevalence. Consequently, the estimate of the effect of latrine adoption on diarrhea prevalence could be biased. To isolate this effect, I use the sanitation campaign as an instrumental variable, since it is correlated with village-level diarrhea rates only through latrine adoption. I then estimate the effect of latrine ownership through two-stage least squares (2SLS) regressions.

FINDINGS

In all, 1044 households were surveyed in 2010: 517 from treatment villages and 527 from control villages. Table 1 lists the household characteristics for each group. Treatment and control households are balanced on most variables. Around 57% of the households in both treatment and control villages are officially below the poverty line. On average, around a quarter of all households report a case of child diarrhea in the two weeks prior to the survey. The households are also balanced on TV ownership and their unanimous belief that open defecation affected women's dignity.

Around 90% of all households are also aware of the link between open defecation and diarrhea. This finding is possibly linked to the widespread exposure to health messages on radio, on which the households are balanced too. As expected, the households are unbalanced on latrine ownership and use. Twice as many households own and use latrines in treatment villages as in control villages. Attitudes to witnessing open defecation are different too: fewer households in treatment village say they will ignore open defecation if they see it.

Households in treatment and control villages are also balanced on other sanitation-related behaviors. Around 90% of households in both groups dispose of children's feces by leaving it in the open. More surprisingly, around 90% of households in both treatment and control villages say that at least one family member practices open defecation, suggesting that households which own latrines may not always use them.

TABLE 1. HOUSEHOLD CHARACTERISTICS IN 20 TREATMENT AND 20 CONTROL VILLAGES FOUR YEARS AFTER AN IEC SANITATION CAMPAIGN IN BHADRAK, ORISSA, 2010.

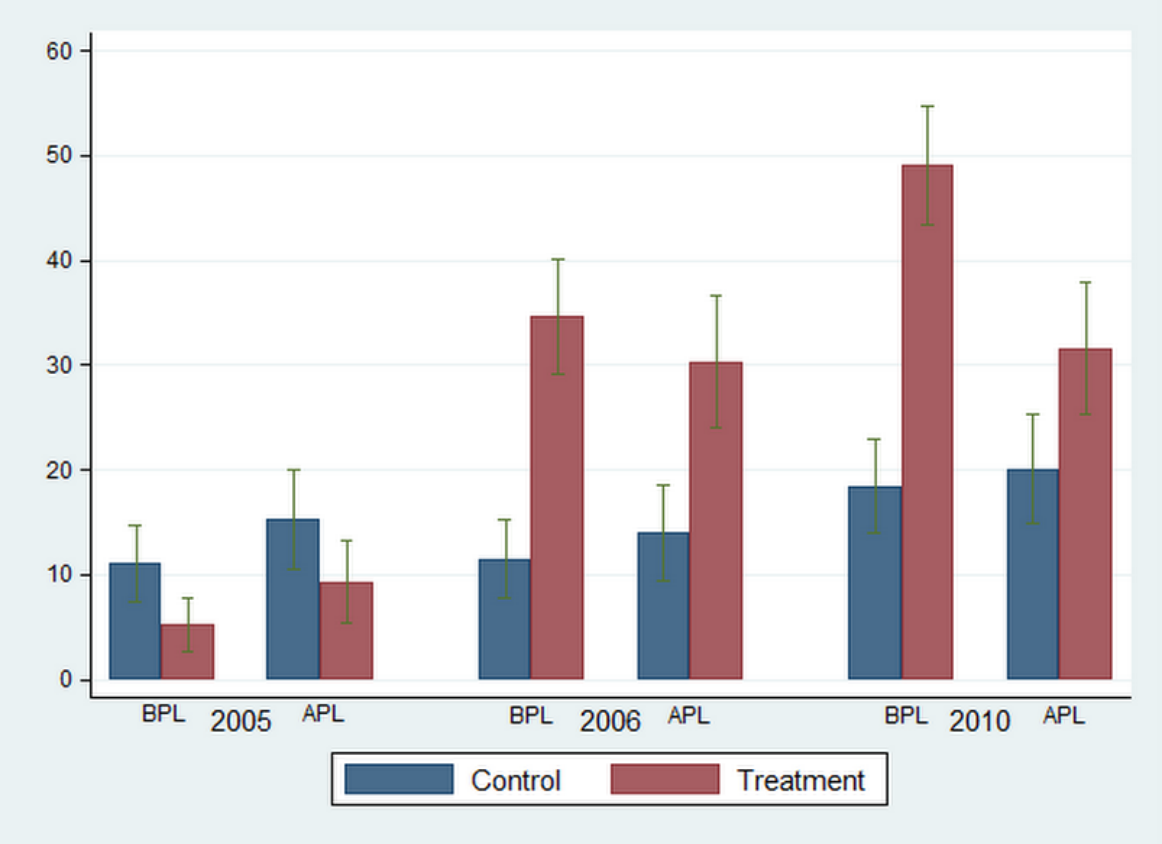
Household Characteristic	Treatment (n=517) %	Control (n=527) %	p-value
Below poverty line (BPL)	58	57	0.730
Female respondent	61	63	0.771
Household head has zero years of education	21	20	0.716
Reported case of child diarrhea in past 2 weeks	19	19	0.950
Owns TV	20	28	0.143
Owns IHL	42	19	0.002
Uses IHL	39	19	0.005
Uses improved water source	97	97	0.855
Leaves feces in the open after open defecation	86	90	0.199
Knows open defecation can cause diarrhea	91	87	0.307
Practices open defecation	86	91	0.183
Believes open defecation affects women's dignity	100	100	0.989
Frequently receives health messages on the radio	32	27	0.447
Does nothing if s/he observes open defecation by another person	75	88	0.010

IHL Ownership

Figure 2 displays latrine ownership for BPL and APL (2010 status) families in treatment and control villages before, immediately after, and four years after the intervention. Both BPL and APL households in treatment villages initially had lower latrine ownership rates than those in control villages. After the intervention, however, latrine ownership soared in treatment villages - from 5.3% to 34.6% for BPL households, and from 9.3% to 30.3% in APL households. In control villages, ownership stayed at around 11% for BPL and 15% for control households.

The trends seen in 2006 seem to have become more pronounced in 2010. Latrine ownership in BPL households continues to rise, going from 34.6% to 49% - a substantial 42% surge. Ownership in APL households rises slightly too, going from 30.3% to 31.7%. In control villages, 18.5% of BPL households and 20% of APL households now own latrines.

FIGURE 2. IHL OWNERSHIP IN TREATMENT AND CONTROL VILLAGES IN 2005, 2006 AND 2010



Figures 3 and 4 break down latrine ownership into village-level data. As seen in figure 3, many households in control villages have seen little increase in latrine ownership between 2006 and 2010. Some of the villages that *have* seen increases – like Arjunbindha, Mangarajpur, Satiuti and Tentulida – have participated in government-sponsored sanitation interventions since 2006 (Senapati 2010).

FIGURE 3. IHL OWNERSHIP IN CONTROL VILLAGES

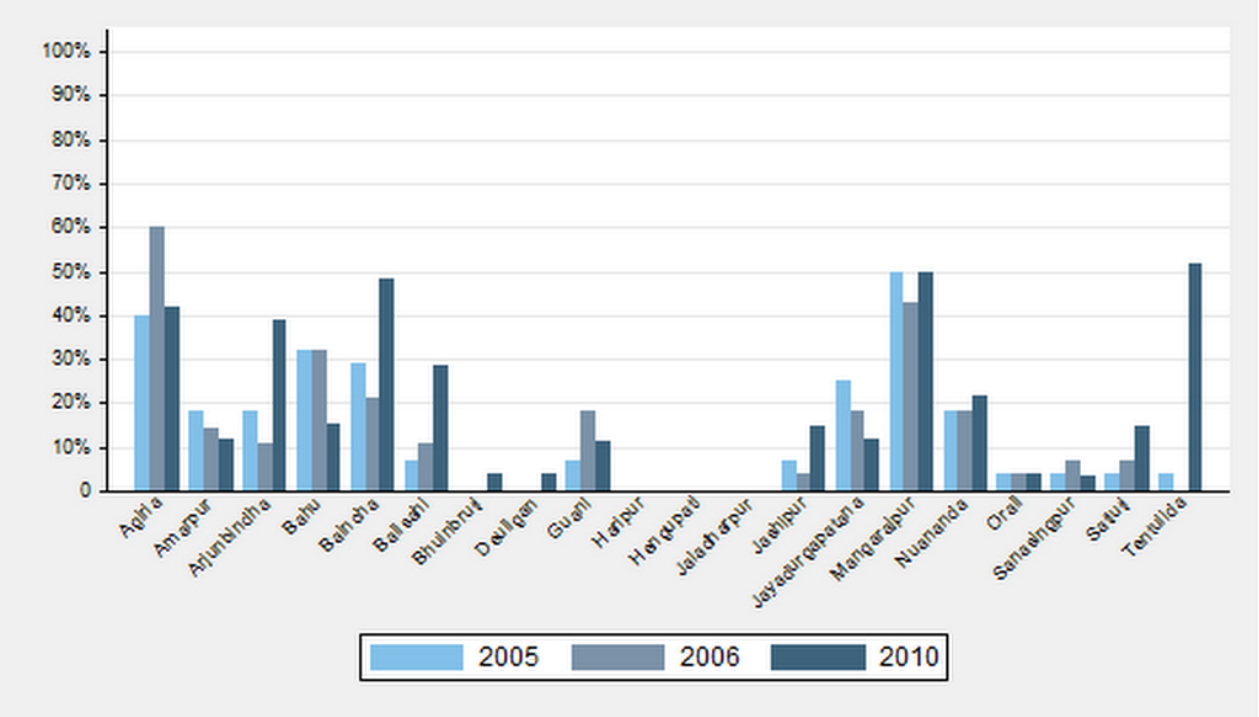


FIGURE 4. IHL OWNERSHIP IN TREATMENT VILLAGES

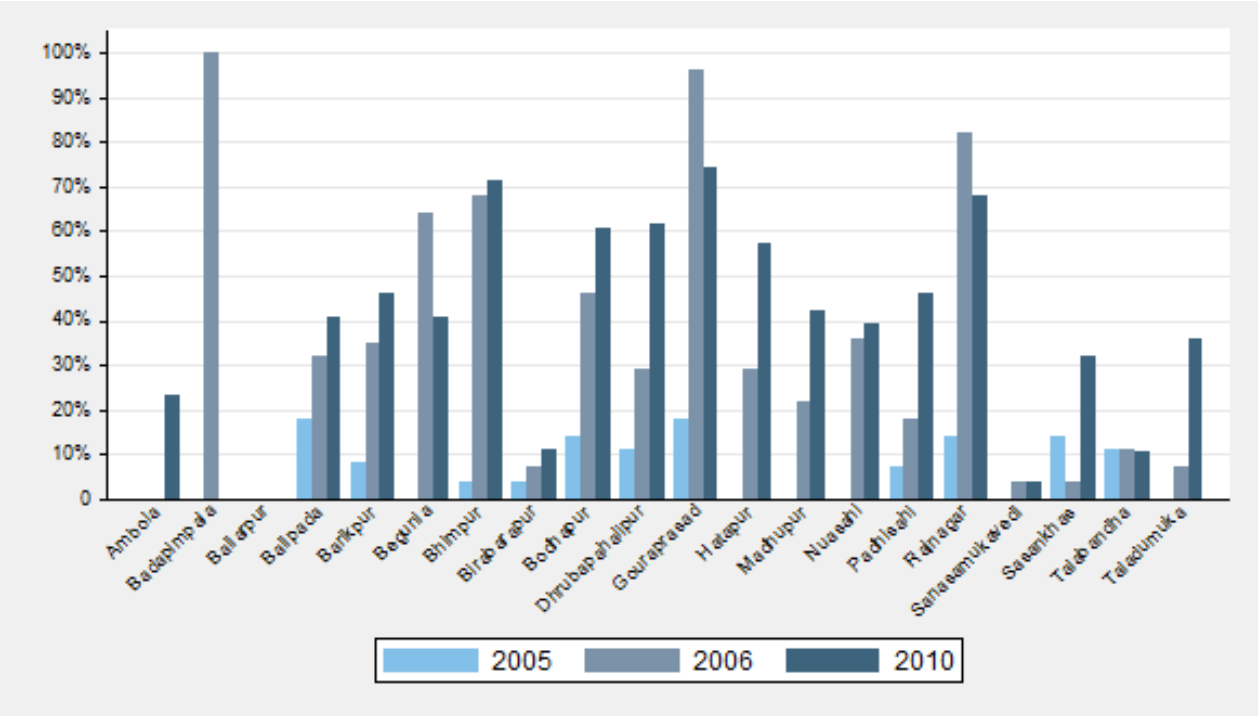


Figure 4 shows how latrine ownership in almost every treatment village has risen between 2006 and 2010. (Badapimpala, which has seen a drastic decrease, only has 4 surveyed households, and is therefore an outlier).

To estimate the effects of the campaign on latrine adoption, I use the difference-in-difference estimator specified earlier. The estimator, presented in Table 2, suggests that the campaign caused a 27% increase in overall continued latrine ownership in households in treatment villages, compared to their counterparts in control villages. The increase was 17% for APL families, and was considerably higher at 35% for BPL families. By taking the difference between these two estimates, we obtain a triple difference estimate of 18%, which suggests that the subsidies given to poor families were responsible for more than half of the continued effect of the campaign.

TABLE 2. DID ESTIMATES OF EFFECT OF SANITATION CAMPAIGN ON CONTINUED OWNERSHIP OF IHLS IN BHADRAK, ORISSA, 2005-2010

	FULL SAMPLE	BPL	APL
Treatment Village	0.274***	0.353***	0.166**
	(0.06)	(0.06)	(0.05)
Owned TV in 2005	0.00518	0.0197	0.0263
	(0.04)	(0.07)	(0.05)
Completely dissatisfied with village sanitation in 2005	0.108*	0.0975*	0.119*
	(0.04)	(0.05)	(0.06)
Constant	-0.00475	0.0108	-0.0306
	(0.04)	(0.05)	(0.05)
Observations	1044	600	444
Adjusted R-squared	0.110	0.154	0.057

STANDARD ERRORS IN PARENTHESES * P<0.05, ** P<0.01, *** P<0.001

The continued increase in latrine ownership in treatment villages suggests that several households adopted latrines after the intervention ended. These 'late adopters' made up close to a quarter of the total number of latrine owning households in treatment villages in 2010. To get a better idea of the different kinds of adoption behavior, I stratified the households in

treatment villages into different categories based on when and whether they adopted or discarded latrines. Table 3 presents the results.

TABLE 3. HOUSEHOLD LATRINE ADOPTION BEHAVIORS IN 2005, 2006 AND 2010

Treatment Households (n=517)	Full Sample (%)	BPL (%)	APL (%)
Didn't own in 2005, 2006 and 2010 (Never owned)	48.9	24.7	24.2
Owned in 2005, 2006 and 2010 (Always owned)	5.2	1.9	3.3
Didn't own in 2005, owned in 2006 & 2010 (Early adopters)	18.9	13.3	5.6
Didn't own in 2005 & 2006, owned in 2010 (Late adopters)	15.7	11.6	4.1
Didn't own in 2005, owned in 2006, didn't own in 2010 (Reverters)	7.5	4.4	3.1

Over 15% of all treatment households constructed individual latrines after the end of the sanitation campaign, indicating considerable diffusion of latrine adoption among treatment households, in addition to persistent latrine ownership. The diffusion is pronounced in BPL households, which comprise around 74% of the late adopters. These figures indicate that the benefits of the campaign did not diminish over time. Rather, the impact of the evaluation was underestimated in the short run.

I examined household and village-level characteristics to try and identify the drivers of late adoption or the factors that led households to build latrines *after* the intervention ended. Table 4 presents the results of three regression models on late latrine adoption; the dependent variable indicates whether a household adopted a latrine between 2006 and 2010. The first column uses household characteristics and assets ownership in 2006; the second also uses hygiene perceptions, and the third adds measures of peer pressure, sanitation exposure and institutional support to build latrines. All errors are clustered.

The results indicate that households which were BPL in 2006 are more likely to have adopted latrines between 2006 and 2010. Hindu households were *less* likely to have adopted latrines. Late adoption also seems to have been influenced by the medical costs that a household bore

in 2006 due to diarrhea, and by village diarrhea levels. Model 3, which uses 2010 characteristics, suggests that late adoption seems to be positively correlated with the proportion of a household's neighbors using IHLs. The effect of neighborhood latrine ownership holds particular import for the evaluation of the impact of the sanitation campaign, because it suggests that social effects play a role in driving latrine adoption. Diffusion through community adoption can have an influence four years after the end of the intervention.

TABLE 4. DRIVERS OF LATE ADOPTION BY TREATMENT HOUSEHOLDS (2006 CHARACTERISTICS)

Household and village characteristics	Model 1	Model 2	Model 3
BPL	0.488**	0.528**	0.189
	(0.217)	(0.235)	(0.177)
Hindu	-1.275***	-1.337***	-1.810***
	(0.200)	(0.340)	(0.257)
Open Caste	-0.048	-0.025	-0.126
	(0.137)	(0.155)	(0.158)
Respondent's Education	0.091	0.120	0.133*
	(0.079)	(0.081)	(0.074)
Expenditures (log)	-0.054	-0.017	0.037
	(0.127)	(0.126)	(0.143)
Nights in hospital	-0.334	-0.384	-0.184
	(0.246)	(0.278)	(0.289)
Medical costs	0.0007**	0.0007**	0.0006**
	(0.0003)	(0.0003)	(0.0002)
Felt sanitation was most important problem in village		0.001	0.001
		(0.006)	(0.007)
Knew open defecation causes diarrhea		-0.152	0.084
		(0.277)	(0.287)
Treated drinking water		-0.071	-0.422
		(0.300)	(0.328)
Mother washed hands at crucial times		0.002	-0.157
		(0.040)	(0.049)
Village diarrhea levels		0.322	0.585**
		(0.272)	(0.263)
Completely dissatisfied with sanitation in village		0.111	0.252
		(0.268)	(0.271)
Household had person with diarrhea in it in two weeks prior to survey		-0.456	-1.134
		(0.621)	(0.819)
Fraction of neighbors who owned IHLs (2010)			1.329***
			(0.230)
Feelings about open defecation (2010)			0.255
			(0.220)
Frequently exposed to health-related messages (2010)			0.095
			(0.112)
Thought NGO performed sanitation-related work in village (2010)			0.093
			(0.202)
Thought BDO performed sanitation-related work in village (2010)			0.280
			(0.291)
Thought DWSM performed sanitation-related work in village (2010)			0.207
			(0.614)
Observations	315	303	264
Adjusted r-squared	0.062	0.086	0.194

STANDARD ERRORS IN PARENTHESES * P<0.1, ** P<0.05, *** P<0.01

Child Nutrition

Table 6 present the results of DID estimates of the effect of the campaign on anthropometric measurements of height-for-age (HAZ) for children in households that participated in the campaign. The dependent variable is a continuous measure of the difference in the HAZ z-scores for individual children between 2010 and 2005. For children who remained under five years of age in 2010, I referred to the WHO child growth standards. For children who were over five in 2010, I used WHO growth reference data for 5-19 year olds. Column 1 presents the reduced-form or intent-to-treat effect; column 2 includes controls; column 3 adds latrine ownership as a control; and column 3 presents the IV estimate using the sanitation campaign as an instrument for latrine ownership. In all, there were 728 children for whom measurements were available from both 2005 and 2010. Table 7 presents a similar analysis for weight-for-age measurements.

Only a few of the results – ITT or IV – in Tables 5 and 6 are statistically significant. The 2010 dummy variable is significant in all the ITT estimates for HAZ, and the Column 2 ITT estimate for WAZ. However the sign of the coefficient is not the same. The results suggest that children's weight-for-age measurements worsened from 2005 to 2010, while there is some evidence that their height-for-age measurements improved.

The estimated effects of the sanitation campaign on WAZ are uniformly positive for WAZ, while it is uniformly negative for HAZ. None of these results, however, are statistically significant at the 10% level. It must also be pointed out that these relationships cannot be said to be definitively causal in nature. Many of the behaviors are not randomly assigned and are endogenous to households. No conclusions about the impact of the campaign on child nutritional status can be reached on the basis of these results.

TABLE 5. DID ESTIMATES OF IMPACT ON SANITATION CAMPAIGN ON INDIVIDUAL WEIGHT-FOR-AGE MEASURES OF CHILDREN SURVEYED IN BHADRAK, ORISSA IN 2005, 2006, AND 2010 (N=1456)

Household-level characteristics	(1)	(2)	(3)	(4)
Treatment village	0.009 (0.709)	0.058 (0.518)	0.043 (0.671)	-1.326 (8.748)
2010 dummy	-1.302* (0.654)	-1.312** (0.510)	-1.312* (0.656)	-1.345 (0.843)
Treatment * 2010	0.111 (0.742)	0.134 (0.722)	0.132 (0.749)	
BPL		-0.534 (0.376)	-0.541 (0.484)	-1.142 (3.934)
Household head's education		-0.050 (0.048)	-0.050 (0.069)	-0.959 (0.324)
Household practices open defecation		0.238 (0.632)	0.296 (0.348)	5.594 (31.301)
Respondent would ignore open Defecation if observed		0.142 (0.520)	0.166 (0.157)	2.266 (12.397)
Owns TV		-0.168 (0.458)	-0.185 (0.237)	-1.741 (9.325)
Household had at least one under-5 with diarrhea in past 2 weeks		-0.363 (0.389)	-0.364 (0.268)	-0.512 (1.067)
Uses improved water source		-0.287 (1.09)	-0.299 (1.031)	-1.390 (6.307)
Knowledge of diarrhea causes		0.076 (0.183)	0.079 (0.160)	0.366 (1.791)
Exposure to sanitation messages		0.365* (0.210)	0.363 (0.291)	0.153 (1.043)
Respondent said NGO had done Sanitation work in village		-0.104 (0.410)	-0.115 (0.265)	-1.097 (5.978)
Score on scale of feelings about open defecation		0.119 (0.330)	0.118 (0.272)	-0.042 (0.729)
IHL ownership			0.096 (0.272)	8.866 (51.755)
Constant	-0.991 (0.630)	-1.891 (2.375)	-1.973 (1.800)	-9.456 (45.452)
Adjusted r-squared	0.0047	0.0033	0.0129	-

STANDARD ERRORS IN PARENTHESES * P<0.1, ** P<0.05, *** P<0.01

TABLE 6. DID ESTIMATES OF IMPACT ON SANITATION CAMPAIGN ON INDIVIDUAL HEIGHT-FOR-AGE MEASURES OF CHILDREN SURVEYED IN BHADRAK, ORISSA IN 2005, 2006, AND 2010 (N=1486)

Household-level characteristics	(1)	(2)	(3)	(4)
Treatment village	0.935 (0.798)	0.866 (0.739)	0.970 (0.786)	12.033 (39.008)
2010 dummy	1.205 (0.423)	1.195*** (0.425)	1.195 (0.426)	1.251 (1.635)
Treatment * 2010	-0.793 (0.846)	-0.782 (0.845)	-0.774 (0.841)	
BPL		-0.205 (0.494)	-0.164 (0.473)	4.196 (14.871)
Household head's education		0.044 (0.045)	0.048 (0.046)	0.431 (1.322)
Household practices open defecation		-0.193 (0.469)	-0.587 (0.447)	-42.549 (142.831)
Respondent would ignore open Defecation if observed		-0.026 (0.378)	-0.187 (0.392)	-17.273 (58.185)
Owns TV		-0.245 (0.379)	-0.128 (0.345)	12.376 (42.561)
Household had at least one under-5 with diarrhea in past 2 weeks		-0.333 (0.426)	-0.322 (0.425)	0.906 (4.425)
Uses improved water source		0.340 (0.819)	0.423 (0.830)	9.272 (30.438)
Knowledge of diarrhea causes		0.011 (0.164)	-0.010 (0.159)	-2.262 (7.687)
Exposure to sanitation messages		-0.020 (0.150)	-0.004 (0.152)	1.682 (5.752)
Respondent said NGO had done Sanitation work in village		0.276 (0.599)	0.353 (0.641)	8.558 (28.047)
Score on scale of feelings about open defecation		0.089 (0.275)	0.100 (0.279)	1.253 (4.144)
IHL ownership			-0.658 (0.528)	-70.729 (238.551)
Constant	-2.758*** (0.390)	-3.423 (2.249)	-2.859 (2.013)	57.198 (203.826)
Adjusted r-squared	0.0044	0.006	0.0068	-

STANDARD ERRORS IN PARENTHESES * P<0.1, ** P<0.05, *** P<0.01

Child Diarrhea

Village-level prevalence

Village-level means of diarrhea prevalence among children under five were about balanced in treatment and control villages in 2005. Treatment villages had an average diarrhea rate of 28.3% while control villages had a rate of 23.8%. Diarrhea dropped in 2006 to about 14% in both treatment and control villages (Dickinson and Pattanayak, 2011). But in 2010, diarrhea rates are higher in all villages. Treatment villages now have a mean rate of 32%, while in control villages, the rate is 31.4%.

Table 5 presents ITT and IV estimates of the effect of the CLTS program on average village-level diarrhea prevalence. In each regression, they y-variable is the average village-level diarrhea rate among children under five in the two weeks prior to the survey. Column 1 presents a simple Intent-To-Treat estimate and Column 2 uses controls for village-level characteristics. Column 3 presents the IV results using the sanitation campaign as the instrument.

Since the 2010 diarrhea rates were calculated using data from both the households and their neighbors, it is conceivable that if the neighbors had higher rates of diarrhea (because they did not participate in the campaign), they could be driving up the average rates. I therefore present in Column 4 ITT results using data only from the households that took part in the campaign, excluding data from the neighbor surveys.

TABLE 7. DID ESTIMATES OF EFFECT OF CAMPAIGN ON AVERAGE VILLAGE-LEVEL DIARRHEA PREVALENCE IN BHADRAK, ORISSA, 2010 (N=40)

Village-level characteristics	**(1)**	**(2)**	**(3)**	**(4)**
Village received treatment	-0.029 (0.048)	-0.015 (0.051)		-0.054 (0.049)
% BPL households		-0.102 (0.125)	-0.064 (0.147)	0.017 (0.122)
% households using improved water sources		0.009 (0.321)	0.011 (0.294)	0.051 (0.360)
% of households practicing open defecation		0.277 (0.227)	0.095 (0.701)	0.109 (0.244)
% owning latrines (IV)			-0.003 (0.004)	
Constant	0.072*** (0.026)	-0.130 (0.408)	-0.012 (0.004)	-0.063 (0.406)
Adjusted R-squared	0.0095	0.0199	0.046	0.044

STANDARD ERRORS IN PARENTHESES * P<0.1, ** P<0.05, *** P<0.01

The models have inconsistent results about the impacts of the sanitation campaign and latrine ownership on diarrhea rates. None of the results are statistically significant. Column 4 shows that the results are not affected by excluding data from the neighbor surveys. I am thus unable to show any impact of the campaign on diarrhea prevalence among children under 5.

To further explore the impact of the campaign on diarrhea, I present estimates in Table 8 of the campaign effect on household-level diarrhea, where the dependent variable is the proportion of children under five in each household who reported a case of diarrhea in the two weeks prior to the survey. Column 1 presents the ITT estimate, column 2 adds controls for BPL status, education, open defecation practice, community monitoring, TV ownership, source of water, knowledge of diarrhea causes, exposure to sanitation messages, perception of sanitation work by NGOs and feelings about the appropriateness of open defecation. Column 3 also uses IHL ownership as a variable, while Column 4 presents the IV estimate, using the campaign as an instrument for latrine ownership.

Only the use of improved water sources is consistently significant across the models. The estimate is negatively signed, suggesting that using an improved water source decreases household-level diarrhea incidence.

I also estimate household-level diarrhea prevalence differently in Table 9, where the y-variable is a binary indicator for whether a household reported any case of child diarrhea in 2005, compared to whether it did so in 2010. The columns follow the format of Table 8. While the use of improved water sources is again significant in the ITT estimate, IHL ownership is statistically significant in the IV model, and the negative sign suggests that having a toilet (regardless of whether it was in a treatment or a control village) decreased the household level prevalence of diarrhea.

TABLE 8. DID ESTIMATES OF IMPACT ON SANITATION CAMPAIGN ON AVERAGE HOUSEHOLD DIARRHEA PREVALENCE IN BHADRAK, ODISHA IN 2005 AND 2010 (N=488)

HOUSEHOLD-LEVEL CHARACTERISTICS	(1)	(2)	(3)	(4)
TREATMENT VILLAGE	-0.058	-0.058	-0.041	
	(0.056))	(0.055)	(0.056)	
BPL		-0.0008	0.010	0.038
		(0.055)	(0.058)	(0.074)
HOUSEHOLD HEAD'S EDUCATION		-0.007	-0.006	-0.005
		(0.008)	(0.008)	(0.008)
HOUSEHOLD PRACTICES OPEN DEFECATION		0.071	0.027	-0.080
		(0.107)	(0.115)	(0.196)
RESPONDENT WOULD IGNORE OPEN		0.008	-0.007	-0.044
DEFECATION IF OBSERVED		(0.075)	(0.083)	(0.088)
OWNS TV		0.009	0.019	0.044
		(0.080)	(0.081)	(0.083)
USES IMPROVED WATER SOURCE		-0.274***	-0.265***	-0.242**
		(0.095)	(0.094)	(0.103)
KNOWLEDGE OF DIARRHEA CAUSES		0.004	0.0005	-0.007
		(0.028)	(0.028)	(0.030)
EXPOSURE TO SANITATION MESSAGES		-0.034	-0.034	-0.034
		(0.030)	(0.030)	(0.030)
RESPONDENT SAID NGO HAD DONE		0.025	0.036	0.065
SANITATION WORK IN VILLAGE		(0.057)	(0.055)	(0.069)
FEELINGS ABOUT OPEN DEFECATION		0.004	0.006	0.008
		(0.040)	(0.040)	(0.039)
IHL OWNERSHIP (IV)			-0.078	-0.269
			(0.091)	(0.256)
CONSTANT	0.112**	0.319	0.383	0.542
	(0.056)	(0.017)	(0.312)	(0.387)
ADJUSTED R-SQUARED	0.0023	0.028	0.019	0.007

STANDARD ERRORS IN PARENTHESES * P<0.1, ** P<0.05, *** P<0.01

TABLE 9. DID (PROBIT) ESTIMATES OF IMPACT ON SANITATION CAMPAIGN ON AVERAGE HOUSEHOLD DIARRHEA PREVALENCE IN BHADRAK, ODISHA IN 2005 AND 2010 (N=1044)

HOUSEHOLD-LEVEL CHARACTERISTICS	(1)	(2)	(3)	(4)
TREATMENT VILLAGE	0.084	0.116	0.129	
	(0.086)	(0.087)	(0.097)	
BPL		-0.070	-0.063	0.020
		(0.074)	(0.075)	(0.046)
HOUSEHOLD HEAD'S EDUCATION		-0.007	-0.006	-0.003
		(0.011)	(0.010)	(0.005)
HOUSEHOLD PRACTICES OPEN DEFECATION		0.067	0.021	-0.245
		(0.144)	(0.180)	(0.172)
RESPONDENT WOULD IGNORE OPEN		0.056	0.036	-0.133*
DEFECATION IF OBSERVED		(0.127)	(0.130)	(0.077)
OWNS TV		0.041	0.054	0.014
		(0.087)	(0.094)	(0.065)
USES IMPROVED WATER SOURCE		0.052	0.060	-0.158*
		(0.262)	(0.262)	(0.084)
KNOWLEDGE OF DIARRHEA CAUSES		-0.011	-0.013	0.002
		(0.037)	(0.037)	(0.020)
EXPOSURE TO SANITATION MESSAGES		-0.074	-0.073	0.024
		(0.053)	(0.053)	(0.020)
RESPONDENT SAID NGO HAD DONE		-0.062	-0.055	0.060
SANITATION WORK IN VILLAGE		(0.010)	(0.098)	(0.051)
FEELINGS ABOUT OPEN DEFECATION		0.131*	0.132*	-0.026
		(0.069)	(0.069)	(0.029)
IHL OWNERSHIP (IV)			-0.079	-0.434*
			(0.116)	(0.259)
CONSTANT	-0.362***	-0.892**	-0.816	
	(0.044)	(0.430)	(0.418)	
R-SQUARED	0.0023	0.007	0.0072	

STANDARD ERRORS IN PARENTHESES * P<0.1, ** P<0.05, *** P<0.01

DISCUSSION

The analysis shows that the effects of a public health intervention on behavior change do not necessarily end with the initial intervention. The high rate of latrine adoption after 2006 suggests that the campaign continued, through social effects and other mechanisms, to influence household sanitation improvements. This result indicates that a short-term evaluation of similar projects is likely to underestimate the true impacts. Cost-benefit analyses which consider the medium- and long-term benefits of these interventions may find their results altered considerably. Further research into the determinants of late adoption can help identify the causal pathways through which this change occurs.

Another important finding is the high proportion of BPL households among late adopters and continuous users. The DID estimator indicates that BPL households, which were given subsidies to construct toilets, far outnumbered APL families, and a triple difference estimate suggests that subsidies given to poor families were responsible for more than half of the continued effect of the campaign. It is an open question if similar results would be obtained in different contexts. However this finding does cast some doubt on the effectiveness of a strict no-subsidy approach, like the one advocated by CLTS supporters like UNICEF and the World Bank. Further research which contrasts no-subsidies approaches with shame-and-subsidies campaigns could provide crucial empirical evidence to help resolve this issue.

The impacts of the sanitation campaign on child health are less conclusive. Only the IV estimate using a binary variable for household-level diarrhea suggests that the campaign had positive effects on child diarrhea. The overall increase in diarrhea levels in both treatment and control villages could be caused by several unobserved factors (like the timing and intensity of the monsoons) which affect the different pathways to diarrhea transmission.

The inconclusive HAZ and WAZ measures could also be caused by differential attrition. Only 743 of the 1572 children surveyed in 2005 could be located in 2010. The attrition could have been caused for instance, by younger children dying due to poor health, or children with better health migrating from home, which would affect the estimates. Differential rates of latrine use in households which own latrines could also be a mediating factor. Over 66% of households which owned latrines in 2010 said that at least one family member continued to practice open defecation, which complicates the situation considerably.

Effect of Institutions: A Qualitative Assessment

In treatment villages, the quality of toilet construction, which was not directly measured through the survey, seemed to be an apparent determinant of sustained ownership and use. Where toilets had been poorly built, they were almost never repaired or used. Brajesh Senapati, the Bhadrak District Project Coordinator for Rural Water and Sanitation Supply (RWSS) admitted that the quality of toilets supplied under the TSC had been uneven in past

years. “Earlier, BPL households had to pay Rs. 300 and the government would pay Rs. 1200 towards the construction of the toilet. That was just not enough to build a good toilet”, he said. “Since 2010, the government has been paying Rs. 2200 and the BPL household pays Rs. 300. But even that is not enough. People will only use toilets as long as they are built well.”

Senapati said a useable toilet, with four walls and a roof, costs at least Rs. 3000. He says BPL families are urged to contribute building materials in kind. In villages close to a production center, the costs of transporting construction materials are lower, which means households have to pay even less. But the lack of all-weather roads in many villages in Bhadrak means that production centers are few and far between.

Debabrata Das, the secretary of Pragati Jubak Sangh, an NGO that works with WaterAid International in Orissa, said that NGOs which work with the government to build toilets get Rs. 50 for finished toilet, as ‘motivation costs’. “Market prices of materials are not reflected in the government subsidy”, he said. “The only incentive an NGO has to continue to work in this field is moral, not economic”. Kishore Club, an NGO which was part of the original CLTS intervention in 2005, has stopped constructing toilets altogether. Subhas Chandra Mahanti, an employee at Kishore Club, said that it could not afford to run any more losses.

K P Behera, the Junior Engineer (RWSS) in Chandbali block, said the government does not have the manpower to monitor latrine use. Once a TSC intervention is completed in a village, there is almost never any follow-up visit. Behera insisted, however, that the problem is not one of supply, but of demand. “Everyone knows the difference between a Nokia phone and a Samsung phone nowadays; they want to buy the best one. But few people are willing to pay the same amount to build a latrine”, he said.

NGOs carrying out sanitation interventions said there are other factors at work too. Debabrata Das said one of the main problems with monitoring latrine use is a lack of co-ordination between government agencies. “The village sanitation committee was supposed to ensure that motivation levels stayed high. But then the National Rural Health Mission provided for the setting up of a Gaon Kalyan Samiti (Village Improvement Committee) which is also supposed to look at sanitation. As a result, nobody does any follow-up.” For latrine use to be sustainable, Das said, monitoring is essential. “You can’t just give birth to a child and then leave it to fend for itself.”

Given the findings about the rise in latrine ownership after the end of the intervention, and the evidence (albeit limited) to show that it decreases household diarrhea prevalence, public investment in similar interventions can go a long way in helping India overcome its sanitation challenges. Further research into the mechanisms that underlie the implementation of the campaign can broaden and deepen its impacts.

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