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IZA DP No. 11446

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ABSTRACT

A Community Based Program Promotes Sanitation*

Basic sanitation facilities are still lacking in large parts of the developing world, engendering serious environmental health risks. Interventions commonly deliver in-kind or cash subsidies to promote private toilet ownership. In this paper, we assess an intervention that provides information and behavioral incentives to encourage villagers in rural Mali to build and use basic latrines. Using an experimental research design and carefully measured indicators of use, we find a sizeable impact from this intervention: latrine ownership and use almost doubled in intervention villages, and open defecation was reduced by half. Our results partially attribute these effects to increased knowledge about cheap and locally available sanitation solutions. They are also associated with shifts in the social norm governing sanitation. Taken together, our findings, unlike previous evidence from other contexts, suggest that a progressive approach that starts with ending open defecation and targets whole communities at a time can help meet the new Sustainable Development Goal of ending open defecation.

JEL Classification: Q53, Q58, D78

Keywords: sanitation, behavioral change, community-based intervention, social norm

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* The authors would like to thank the Bill & Melinda Gates Foundation for funding this study. We are grateful for the excellent research assistance provided by Natalia Cantet and Carolina Lopez. We would like to acknowledge the valuable comments received from Britta Augsburg, Radu Ban, Paul Gertler, Nicolas Osbert, Alix Zwane, and two anonymous referees as well as participants in several seminars. We also thank Maria Adelaida Lopera, Pablo Gluzman and Moussa Coulibaly for their superb assistance with field training and field work management. Finally, we thank our field team recruited by GREAT Mali for collecting data during a tumultuous time in rural Mali, UNICEF and the Directorate of Sanitation of Koulikoro.

1. Introduction

As of 2015, 2.4 billion people still do not benefit from adequate sanitation. This includes 892 million people practicing open defecation (WHO and UNICEF 2017). Progress has been slow: the percentage using improved sanitation facilities rose from 59 % in 2000 to 68 % in 2015.

We conducted an experiment between 2011 and 2013 to assess the effectiveness of a sanitation program implemented in rural Mali and found massive changes in sanitation related behavior. We have previously published data from the same experiment in The Lancet Global Health (Pickering et al. 2015), where we report no impact from the intervention on child diarrheal prevalence and, at the same time, improvements in child growth. The paper suggests that improvements in sanitation may have prevented growth faltering through pathways others than reductions in diarrhea. The purpose of the current paper is different in that sanitation behavior is our main outcome of interest. In another unpublished paper co-authored by one of us (Gertler et al. 2015), evidence from sanitation experiments run in four different countries are compared. With the exception of Mali, the sanitation interventions show very modest effects on health outcomes. Mali was the only place where a pure behavioral program was implemented, while the others offered a mix of behavioral and market-oriented measures (demand-side subsidies and/or increase in the supply of trained masons and construction material). Herein, we aim to understand pathways through which improvements in sanitation were made possible with such a "simple" behavioral intervention.

There is growing evidence that behavioral interventions can help solve environmental problems (Luoto et al. 2014, Croson and Treich 2014). Such interventions are now widely used in the Water, Sanitation and Hygiene sector (Cairncross 2003, Jenkins and Sugden 2006, Mara et al. 2010). Community-Led Total Sanitation is a participatory approach that targets rural communities and encourages them to collectively end open defecation (Kar 2003). CLTS programs exist in more than 20 countries in Africa and Asia and supported by local and international NGOs, governments and other international organizations (Chambers 2009), though there is little evidence on their effectiveness.

What are the mechanisms through which CLTS may lead to improved sanitation behavior? What degree of improvement can be expected from an approach that relies on soft incentives to increase the demand for sanitation facilities? To construct a theory of change, we make explicit our assumptions about the causal relationships between the intervention's activities and mediating factors that are expected to lead to improved sanitation.

Based on this theory of change, we designed and conducted a policy experiment in rural Mali, in the region of Koulikoro. To avoid bias from selective program placement, we randomly selected CLTS intervention areas. We collected detailed information on sanitation practices as well as on individual and social determinants of sanitation choices. To limit bias from self-reports, part of the data comes from observations by field agents. To explore the mechanisms that led to the observed change, we collected and analyzed data on a set of possible mediators: perceptions of risk related to sanitation choices, knowledge of preventive actions that could be undertaken to limit these risks, and perceived private and social benefits and costs, including cost of latrine construction and cost associated with social shaming.

We find that CLTS increased private latrine ownership by almost a factor two (treatment: 61.7% vs control: 33%), an effect that is statistically significant. Latrine use increased by the same factor. CLTS also reduced open defecation (OD) substantially. These findings are robust to all metrics that we consider, whether self-reported or the result of observations by field agents.

We also find that information regarding health gains from safe sanitation does not play a role in the sanitation behavioral changes we observe. Households in both intervention and control areas were already quite knowledgeable about the risks associated with poor sanitation. In contrast, information regarding availability of cheap technical solutions to build toilets led households to update their beliefs on the cost of a latrine. Building new latrines and repairing existing ones is perceived to be much more affordable as a result of CLTS. Such a revision in beliefs can be expected to directly increase demand for sanitation.

In addition, we find evidence of a significant increase in social disapproval of OD because of CLTS, consistent with the emergence of a new norm regarding defecation practices in the community. Finally, we provide evidence of a role for baseline latrine owners in enforcing the new norm. Baseline latrine owners hold more accurate information on the extent of latrine use in the community. Armed with more accurate information, they can better enforce the norm, increasing the cost faced by those deviating from it. Baseline latrine owners also revised their beliefs on cost barriers to private latrine ownership. They now are more likely to believe that everyone can afford a private latrine and thus more likely to feel legitimate in enforcing this norm.

Our paper contributes to a recent literature assessing policy options for improving sanitation outcomes using experimental methods (Clasen et al. 2014, Guiteras et al. 2015a, Patil et al 2015, Briceño et al. 2015, Cameron et al. 2013). These papers evaluate different sanitation interventions that combine features of a CLTS program with financial and supply measures. None of these papers, however, evaluates the impacts of a « pure » CLTS program, i.e., an intervention aimed at producing open-defecation-free communities without other measures like monetary subsidies or supply-side marketing. In general, these experiments show little impact on latrine coverage and use and no impact on health.

Data from this experiment are used in two other papers (Pickering et a;. 2015 and Gertler et al. 2015). Both papers focus on health impacts, though they also document effects on sanitation as “first stage” evidence. In the current paper, we provide a more thorough analysis of sanitation behavioral responses to CLTS. We offer a conceptual framework that makes explicit channels through which a pure behavioral change sanitation campaign may lead to reduction in OD, and test for pre-specified mediating factors. Such analysis is absent from the two other papers.[1]

This paper adds to the existing evidence explaining the failure of many sanitation interventions to deliver strong impacts on health. Such a failure may in part be due to weak implementation of the behavioral components when programs include financial and supply incentives (Gertler et al. 2015, Briceño et al. 2015, Hammer and Spears 2016). Failure can

[1] See Appendix 1 for a comparison of this study with the two previous one using the same experiment.

also come from design issues.[2] In order to be able to disentangle design vs implementation, one needs to properly document programs as implemented. We provide evidence that CLTS in Mali was implemented as planned. Nor was there any major disruption from the political situation due to the conflict in the North of the country. The success of CLTS in Mali is thus consistent with proper implementation of a well-designed program.

Even though we (and others in this literature) randomly selected intervention areas in order to avoid bias from selective placement, a bias in self-reported outcomes due to the desire to conform to the prescription of the intervention could lead to an overestimation of the true program effects (Hawthorne effect). We investigate this issue and find no difference between self-reports and observations by field agents. We thus argue that the impacts can reasonably be considered as causal effects of the program.

Our experiment does not include the multiple treatment arms needed to properly test for separate explanations for the effect of the program. However, we outline the possible determinants of sanitation choice and our hypotheses on how CLTS could affect this choice. We then use the rich set of data on intermediary outcomes that we pre-specified at the design stage and purposively collected to distinguish between the separate explanations for program effects that we offer in our theory of change. Our analysis allows us to dismiss some of these competing explanations and guides the discussion of the study findings.

Our paper is organized as follows. In section 2, we describe the intervention and provide a conceptual framework to highlight the mechanisms behind program success. In Sections 3 and 4, we present the experimental design and data sources respectively. In Section 5, we detail how the program was implemented. In section 6, we discuss the main findings and we conclude in section 7.

[2] Clasen et al. (2014) study in Orissa as an example of a well-implemented program for which lack of impact on open defecation is likely to be due to design issues. Failure may be due to (1) the fact that toilet construction does not necessarily translate into toilet use, (2) not enough households within the community were using safe sanitation facilities to actually obtain health gains.

2. Program Description and Conceptual Framework

In this section, we describe how CLTS[3] is designed and implemented in rural Mali. We chose to study sanitation in Mali because (1) the country's sanitation coverage is typical of that of Western Africa,[4] (2) a CLTS program was being piloted in rural areas at the time we started this research. In the following, we will frame our predictions about the effects of CLTS in Mali by exploring the possible determinants of sanitation choice. This allows us to form hypotheses about how CLTS may affect this choice.

2.1 Program details

2.1.1 Objective and rationale

CLTS is an approach designed to induce people to stop open defecation and increase use of privately owned latrines. This objective should be attained by increasing awareness regarding the community sanitation situation and the need to find appropriate solutions.[5] Increased awareness and availability of cheap solutions should, in turn, lead to increased demand for safe sanitation. The program is deemed successful when all community members commit to eliminating OD and achieve this goal.

The second distinctive feature of CLTS is that it advocates the creation of open-defecation-free villages as an ultimate goal and thus targets a change at the level of the whole community. The program offers rural communities the opportunity to be certified as OD-free. A necessary condition is that OD is no longer practiced by anyone in the community. Open defecation needs to be limited because it causes externalities by polluting soil and water sources (Humphrey 2009). The program focuses on individual behavioral change as a method of reducing the population's risk of disease. But why does CLTS set the target level of zero open defecation? One rationale is that the social payoff from ending OD increases with the number of villagers that stop. Feedback on others' intentions and choices

[3] CLTS is a community-based rather than a community-led program (Mansuri and Rao 2004) as community members participate to the implementation rather than to the design of the program.

[4] Mali belongs to the group of countries, essentially located in Sub-Saharan African, where less than 50% of the population use improved sanitation (WHO/UNICEF 2015).

[5] The complete description of CLTS is available at http://www.communityledtotalsanitation.org

may be obtained through social interactions during community meetings. Social comparison has been shown to have a significant effect regarding other environmental problems (Allcott 2011, Goldstein et al. 2008), and may act as a behavioral incentive, if, for instance, there is a preference for conformism or if villagers learn from each other about the private costs and benefits of alternative choices.

2.1.2 Targeted population

The program targets small rural communities facing a sanitation problem. Communities are geographically defined locations at the level of which the intervention is implemented. The following criteria define eligibility:

1- the community must be located in a rural area,
2- the village population should be between forty and seventy households
3- village latrine coverage should be sixty percent or less.

2.1.3 Operations

In Mali, CLTS is a program run by the Direction Nationale de l'Assainissement (National Sanitation Office), with support from UNICEF. There are three main activities. The first, called "triggering", consists in a community gathering that lasts 3 to 5 hours during which the CLTS agents focus everyone's attention on the issue of sanitation. The main output of this meeting is a detailed timeline describing the commitments made by each household to build a latrine or repair an existing one.[6] The second activity consists in follow-up visits to each household, to help monitor the commitments made during the triggering session. Visits are conducted by CLTS staff and community members identified as local sanitation champions during triggering. They are planned on a bi-weekly basis for up to three months, depending on the speed at which commitments are fulfilled. The last activity is awarding OD-free status to those communities that are successful in eliminating OD. Local authorities are invited to inspect the village to check that no OD zones can be found, and that each household owns to and exclusively uses a private latrine to defecate. Latrines must be

[6] More on triggering in the next paragraph.

equipped with a cover and a hand-washing station.[7] Local authorities are in charge of issuing certification for OD-free villages. The awarding of OD-free status attracts media coverage and is celebrated by villagers.

The initial "triggering" session is at the heart of the program. During this community gathering, participants are invited to express their views on the village sanitation situation. The discussion is facilitated by CLTS staff trained to broach the subject of defecation, taboo here as in most places in the world.[8] CLTS facilitators are also trained not to be perceived as lecturing the population, and are expected to step aside to let local sanitation champions take the lead in the discussion. To make the discussion more concrete, CLTS facilitators usually organize a series of activities.[9] In most villages, facilitators demonstrate how contamination from feces to food and water may occur through flies. These activities are meant to trigger strong emotions of disgust, to elicit social disapproval of OD and to make villagers want to commit to ending OD and becoming equipped with a latrine. To encourage reluctant households to commit, facilitators promote latrines that can be locally built using available resources, making it plain that everyone can afford a latrine.

2.2 Conceptual framework

In what follows, we summarize and explain the possible determinants of sanitation choice and hypothesize how CLTS may affect this choice. To do so, we highlight the main incentives embedded in the design of the program that may have led to a change in behavior. Based on this theory of change, we identify intermediary and final performance outcomes and describe the set of hypotheses that we test in Section 4.

[7] According to the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation, CLTS latrines are "improved sanitation facilities" as they hygienically separate human excreta from human contact.

[8] CLTS hires its staff locally. They sometimes hire from the caste of griots, whose birthright, in West African societies, includes being allowed to talk about subjects that are considered as taboo by the rest of the community (e.g., violence against women).

[9] They may ask the community for a tour of the village to map OD areas. They may also ask villagers to try to estimate the quantity of feces produced each year and assess out-of-pocket health expenditures incurred. Villagers may also be asked to recall the main diseases that affected the village in the past year.

2.2.1 Choice of sanitation technology

At the individual level, adoption of good sanitation practices depends on the perceived benefits and costs. Households may value the instrumental role of sanitation in disease prevention (Dupas 2011). They may also value latrine use directly, as a more comfortable, safer and cleaner option than open defecation (Routray et al. 2015). Finally, adoption may depend on the perceived affordability of latrines: the cost of building/acquiring them and keeping them functional.

Moreover, one individual's sanitation practice may also be influenced by the choices made by others in the community (Jenkins and Curtis 2005, Guiteras et al. 2015a, Shakya et al. 2015). The strategic interactions between community members could yield two opposite outcomes. On the one hand, any health benefits may depend on the cleanliness of the surrounding environment. Acquiring a latrine is costly, and benefits accrue to all in the community, potentially leading to a free-rider problem. The social incentive may thus result in under-provision of clean sanitation at the community level, if a community member's own effort and other people's effort to ensure a clean environment are substitutes. These interactions may lead to an equilibrium of poor sanitation. On the other hand, there may be positive strategic interactions if the incentive to adopt good sanitation practices increases when others in the community adopt them. Social pressure to conform to the practices of others would generate this type of incentive. Under social pressure, using latrines becomes more valuable the more people use them, making decisions to adopt good sanitation practices complements at the community level. If these strategic complementarities are strong enough, multiple equilibria may emerge. Everyone may prefer the good sanitation equilibrium because it leads to a cleaner environment with higher health benefits. Yet communities could be stuck in a poor sanitation equilibrium because of a coordination failure.

Finally, decisions over sanitation may be made based on incomplete information regarding several dimensions of the problem. Knowledge of the health benefits from better sanitation practices may be limited. Villagers may not be aware of other non-health benefits such as comfort, perception of privacy and other attributes of sanitation practices. Additionally, they may be overestimating the cost of building or acquiring a latrine. Latrines

are durable goods and, where there is low coverage, might be regarded as experience goods (Dupas 2014). Lastly, talking about sanitation practices may be such a taboo that individuals have inaccurate information on support for the practice at the community level.

2.3 Result chain

To identify the potential channels through which CLTS may lead to behavioral change, this section builds on the previous discussion of the determinants of sanitation choice. There are two complementary mechanisms through which CLTS may result in the adoption of better sanitation practices: (1) by altering the information set available to a household, (2) by coordinating villagers' efforts towards adopting better sanitation practices. When a few villagers start changing their behavior as a result of the change in their information set, others may follow. Feedbacks about villagers' intentions and choices during the public meetings may magnify the direct impact of information. Thus, targeting communities, rather than individual households, may speed up the process of behavioral change.

We now explicitly lay out the hypotheses that we will be testing. First, villagers may adopt better sanitation practices because CLTS improves their knowledge of the risks associated with poor sanitation and of the preventive actions to undertake. In the study villages, lack of awareness of the relationship between OD and poor formal health education may be a barrier to adoption of good sanitation practices. This lack of awareness is plausible in a population where more than 65% of the adults are illiterate. In this case, CLTS is best viewed as an education/information program. This leads us to our first hypothesis, stated below.

Hypothesis 1*: CLTS improves knowledge of the risks associated with poor sanitation and of the preventive actions to undertake to limit these risks.*

If we find no evidence of impact on knowledge and awareness, we can reject *hypothesis 1, thereby eliminating an implausible transmission mechanism*. However, if information on health risks is to be considered a channel for impact, another condition, which we do not test, must be satisfied: knowledge of the risks associated with poor sanitation and of the preventive actions to undertake needs to translate into better sanitation practices.

Second, villagers may adopt better sanitation practices because they learn through CLTS about cheap solutions for building private latrines. This supposes that limited information regarding the cost of installing and maintaining latrines is a barrier that CLTS helps to overcome. Only 35% of households own a private latrine in control villages, and while CLTS does not change their liquidity constraint, it may change their perception of the cost. Mistaken perceptions may have persisted because the communities are remote and villagers have little experience of sanitation facilities. Accordingly, CLTS may generate its impact by providing information on locally available technical solutions to improve sanitation.

Hypothesis 2*: Villagers learn about cheap solutions for building private latrines through CLTS.*

If *hypothesis 2* is true, we expect to find that their perceptions of cost have changed: more villagers should find latrines affordable. If we find no evidence of an impact on perception of cost, we can reject *hypothesis 2* and eliminate an implausible transmission mechanism.

Third, an original feature of CLTS is that its activities target and mobilize the whole community rather than individual households. Reaching out to the whole village at once may be more effective than approaching each household individually if social interactions are strong determinants of behavior. Social interactions may influence decisions if villagers share resources and information and learn from each other, or through conformism (Durlauf 2006). Targeting the community may make it easier to obtain a critical mass of households switching to private latrines, so that open defecation is no longer "the way we do it here". The success of a community-based approach will depend on the nature of the strategic interactions between community members. As previously discussed, social interactions may amplify or reduce program impact arising from changes in incentives at the individual level.[10] This is because two potentially opposing forces may be at work. On the one hand, by mobilizing the community, CLTS may reduce potential improvements in sanitation arising from a change in individual incentives, because of the free-rider problem. On the other hand, by stirring up strong emotions of shame regarding OD and of pride in the

[10] Hypotheses 1 and 2 pertain to changes in incentives at the individual level. Hypothesis 3 concerns a change in the social incentive structure.

achievement of OD-free community status, CLTS may help coordinate everyone's efforts towards ending OD, thereby moving the community towards a better sanitation equilibrium.

The size and direction of social effects is an empirical question. If CLTS works as a coordination device, everything else held constant, the private incentive to use latrines may increase when OD becomes a shameful practice. In control villages, we find that most people still defecate in the open with little or no social disapproval. In treatment villages, when asked to recall the most memorable CLTS activities, villagers report being deeply impressed by the demonstration of food and beverage contamination by feces through flies. This activity was purposely designed to trigger strong negative emotions of shame and disgust towards OD, so that villagers would regard OD as a practice to be frowned upon (Hopfensitz and Reuben 2009, Biran et al. 2014, Jannat et al. 2016). With hypothesis 3, we test whether CLTS increases social disapproval of OD, which would be indicative of a change in the prescriptive norm of behavior.

Hypothesis 3*: CLTS elicits social disapproval of OD, which makes ending OD a desirable outcome for the community.*

If we find no evidence of impact on social disapproval of OD, we can reject hypothesis 3. As previously, testing hypothesis 3 allows us to check one key mechanism and discard the explanation if no evidence is found to support the hypothesis.

3. Research design

3.1 Sampling frame

We chose to conduct our study in the region of Koulikoro. The region is located in the Western part of Mali and is the second largest in population. Koulikoro has a largely rural population, 2.4 million in 2009. The region comprises a diverse set of agro-climatic zones, Sahelian arid in the North and Sudanese wet in the South, which is irrigated by several rivers.

CLTS targets relatively small villages (30-70 households) that have low latrine coverage (less than 60% of households should own a private latrine). To be included in the study sample, communities had to satisfy CLTS requirements and not be already enrolled in CLTS. Moreover, CLTS typically intervenes in villages that are a significant distance apart, for two

reasons. First, physical contamination by fecal elements carried by air and water from neighboring communities may limit the benefits of the intervention, thereby discouraging the targeted villages from adopting clean practices. Second, CLTS relies on social contagion to generate demand from neighboring communities for the services it provides. Through word of mouth, neighboring villages are galvanized into directly requesting the support of CLTS to help them change sanitation practices. It was thus important that our sampling strategy respected this additional "spacing" constraint. We therefore used a systematic sampling design ensuring that study villages were all sufficiently distant from each other.

The sampling frame includes all small rural villages with low latrine coverage and no sanitation program in place, a total of 402 villages. Our main source of information for sampling was the Census data from 1998 (Infrastructure du Recensement 1998). We updated village size by applying population growth rates from the 2009 Census. We complemented these data with a list of villages that had already undergone a CLTS intervention, obtained from the Koulikoro Sanitation Office (Direction Régionale de l'Assainissement de Koulikoro).

We used a systematic sampling method that allowed us to respect minimum spacing between study villages, in order to limit spillovers between treatment and control group villages. Compared to the program when at scale, the impact estimate obtain in our study should be thought as a lower bound to the actual impact as spillovers from adjacent non-CLTS villages are likely to be negative.[11]

We drew a systematic sample based on the following steps:

1. We picked a village (the primary sampling unit) at random from the sampling frame.

2. We drew a circle of radius 10km around the village and picked another village at random from outside that circle.

3. We repeated steps (i) and (ii) until we obtained the desired number of villages.

Our main survey module (the household questionnaire) gathered detailed information on all households living in the sample villages with at least one child below age 10 (quasi-census of the population in the selected villages). We also collected information at

[11] We thank referee 1 for raising this important point.

the village level and at the household and individual levels for all household members. Figure 1 contains a map of our study area.

3.2 Research protocol

Usually, CLTS enrolls high-demand villages first, relying on word-of-mouth and media coverage of the certification event to generate demand in the neighboring communities. In this context, a simple difference in mean outcomes between treated and untreated communities could not be attributed to CLTS alone, since it would also reflect the underlying differences in demand for sanitation in the two types of communities. These differences in demand may reflect differences in the household composition of the communities (sorting) and differences in the costs and benefits of sanitation technology (e.g., certain soil types may make it more costly to build latrines).

Estimating the causal effect of CLTS required a valid counterfactual to measure what would have happened in the absence of the intervention. We constructed the counterfactual using random assignment. Because of the nature of the intervention, our unit of randomization is the village. We randomly assigned villages to treatment and control groups after baseline data collection.

To determine the number of villages to include in our study sample, we conducted power calculations aimed at detecting a 25% decrease in diarrhea incidence among children under the age of 5. We based the exercise on DHS data for 2001 for Koulikoro. At least 120 villages were required in our study sample, and we included 121, assigning 60 of them to treatment (CLTS) and the remaining 61 to control.

We collected baseline data in these 121 villages in April-June 2011. The CLTS intervention program was then implemented between September 2011 and June 2012. We collected follow-up data in April-June 2013, approximately 18 months after the end of program operations and with a 2-year lapse between baseline and follow-up. All baseline households plus any new households with children below age 10 were surveyed at follow-up.

3.3 Data

We recorded data on socio-economic characteristics, sanitation and hygiene practices, children's health outcomes,[12] as well as on the intermediary outcomes identified as potential indicators of the channels through which CLTS may affect behavior.[13] Most of the data is self-reported, but we also have direct observations by field agents on the presence and use of a private latrine and of a hand washing station, on the quality of the latrine used, on hand hygiene and on the cleanliness of the latrine and surroundings. We also asked about the practice of OD by different demographic groups in the household, satisfaction with the sanitation situation and safety concerns for women. We questioned the household on their understanding of health risks due to poor sanitation and on their knowledge and awareness of prevention measures, and we collected data on their attitude towards OD and beliefs about its prevalence at the community level. At the end of the survey, we also asked treatment group households about their experience with CLTS.

Our baseline data covers 4532 households, 2166 and 2366 corresponding to control and treatment respectively (Appendix Table 2). For the follow-up, we recorded information on 5206 households, and were able to match 4031 to the original dataset. The new households could fall into one of three categories: 1) households having migrated into the study community since baseline, potentially due to violence in other areas of the country;[14] 2) households with new children born since baseline; or 3) households that were present at baseline, but could not be matched to a baseline observation because the head of household changed or because the household merged with another household in the village. Table 1 shows the number of "new" households reporting that they were not interviewed at baseline (N=897). Unlike Pickering et al. (2015) and Gertler et al. (2015) who

[12] Our study is registered at clinicaltrials.org under NCT01900912. We investigate the program's impact on health in a companion paper (Pickering et al., 2015). We find significant effects on children's anthropometric outcomes, but no effect on diarrhea.

[13] Data on other outcomes were collected (e.g., water quality, social networks, public goods games) but these were not intended as intermediary outcomes or mediators for behavioral change.

[14] The percentage of households indicating migration to the area due to conflict is 0.98%.

use data from the same experiment,[15] our estimation sample is based on all households with children below age 10 present at endline, except when we examine impacts by subgroups with different baseline characteristics.

We are studying a poor rural population living in small villages (average population size around 300 individuals, see Appendix Table 3). Household size is large (7.6 members), with about 3.4 children below age 10. Households have been residing in their community for about 38 years, although 30% of them have at least one migrant member. A majority of households is Muslim and Bambara (main ethnic group in Mali). Most household heads are illiterate and work in agriculture. In these small communities, villagers participate in roughly 2 village organizations and can rely/would help 3.4 other community members in case of need. About a third of households own a private latrine, and more than a third of adults report practicing OD.

In Appendix Table 3, we compare treatment and control communities over a set of observed variables at baseline. We do not find statistically significant differences in means for a set of socio-economic characteristics.

4. Evidence on program implementation

In this section, we provide evidence on how the program was implemented in our study villages. Studies in other countries have found low take-up to be associated with weak implementation (Gertler et al. 2015). We also consider threats from the political situation and conflict in the country during the period of our study. We rely on two sources of data to check actual program implementation. The first is an internal report by UNICEF on CLTS operations in the study villages. The second is data directly gathered from respondents to our household survey (follow-up survey in CLTS villages).

According to UNICEF (2011), operations were successfully completed in all 60 treated villages, and OD-free status was achieved in 58. However, two difficulties were reported: 1) communities were more scattered geographically than in standard operations;

[15] Because the focus in these other two papers is on health effects, their analyses are restricted to households with children under 5 who were present at baseline, resulting in smaller sample sizes. We find that partially treated households (observed only at follow-up also experience sharp improvements in sanitation (results available upon request).

2) attacks in the North of Mali made operations more risky in the Nara district, deterring some of the recruited trainees from completing their field work. The report provides qualitative information on the triggering process, documenting whether villagers participated in the various triggering activities and how well these were perceived. Appendix Table 4 summarizes the information from UNICEF's qualitative report. The last two columns present statistics for a variable that takes value 1 if the triggering activity was successfully conducted and 0 if it failed to rally community members. The least successful activity was inviting adults to tour OD areas in order to map them (known as the walk of shame). Only 16% of the villages where the activity took place perceived it positively, and mapping was completed in only 55% of the communities. The communities seem well aware of the most common diseases, and usually able to identify them (diarrhea, malaria, cough and stomach ache). Communities successfully estimated the volume of feces and health expenditures in the previous year. Also, there seemed to be no problem identifying local champions.

During our follow-up survey, we asked respondents in treated villages about their experience with CLTS implementation. Nearly all households in CLTS villages could identify their village as a CLTS program beneficiary. A total of 77% of respondents in treatment villages reported attending the CLTS triggering event. Females were over-represented among participants: 91% reported at least one female household member attended, 77% reported at least one male. As many as 77% reported that children participated in the triggering activities.

Not only did most households recall participating in a CLTS triggering session, but they also remembered specific activities. Not surprisingly, the activity most vividly recalled was a demonstration of flies moving from fresh stool to food and water (87% remembered this activity). Other activities were also well recalled: mapping of open defecation areas (82%), private commitments to build latrines (82%), the videotaping of the whole event (81%), the tour of open defecation areas in the village (78%), and estimating the amounts of feces produced and the costs of treatments for disease (70%). Two thirds of households (64%) reported having made a commitment during triggering: among these, 92% committed to building latrines and 83% to stopping open defecation (OD). When asked if they had fulfilled their commitments, 76% reported completing the construction of a latrine and 80%

reported they had stopped open defecation (16% reported that they had reduced open defecation by half).

The frequency of monitoring visits in the treatment villages varied. Heterogeneity can be expected, with communities taking more or less time to honor their commitments. A total of 76% of households reported that the CLTS program had inspected their household; the mean number of inspections was 3. Almost all households who reported being inspected identified their village as a certified OD-free village. Most recalled that certification took place between March and June 2012.

Overall, based on both our data collection and UNICEF reports, the program was implemented according to design with no major obstacles. This CLTS experiment in Mali also stands out with respect to other CLTS-type policy experiments for which implementation data are reported. These include Indonesia's Total Sanitation and Sanitation Marketing program and India's Total Sanitation Campaign. In Indonesia, merely 25% of treatment households reported knowing about CLTS triggering taking place in their community (Cameron et al. 2013) and only 13% reported attending such a meeting. In Madya Pradesh in India, 29% of households in Total Sanitation Campaign treatment villages reported participating or being aware of CLTS activities (against 15% in control villages).

5. Main findings

In the following, we provide evidence of large and statistically significant changes in defecation practices as a result of the program, as Tables 4 to 6 show. All the villages selected to be in the treatment group agreed to participate. These villages were selected as representative of the target villages for the intervention. As a result, our estimates pertain to average effects of the intervention for the targeted communities (ATT). We estimate these impacts by OLS, clustering standard errors at the village level. We estimate these effects using the follow-up data only (see Appendix table 5 for a difference-in-difference table that shows little change through time in control communities). We first document impacts based on self-reported and observed latrine ownership and use. We then discuss the impacts on OD practices for different demographic groups (adults, children, the elderly) as well as by gender. We also describe how the program affects the quality of sanitation

facilities used in the study communities. Finally, we provide evidence on changes in household satisfaction with their sanitation situation and experience.

5.1 Latrine ownership and use, OD practice

We find a 28 p.p. increase (column 1, in Table 1) in private latrine ownership as a result of CLTS (treatment: 61.7% vs control: 33%). In relative terms, latrine ownership almost doubled as a result of CLTS, even though no village where *everyone* owns a private latrine at the time of follow-up.[16] Latrine use (column 2, Table 1) was very similar to latrine ownership in both treatment and control (use is defined as at least one household member using the latrine). However, this outcome is self-reported and may be overestimated in treatment villages due to a social desirability bias. For that reason, we also used data resulting from observations by field officers to gauge the extent to which social desirability bias is an issue. We asked field agents to record, based on the rapid direct observation method, whether the latrines seemed to be used regularly (yes; no; cannot say). We also asked them to indicate whether there was a footpath leading to the latrine that appeared to be used on a regular basis (yes; no; cannot say). Columns 3 and 4 (Table 1) show that observed use (observation by field agents) is similar to self-reported use in both treatment and control localities. Consequently, the estimated impact is similar, whether we use self-reported or observed outcomes.

While 82% of households in control villages reported that at least one household member regularly practiced OD when at home, this was true of only 40% in treatment villages (column 5, Table 1). This 42 p.p. drop in OD practice is consistent with the increase in latrine use that can be attributed to the program.[17] OD was also less likely to be practiced inside the village (column 6, Table 1).

[16]All treatment villages in our study sample were reported to have 100% latrine coverage at the time of certification. It may be that latrine use declined post-certification, or that inspections prior to certification were not thorough.

[17] However, given the way we constructed our sanitation variables, OD and private latrine use are not necessarily mutually exclusive, though they are for about 70% of all households. In about 20% of households, there is at least one member who regularly use the private latrine and at least one member who regularly OD. Another 10% of households is neither practicing OD on a regular basis, nor using private latrines. These are using shared latrines.

Different members of the household appeared to have different practices, and cultural norms and habits may explain differences between gender and age groups. We find a large increase in the proportion of children under 5 using latrines or potties (column 1, Table 2). Consistent with the three-fold increase in latrine/potty use resulting from CLTS, we find a huge reduction in the proportion of children regularly practicing OD: from 82% in control villages to 41% in treatment villages (column 2, Table 2). For children under 10, latrine use more than doubled as a result of the program (columns 3 and 5, Table 2) and their OD rates dropped from around 65% to 23%. For adults (columns 1 to 4, Table 3), reported latrine use was much higher than for children in the absence of the program (31% for adults vs. 13% for children). Adults were also less likely to report that they practice OD on a regular basis compared to children in the absence of the program (33% for adults vs. 65% for children).

The large reduction in OD (in absolute terms) among children is consistent with them being mobilized by CLTS. Indeed, 79% of households in CLTS villages reported attending triggering activities with their children and specific activities were organized in 77% for children in these villages (Appendix table 4). The effects on adults were similar in relative terms to those on children. Latrine use almost doubled as a result of CLTS (from 31% in control villages to 59% in treatment villages). Regular OD practice was less frequent in treatment villages (10%) than in control villages (33%), a 23 p.p. drop attributable to the program. The effects on both latrine use and OD practice were similar across genders for both children and adults. The elderly (columns 5 and 6, Table 2) fell somewhere between the children and the adults: latrine use was uncommon and comparable to that of the children (15%) in the absence of the program. The program had less impact on the elderly than on the children (18 p.p. increase) but a comparable impact to that on the adults in relative terms (doubling). Regular OD practice by the elderly in the absence of the program (32%) and the effect of the program (23 p.p. drop) were similar to those found for adults.

5.2 Quality of latrines

Since latrines are privately supplied, the quality of latrines obtained though CLTS merits examination. CLTS promotes pit latrines equipped with a cover to limit the proliferation of flies from the pit and with a hand-washing station (a bucket of water and either soap or ashes). Latrines must be used exclusively by the household, with no sharing with neighbors.

In the following, we examine the extent to which these requirements were met. As previously, we compare average outcomes in treatment and control communities, without conditioning on latrine ownership.

Overall, there were more latrines in accordance with CLTS requirements in treatment than in control localities (columns 1-4, Table 4), based on direct observations by field agents.[18] There was a 34 p.p. increase in households with latrines equipped with a cover on the pit (from 9% in control areas to 43% in treatment areas). In the absence of the program, very few households had latrines equipped with hand-washing stations, while latrines in CLTS villages were more likely to be equipped with a hand-washing station. However, full compliance with all CLTS requirements is only of the order of 20%. Although many more households are equipped with a private latrine as a result of the program, only a fifth of all households in CLTS villages had private latrines meeting all CLTS standards. Finally, if we examine other latrine quality features, beyond the set of criteria chosen by the program, we obtain the same conclusions (Table 5). The proportion of households whose latrine is equipped with a concrete slab increased by about 5 p.p. (column 1); with a roof, 1 p.p. (column 2); with a door, 10 p.p. (column 3); and with a potty, 5 p.p. (column 4). Although these effects are large in relative terms and statistically significant, they remain small in the absolute.

In summary, as a result of CLTS, households were equipped with private latrines that they used to a large extent. But they still appeared unable or reluctant to meet the full CLTS requirements. One major debate among sanitation experts is whether to use a progressive approach, moving up from open defecation to unimproved facilities to shared facilities (e.g., community latrines) to improved latrines, to address the sanitation problem in developing countries. The latrines promoted by CLTS are improved sanitation facilities: they are basic pit latrines equipped with a slab that allows human excreta to be hygienically separated from human contact. We find strong evidence that CLTS was successful in promoting basic improved latrines that are well suited to the Malian context. However, CLTS additional

[18] If the household did not own a private latrine, these observations could not be made and the variable takes value 0. We include non-latrine owners in the sample because conditioning on private latrine ownership might have introduced a bias (Angrist, Bettinger and Kremer, 2006).

requirements (hand-washing station, pit cover) were only met in a few cases. This, in turn, suggests that a gradual approach to total sanitation may be a more pragmatic solution.

5.3 Satisfaction and perceived amenities

Since CLTS is a collective endeavor, those who manage to acquire a latrine can be expected to be satisfied with their experience, while those who do not are likely to feel less satisfied with their sanitation situation than if there had been no program. Overall, we find that CLTS results in a 20 p.p. increase in the proportion of households feeling satisfied with their sanitation situation (Table 6, column 1) as opposed to unsatisfied or very unsatisfied. This is a substantial increase over the satisfaction rate in the control areas (50%). We also asked villagers about their degree of satisfaction with important attributes of the place they commonly use to defecate (cleanliness, comfort, being functional and offering privacy). CLTS improved satisfaction along all these dimensions (Table 6): the location is found to be cleaner (column 2); more functional (column 3); to provide more privacy (column 4); and to be more comfortable (column 5).

Here, an important remark is in order. Our understanding is that CLTS is "merely" changing choice architecture, leaving people to freely choose to adhere to it, just as they freely choose to accentuate social stigma on those practicing OD. Assessing the welfare consequence of an intervention that coaxes individuals to adopt "good" behavior is challenging in two respects (Bernheim 2008). It may be difficult to infer people's true preferences simply by observing their choices: how can we know whether the intervention actually makes people better off, "*as judged by themselves*"? (Thaler and Sunstein 2008, page 5, italics in original) It may also be difficult to learn much from asking them to rate their sanitation experience. That's because CLTS-type interventions foster, through disgust and shaming (Guiteras et al. 2015b), a social norm that may make ODers less likely to state they are happy with their experience.

5.4 Women's safety

In the absence of latrines, women may feel unsafe going to the bush, especially at night. They may fear harassment and may judge the privacy inadequate. As a result of CLTS, fewer women find the place they use for defecation unsafe at night (from 17% in control areas to

7% in treatment areas) (column 1, Table 7). They are also less likely to find that it does not provide adequate privacy (10 p.p. drop from 26%) (column 2, Table 7). Yet the program does not appear to lessen harassment: few women reported experiencing harassment when defecating in either treatment or control localities (column 3, Table 7).

5.5 Evidence on potential mechanisms

In the previous section, we provided evidence of a substantial increase in latrine use and decrease in open defecation due to CLTS. In this section, our aim is to shed light on the mechanisms generating such a large impact.[19]

CLTS may be viewed as a program that provides information and educates people on sanitation issues and solutions. We test whether CLTS (1) improves knowledge of the risks associated with poor sanitation and of the preventive actions to undertake to limit these risks, (2) makes villagers learn about cheap solutions for building private latrines through CLTS. In addition, the entire CLTS triggering is designed to make OD unacceptable. We test whether (1) CLTS increases social disapproval of OD, (2) there is a role for baseline latrine owners in enforcing the new norm.

The findings are striking. Households in both CLTS and non-CLTS villages were actually quite knowledgeable on the health risks and on the preventive actions to undertake, despite high levels of illiteracy (less than a third of household heads report knowing how to read and write). About 98% of households in control villages knew that poor sanitation causes illness in children (column 1, Table 8). We find little or no evidence of improvements in knowledge of the consequences of poor sanitation for children's health. When asked about the most relevant action to undertake to prevent diarrhea in children (answers not prompted), about 85% of households in control villages mentioned improving

[19] Because CLTS has different components, one approach to identifying these mechanisms would be to apply various CLTS-like interventions, each stressing different aspects of the program. For example, a pure information intervention vs one with a focus on changing attitudes towards open defecation. Since this was not possible in our setting, we evaluated CLTS as part of a local government action to reduce OD, and explore the different mechanisms through the hypotheses laid out earlier in the paper.

sanitation or hand hygiene as preventive actions (column 2, Table 8).[20] There is no difference between CLTS villages and control villages. Asked when it is important to wash hands (answers not prompted), about 94% of households in control areas knew they should wash their hands at specific times during the day (column 3, Table 8).[21] Again, there is no program effect. All in all, villagers appeared to be well informed already and we find no evidence that CLTS provides information/educates villagers on the risks associated with poor sanitation.

We find some evidence of change in households' perception of latrine cost. Villagers were asked whether they believed latrines were too expensive for members of their community to have them. As a result of CLTS, households are less likely to believe that latrines are too costly to afford (35% in control villages vs. 21% in treatment villages, a 14 p.p. decrease; column 1, Table 9). The impact on private latrine ownership is significantly higher for those who hold low prior beliefs over affordability by 8 p.p. (column 2, Table 9). Our interpretation is that by correcting misperceptions on the affordability of latrines, CLTS may encourage villagers to own private latrines.

We find that social disapproval of OD, measured as how shameful it is to practice OD, significantly increased as a result of CLTS (column 1, Table 10). Our interpretation is that, by eliciting social disapproval against OD, CLTS makes ending OD a desirable outcome for the community and fosters the emergence of a new norm regarding defecation practices.

We now provide suggestive evidence supporting the fact that baseline latrine owners have a specific role to play in enforcing the new norm. We find that baseline latrine owners are changing their beliefs on cost barriers to private latrine ownership (column 1, Table 10) at the same rate as non-owners (column 2, Table 10). They now are more likely to believe that everyone can afford a private latrine. Our interpretation is that baseline latrine owners may now feel legitimate in enforcing the new norm. In addition, we find a lower

[20] Defined as reporting at least one of the following as a preventive action against child diarrhea: hand washing, bathing, using latrines, keeping house clean, preparing and storing food and water properly, drinking clean water.

[21] Defined as reporting, without being prompted, any of the following hand-washing practices: after latrine use, after cleaning a child, before and after eating, before preparing food.

proportion of households holding incorrect beliefs as a result of the program (column 1, Table 11). This reduction in the share of households holding incorrect beliefs is driven by a decline in the proportion of households overestimating latrine use (column 2, Table 11), with no change for those underestimating it (column 3, Table 11).[22] Interestingly, these effects are driven entirely by changes in beliefs among baseline latrine owners (columns 4 to 6, Table 11). This group thought latrine use was more prevalent than it actually was. CLTS helped correct this misperception. Baseline latrine owners are thus found to hold more accurate information on the extent of latrine use in their community. Our interpretation is that, armed with more accurate information, this group can better enforce the norm, increasing the cost faced by those deviating from it.

Findings from other recent studies support our interpretation. Guiteras et al. (2015a), Shakya et al. (2015) also find that social influences at the village level can affect the adoption of good sanitation behavior. Guiteras et al. (2015a) provides experimental evidence for Bangladesh on demand spillover effects among residents of the same village. Shakya et al. (2015) provides non-experimental evidence for India of the role of social networks in latrine ownership.

6. Discussion and conclusion

In this paper, our focus is on one type of community-wide sanitation intervention that was shown to reduce stunting and improve child growth (Pickering et al., 2015). Surprisingly, there is little evidence that sanitation interventions generate health gains (Schmidt 2014, Garn et al. 2016), despite a large consensus in the health community that sanitation is important for health (Ferriman 2007). Such a failure may in part be due to the fact that changing sanitation habits is hard: if so, the weak link may be the interventions, not the sanitation. Recent evidence shows that a village-level intervention in rural India that bundles and partially subsidizes private latrines and bathing facilities equipped with tap water leads to sharp increases in latrine coverage and health gains, suggesting that neglect

[22] Overestimating latrine prevalence takes value 1 if household believes latrine to be commonly used when they are not, 0 otherwise. Underestimating latrine prevalence takes value 1 if household believes latrine to be uncommon in the community when they are not, 0 otherwise.

of complementarities across water and sanitation may explain failure of other sanitation programs in India (Duflo et al. 2015).[23]

The new Sustainable Development Goals call for the elimination of open defection in the next fifteen years. We find evidence that a community-based behavioral intervention led to a sizeable increase in latrine use and reduction in open defecation in rural Mali without subsidies and without bundling sanitation with tap water connections. CLTS almost doubled private latrine ownership and use, a substantial achievement given that about a third of all households in the control group own or use a private latrine. Open defecation was reduced by half as a result of CLTS, a considerable change considering that 82% of the control group practiced OD when at home.

Compared to previous results on CLTS+ interventions, these are large effects. Several explanations can be put forward. Our Malian setting differs greatly in terms of climate, population density and culture from countries like India, Bangladesh and Indonesia. In particular, in India, norms of purity and pollution are found to be a barrier to latrine use (Coffey et al. 2017). The Tanzanian experiment led to comparable relative reductions in OD, though lower in absolute terms than in our setting. Another noticeable difference is that, while a pure CLTS approach was used in Mali, in all these other experiments, a community-based behavioral approach inspired by CLTS was combined with market-based instruments (demand subsidies and supply-side measures). We are not suggesting that synergies between these approaches are impossible (Guiteras et al 2015a). But we provide evidence that the scale of implementation of CLTS in Mali is considerably larger than in the other settings, consistent with the stronger response to the program in the Malian experiment than in the other experiments (Schmidt 2015, Gertler et al. 2015). Focusing more specifically on the Indian case, abuse by contractors paid by householders out of the government subsidy has been reported, and may have led to the construction of poor quality latrines that go unused (Routray et al. 2015).

Measurement of latrine use and OD is more difficult than measurement of ownership a latrine. Yet, ownership is not a sufficient condition for use, e.g., if the latrine

[23] Other programs in India unsuccessfully experimented with community-level approaches and subsidies. The distinctive feature of the program assessed in Duflo et al. is the promotion of bathing facilities equipped with tap water.

owned does not provide services needed (as when the latrine is broken or does not provide enough privacy). We found no evidence of reporting bias when self-reports of latrine use were compared with observations by field agents. Direct observations of toilets by field agents are considered better than self-reports for unbiased measurement, but one common limitation of direct observations is that they provide no information on individual use or frequency of use. However, focusing the attention of the international community on latrine use rather than latrine ownership, as well as OD practices, has identified the issue of non-use of existing latrines.

Our findings suggest that a progressive approach that starts with the modest goal of having people stop OD and get equipped with basic pit latrines can be effective. It is important to note that, although based on a rudimentary technology, the improvements in sanitation attributable to CLTS have been recognized as advances towards Millenium Development Goals.[24] These improvements are associated with an increase in households' satisfaction with their sanitation situation and experience. Key to such improved sanitation is the large uptake in CLTS communities, where on average 60% of households own and use a latrine. This high uptake may, in turn, explain why young children also experience health improvements (Pickering et al. 2015).[25] Yet, this progressive approach may not be feasible in other settings, like India, where basic pit latrines, though affordable to most, may not be socially acceptable (Coffey and Spears 2017).

We find that information on health risks associated with poor sanitation does not play a role in changing sanitation behavior, as households are already quite knowledgeable. This is consistent with other findings on the ineffectiveness of health messages in promoting behavioral change (World Bank Development Report 2015). In contrast, we find striking changes in beliefs concerning the affordability of latrines. By providing information on

[24] According to the WHO/UNICEF Joint Monitoring Programme for water supply and sanitation, an improved sanitation facility is one that hygienically separates human excreta from human contact. As such, pit latrines promoted by CLTS are considered as improved sanitation.

[25] In Pickering et al. (2015), we offer one of the first piece of strong evidence of a link between sanitation and health. Cutler and Miller (2006) is a major contribution, although the focus is on connection to sewage. Spears (2013) find that much of the variation in international child health is explained by sanitation. In rural settings where sanitation infrastructure typically does not involve connection to sewage, there is little evidence of health impacts from existing field experiments (e.g., Clasen et al., 2014, Patil et al. 2014).

appropriate technical solutions that are affordable by most, CLTS may help villagers fulfill an unsatisfied demand for better sanitation. The program also appears to change beliefs about whether OD is a shameful practice, with social disapproval of OD significantly increasing as a result of CLTS. This suggests that behavioral change resulting from the change in beliefs about affordability may be magnified through social interactions at the community level. Further research is needed on the role of social interactions in fostering the adoption of preventive behavior (Perkins et al. 2015). What types of social interaction can be useful to harness? Community behavioral interventions often start by exploiting community interactions during village meetings, followed by local sanitation leaders doing follow-up monitoring door to door. In future work, we are planning to study the issue of declining adherence to hygienic behaviors in India, with the aim of investigating the role of local community leaders.

One final remark is in order. While latrine coverage almost doubled in our study area as a result of the program, one year after the end of intervention, no community had eliminated OD, although 58 out of our 60 intervention villages were certified OD-free. A possible explanation is that these villages were incorrectly certified OD-free although they did not meet the 100% latrine coverage requirement. Alternatively, households may have slipped back to OD. This, in turn, raises the issue of sustainability. Is a "one-shot" intervention sufficient to obtain a permanent change in behavior? Assessing sustainability may require an experiment to be conducted over 5 years or more (Clasen et al. 2014), which could be very difficult to justify and perform (Schmidt 2015). The long-term success of a behavioral change intervention can be expected to depend on the persistence of newly-formed habits (Croson and Treich 2014). It may well take more than one community behavioral intervention visit to achieve permanent improvement in sanitation practices.

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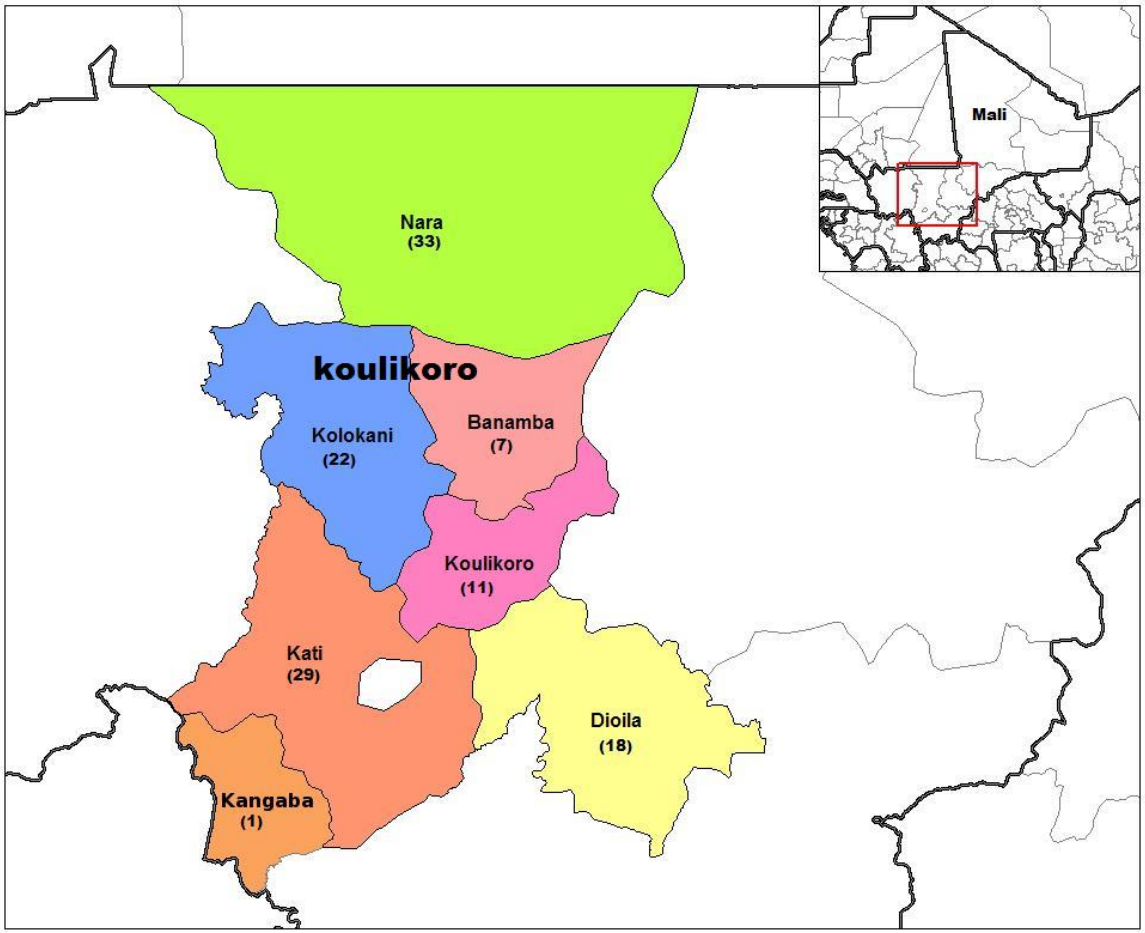
Figure 1: Map of study area



Note: Number of study villages in each district between parentheses

Table 1: Household latrine ownership and use, OD practice

VARIABLES	Ownership of a private latrine	Self-reported use of private latrine	Observed proof of use[1]	Observed foot path towards latrine	OD is main practice when at home	OD inside the village
CLTS treatment	0.287***	0.283***	0.274***	0.234***	-0.419***	-0.0660*
	(0.0358)	(0.0362)	(0.0354)	(0.0334)	(0.0364)	(0.0396)
Constant	0.330***	0.325***	0.310***	0.256***	0.821***	0.349***
	(0.0248)	(0.0248)	(0.0239)	(0.0205)	(0.0192)	(0.0300)
Observations	5,148	5,148	5,132	5,132	5,148	5,148

Note: OLS estimates, standard errors clustered at the village level. *** p<0.01, ** p<0.05, * p<0.1.

[1] "Observed proof of use" is based on direct observation by field agents.

Table 2: Latrine use and OD practices among children

VARIABLES	Latrine/Potty: child under 5	OD: child under 5	Latrine: Girls aged 5-10	OD: Girls aged 5-10	Latrine: Boys aged 5-10	OD: Boys aged 5-10
CLTS treatment	0.286***	-0.410***	0.279***	-0.424***	0.290***	-0.437***
	(0.0325)	(0.0371)	(0.0329)	(0.0463)	(0.0334)	(0.0453)
Constant	0.101***	0.823***	0.134***	0.653***	0.134***	0.663***
	(0.0146)	(0.0193)	(0.0162)	(0.0327)	(0.0157)	(0.0311)
Observations	4,765	4,439	4,033	2,693	4,135	2,720

Note: OLS estimates, standard errors clustered at the village level. *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Latrine use and OD practice among adults

VARIABLES	Latrine: Women	OD: Women	Latrine: Men	OD: Men	Latrine: Elderly	OD: Elderly
CLTS treatment	0.283***	-0.227***	0.281***	-0.235***	0.186***	-0.237***
	(0.0366)	(0.0497)	(0.0370)	(0.0489)	(0.0307)	(0.0500)
Constant	0.319***	0.326***	0.313***	0.335***	0.151***	0.323***
	(0.0250)	(0.0420)	(0.0250)	(0.0414)	(0.0150)	(0.0454)
Observations	5,127	5,094	5,044	4,885	3,533	1,288

Note: OLS estimates, standard errors clustered at the village level. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Quality of latrines

VARIABLES	Observed: Cover over the pit	Observed: Bucket of water	Observed: Soap	Observed: Bucket of ash	Full compliance with CLTS requirements
CLTS treatment	0.342***	0.142***	0.0824***	0.183***	0.206***
	(0.0282)	(0.0180)	(0.0128)	(0.0222)	(0.0234)
Constant	0.0898***	0.0144***	0.0168***	0.00239*	0.00638***
	(0.00986)	(0.00274)	(0.00309)	(0.00123)	(0.00196)
Observations	5,148	5,148	5,148	5,148	5,148

Note: OLS estimates, standard errors clustered at the village level. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Other equipment for latrines

VARIABLES	Other: concrete slab observed	Other: roof observed	Other: door observed	Other: potty observed
CLTS treatment	0.0473**	0.0160***	0.0977***	0.0502***
	(0.0182)	(0.00566)	(0.0266)	(0.0124)
Constant	0.0583***	0.00559***	0.117***	0.0172***
	(0.00773)	(0.00186)	(0.0155)	(0.00418)
Observations	5,148	5,148	5,148	5,148

Note: OLS estimates, standard errors clustered at the village level. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Satisfaction and perceived amenities

VARIABLES	Satisfaction with sanitation situation[1]	Place is clean[2]	Place is functional[3]	Place provides privacy[4]	Place is comfortable[5]
CLTS treatment	0.195***	0.252***	0.160***	0.172***	0.172***
	(0.0388)	(0.0391)	(0.0397)	(0.0473)	(0.0473)
Constant	0.497***	0.497***	0.386***	0.522***	0.526***
	(0.0296)	(0.0296)	(0.0267)	(0.0272)	(0.0345)
Observations	5,148	5,124	5,123	5,124	5,123

Note: OLS estimates, standard errors clustered at the village level. *** p<0.01, ** p<0.05, * p<0.1.

[1] Variable takes value 1 if satisfied and 0 if unsatisfied or very unsatisfied.

[2,3,4,5] Variables take value 1 if good or fair and 0 if poor.

Table 7: Sanitation and women's safety

VARIABLES	Place is unsafe at night	Place does not provide privacy to women	Women harassed
CLTS treatment	-0.101***	-0.102**	-0.00416
	(0.0355)	(0.0427)	(0.0127)
Constant	0.174***	0.259***	0.0367***
	(0.0295)	(0.0325)	(0.00694)
Observations	5,148	5,148	5,148

Note: OLS estimates, standard errors clustered at the village level. *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Knowledge of health benefits and preventive actions

VARIABLES	Know health risks of poor sanitation	Know preventive actions[1]	Know when is important to wash hands
CLTS treatment	0.00336	-0.00950	0.0127
	(0.00521)	(0.0206)	(0.0105)
Constant	0.979***	0.846***	0.936***
	(0.00336)	(0.0150)	(0.00773)
Observations	5,148	5,148	5,148

Note: OLS estimates, standard errors clustered at the village level. *** p<0.01, ** p<0.05, * p<0.1.

[1] Variable takes value 1 if reports, without being prompted, at least one of the following as preventive actions: hand washing, bathing, using latrines, keeping house clean, preparing and storing food and water properly, drinking clean water (0 if unable to identify any of those as preventive actions).

Table 9: Beliefs over latrine affordability and ownership of a private latrine

VARIABLES	Believes latrine to be unaffordable	Ownership of a private latrine
CLTS treatment	-0.141***	0.263***
	(0.0325)	(0.0433)
Interaction CLTS treatment with baseline belief over latrine affordability	-	0.0849**
		(0.0383)
Baseline belief over latrine affordability[1]	-	-0.0967***
		(0.0275)
Constant	0.347***	0.401***
	(0.0248)	(0.0295)
Observations	5,148	3,940

Note: OLS estimates, standard errors clustered at the village level. *** p<0.01, ** p<0.05, * p<0.1. [1] Baseline belief over latrine affordability takes value 1 if believed prior to CLTS that latrines were not affordable to all, 0 otherwise. Note that sample size decreases in column 2 because we implicitly restrict the sample to households that we could follow-up from baseline to endline by conditioning on baseline beliefs.

Table 10: Social norms

VARIABLES	Agree/Strongly agree: OD is shameful	Baseline latrine owners: Believes latrine to be unaffordable	Baseline non-owners: believes latrine to be unaffordable
CLTS treatment	0.136***	-0.118***	-0.164***
	(0.0262)	(0.0383)	(0.0404)
Constant	0.723***	0.281***	0.380***
	(0.0194)	(0.0305)	(0.0299)
Observations	5,148	1,392	2,604

Note: OLS estimates, standard errors clustered at the village level. *** p<0.01, ** p<0.05, * p<0.1.

Table 11: Incorrect beliefs

VARIABLES	Incorrect beliefs over latrine prevalence[1]	Overestimate latrine prevalence[2]	Underestimate latrine prevalence[3]	Incorrect beliefs over latrine prevalence[1]	Overestimate latrine prevalence[2]	Underestimate latrine prevalence[3]
CLTS treatment	-0.142**	-0.167**	0.0244	-0.0396	-0.0777	0.0381**
	(0.0598)	(0.0653)	(0.0173)	(0.0692)	(0.0731)	(0.0175)
Interaction treatment with baseline latrine owner	-	-	-	-0.288***	-0.262***	-0.0266
		-		(0.0633)	(0.0653)	(0.0171)
Baseline latrine owner[4]	-		-	0.154***	0.136***	0.0175**
				(0.0454)	(0.0462)	(0.00780)
Constant	0.390***	0.350***	0.0405***	0.333***	0.306***	0.0262**

	(0.0376)	(0.0424)	(0.0135)	(0.0427)	(0.0435)	(0.0109)
Observations	5,130	5,130	5,130	3,979	3,979	3,979

Note: OLS estimates, standard errors clustered at the village level. *** p<0.01, ** p<0.05, * p<0.1.

[1] Incorrect beliefs over latrine prevalence takes value 1 if household believes latrine to be uncommon in the community when actually most villagers use latrines, 0 otherwise.

[2] Overestimate latrine prevalence takes value 1 if household believes latrine to be commonly used when they are not, 0 otherwise.

[3] Underestimating latrine prevalence takes value 1 if household believes latrine to be uncommon in the community when they are not, 0 otherwise.

[4] Baseline latrine owner takes value 1 if owned a private latrine prior to the program, 0 otherwise.

Note that sample size decreases in column 4-6 because we implicitly restrict the sample to households that we could follow-up from baseline to endline by conditioning on baseline latrine ownership.

Appendix Table 1: Comparison of this study and the other two papers using data from the same experiment.

	This study	Pickering et al. (2015)	Gertler et al. (2015)
Main outcome of interest	Sanitation outcomes and sanitation related behavior (Tables 1-7)	Child health, including diarrhea and anthropometrics (Tables 3 and 4)	Child anthropometrics (Tables 7-8)
Secondary outcome of interest	Knowledge, beliefs, norms (Tables 8-11)	Sanitation outcomes and sanitation related behavior (Table 2)	Measure of intensity OD practice ranging from 0 to 6 (Table 3, 5-6) and type of facilities any/shared/private (Table 4)
Sample size	5206 households, includes both those present in baseline and follow-up and households present at follow-up only (described in Appendix Table 2)	4031 households, includes only households present at both baseline and follow-up (described in figure 1)	Same sample as Pickering et al. (Tables 1 and 2)
Balance check	Appendix Table 3	Table 1	Table A3 for the Mali experiment, A1-A2 and A4 for the other three experiments

Appendix Table 2: Sample size at baseline and follow-up

	No. of households in full sample	No. of households in control villages	No. of households in CLTS villages
In baseline	4532	2166	2366
In follow-up	5206	2536	2660
Matched baseline/follow-up	4031	1911	2120
New	897	486	411

Appendix Table 3: Baseline characteristics of treatment and control groups

	CLTS treatment villages			Control villages		
	N	Mean	S.D.	N	Mean	S.D.
Number of households per village	2365	341,13	142,30	2165	293,57	100,17
Household size	2365	7,56	3,73	2165	7,64	4,05
Number of children below age 10	2365	3,34	1,97	2165	3,44	2,12
Number of adults (age 15-45)	2365	2,50	1,31	2165	2,48	1,37
Number of elderly (age 45+)	2365	0,78	0,94	2165	0,81	1,17
Duration of residency in village	2348	38,28	16,32	2131	38,88	15,99
Has a migrant household member	2365	0,30	0,46	2165	0,28	0,45
Muslim	2353	0,88	0,32	2154	0,90	0,30
Bambara by ethnicity	2360	0,68	0,47	2164	0,65	0,48

Head is married	2362	0,98	0,14	2165	0,98	0,14
Head has no education	2175	0,81	0,39	1971	0,81	0,39
Head is illiterate	2218	0,69	0,46	2031	0,68	0,46
Head works in agriculture & forestry	1950	0,54	0,50	1763	0,46	0,50
Head works in livestock farming & fisheries	1950	0,05	0,22	1763	0,06	0,24
Head holds a business	1950	0,07	0,26	1763	0,08	0,28
Head works in construction	1950	0,01	0,10	1763	0,02	0,13
Index of household assets	2354	-0,11	0,82	2147	-0,08	0,86
Index of working assets	2357	-0,13	0,87	2152	-0,11	0,87
Number of organizations in which head participates	2365	1,90	1,42	2165	1,90	1,36
Number of households head can rely on in time of need	2361	3,40	2,04	2163	3,31	1,80
Number of households who would help him if needs be	2361	3,39	2,23	2162	3,39	1,83
Ownership of a private latrine	2365	0,33	0,47	2165	0,35	0,48

Male members mainly practice OD	2223	0,36	0,48	1976	0,34	0,47
Female members mainly practice OD	2286	0,35	0,48	2038	0,35	0,48

Notes: Summary statistics based on baseline sample. Index of assets obtained through factor analysis.

Appendix Table 4: Qualitative Indicators of CLTS activities in Koulikoro

Category	# of times mentioned	# of times not mentioned	Mentioned as positive	Mentioned as negative	Mean	Std. Dev.
1. Community welcome	37	23	31	6	0.83	0.374
2. Team's introduction	58	2	58	0	1.00	0.000
3. Cartography, map of OD areas	56	4	56	0	1.00	0.000
Regular OD	33	27	33	0	1.00	0.000
Urgent OD	34	26	33	1	0.97	0.171
4. Splitting of adults and infants	57	3	51	6	0.89	0.310
5. Choice of leaders	59	1	59	0	1.00	0.000
6. March of shame (*'Marche de la honte"*)						
Children	46	14	41	5	0.89	0.315
Adults	49	11	8	41	0.16	0.373
7. Calculation of the volume of feces per day/month/year	59	1	59	0	1.00	0.000
8. Calculation of health expenditures in CFA	60	0	60	0	1.00	0.000
9. Naming the main three diseases present in the community	51	9	51	0	1.000	0.000
10. Community engagement to build/repair latrines	60	0	60	0	1.000	0.000

Source: Authors' calculations based on UNICEF "Rapport de Formation"

Appendix Table 5: Fraction owning a private latrine by experimental groups and by date

	Before	After	Difference
T=1	.34	.65	.31
	(.47)	(.47)	(.01)
	[2,101]	[2,101]	
T=0	.35	.34	-.01
	(.47)	(.47)	(.01)
	[1,895]	[1,895]	

Note: Standard errors in parenthesis, sample size in brackets.