Final report: Impact evaluation of community-led total sanitation (CLTS) in rural Mali

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Executive Summary

Globally 2.5 billion people lack access to an improved sanitation facility; in Mali, only 15% of rural households use improved sanitation (JMP 2014). Community-led total sanitation (CLTS) uses participatory approaches to facilitate sustained behavior change to eliminate open defecation by mobilizing communities in order to achieve that goal. Although CLTS has been implemented in over 50 countries, there is a lack of rigorous and objective data on its outcomes in terms of sanitation and hygiene behavior, and on health impact such as diarrhea and child growth.

This report covers the main findings of the impact evaluation of a community-led total sanitation (CLTS) campaign implemented by the government of Mali (Direction Nationale de l’Assainissement) with the technical and financial support of UNICEF. We conducted a cluster-randomized controlled trial among 121 villages randomly selected in the region of Koulikoro in order to evaluate health and non-health program impacts. Baseline data was collected during April-June 2011, the CLTS intervention program was implemented in 60 villages between September 2011 and June 2012, and follow-up data was collected in April-June 2013. A total of 4,532 households were enrolled at baseline and 5,206 were visited at follow up; 89% of baseline households (N=4,031) were successfully matched to a household at follow up. The primary outcomes and impacts presented in this report are reported for those households present at both baseline and follow up.

The CLTS campaign was highly successful in increasing access to private latrines, improving the quality of latrines, and reducing self-reported open defecation. Access to a private latrine almost doubled among households in CLTS villages (coverage increased to 65% in CLTS villages compared to 35% in control villages). Self-reported open defecation rates fell by 70% among adult women and men, by 46% among older children (age 5-10), and by 50% among children under five. Children too young to use latrines were also more likely to use a child potty in CLTS villages. The program also increased perceived privacy and safety during defecation among women. These results were sustained over time.

Observations by field staff support respondent-reported reductions in open defecation, use of cleaner latrines, and improved hygiene in CLTS villages. Latrines in the CLTS households were 3 times more likely to have soap present (PR: 3.17, 95% CI: 2.18-4.61) and 5 times more likely to have water present (PR: 5.3, 95% CI: 3.49-8.05). Latrines at CLTS households were more than twice as likely to have a cover over the hole of the pit (PR: 2.78, 95% CI: 2.24-3.44), and 31% less likely to have flies observed inside the latrine (PR: 0.79, 95% CI: 0.68-0.93). CLTS households were also half as likely to have piles of human feces observed in the courtyard (PR: 0.54, 95% CI: 0.37-0.79).

Statistically significant impacts on child diarrheal or respiratory illness were not observed among children under five years of age when analyzing follow-up data only. It should be noted that even though randomization occurred after baseline data collection was complete and socio-economic characteristics were balanced across groups, most symptoms of diarrheal and respiratory illness were more prevalent in CLTS villages at baseline.
However, using a difference-in-difference modeling approach to account for baseline differences, we find significant reductions in loose or watery stool as classified by the stool chart among non-exclusive breastfeeding children. With the difference-in-difference estimator, we also find significant reductions in respiratory illness, including cough, difficulty breathing, and congestion.

There is evidence that the CLTS program has a positive and significant impact on growth outcomes among children less than five years of age. When accounting for baseline height measurements, children under five years old in CLTS villages were taller (+0.16 height-for-age Z-score, CI: 0.0, 0.32) and 13% less likely to be stunted (RR: 0.87, CI: 0.75, 1.0). Improvements in child weight (+0.09 weight-for-age Z-score, CI: -0.04, 0.21) and a reduction in the proportion of children underweight (RR: 0.85, CI: 0.70, 1.03) were also observed but were not statistically significant. However, the program significantly reduced the risk of severe stunting by 26% and the risk of being severely underweight by 35%.

We measured self-reported all-cause and cause-specific under-five child mortality among the study population as a secondary outcome. Each household was asked to report the age and gender of any household member that had died in the past 12 months and the cause of death. There was no significant difference in all-cause mortality between control and treatment arms (Poisson regression, robust standard errors are the village level). However, we found a 57% reduction in diarrheal-related under-five mortality in CLTS villages (RR: 0.43, Robust Std. Err: 0.16, 95% CI: 0.21-0.88; N=23 child diarrheal deaths in control, N=11 child diarrheal deaths in CLTS).

In addition, we designed a series of experimental games to measure the role of cooperation in the success of CLTS. We conducted these games over all 121 communities included in the study sample and at both baseline and follow-up. About one half of households in each community were randomly invited to participate to the games. All games were incentivized using valued items (rather than cash). We found a positive and statistically significant impact of the CLTS program on game contributions, indicating that pro-social behavior increased in these communities.

This study provides evidence that a pure behavioral intervention with no monetary subsidies substantially increased access to sanitation facilities in rural Mali. Latrines were also cleaner and better stocked with handwashing supplies in treatment villages, indicating improved hygiene behavior. Our findings suggest CLTS improved child growth, reduced the prevalence of stunting among children, and reduced child mortality due to diarrhea. However, the program did not have a significant impact on self-reported diarrheal illness, thus the program may have impacted child growth and mortality through pathways other than preventing diarrhea, such as reducing the subclinical condition of environmental enteropathy via decreased exposure to environmental fecal contamination.
1. Study Design and Research Objectives

This evaluation focuses on the effectiveness of a community-led total sanitation (CLTS) program implemented by the government of Mali in small rural communities with poor sanitation coverage, with the technical and financial support of UNICEF. CLTS is an approach that aims at improving sanitation through community mobilization. CLTS does not provide subsidies or hardware, an approach sometimes associated with low take-up (i.e., low latrine usage). Latrine construction for individual households is an important intermediary target, but the ultimate goal of CLTS is to create whole communities that are free of open defecation.

The program result chain is simple. Community members of beneficiary villages are invited to a public meeting, and a number of activities are conducted to raise awareness on the risks associated with open defecation and to develop a plan to build latrines. CLTS facilitators register villagers’ stated commitments and conduct follow-up visits for a period from 1 to 3 months in average. The village is then inspected to determine if all households own a private latrine equipped with a basic handwashing station and to observe any evidence of open defecation. If the village passes the inspection, the CLTS program offers a party to celebrate the end of open defecation. Certification as an open-defecation-free village is the main output of the program. This research assesses additional primary outcomes and impacts of the program, including access to private latrines, hygiene and water quality, and child health. Secondary impact indicators include education, labor, social attitudes, and the capacity for collective action.

The biological rationale for this result chain is that contamination of hands, food, and water by fecal elements, either through human waste, human contact, or flies, leads to infection with gastro-intestinal pathogens. Diarrhea can cause malnutrition, both by dehydrating individuals and by evacuating nutrients before they can be absorbed by the body. Environmental enteropathy may also be caused by exposure to fecal contamination and pathogens; this condition occurs when inflammation of the small intestine reduces capacity to absorb nutrients (Humphrey 2009). Parasites, such as soil transmitted helminthes, can also be transmitted when human waste is not safely contained in the environment (Bethony et al. 2006). Nutritional energy is diverted from growth to fight parasitic and other infections. Reduction in exposure to fecal contamination through improved sanitation and water infrastructure has been shown to lower child mortality (Watson 2006; Cutler and Miller 2005; Gamper-Rabindran, Khan, and Timmins 2008). There is also some evidence that sanitation interventions can improve child growth outcomes (Spears, Ghosh, and Cumming 2013), but rigorous causal evidence is lacking (Dangour et al. 2013).

Non-health impacts have also been posited to result from reduction in sanitation-related disease. Fewer infections in school-age children may lead to a decrease in illness-related absenteeism. Time allocation of older children and mothers may be altered as time spent caring for sick community members is freed up. Labor supply and school participation may increase as a result. Finally, CLTS is hypothesized to work through community mobilization. Community members may change beliefs about their capacity to act, making
them rely less on external factors, and more on their community. In particular, they may become better at solving social dilemmas, whenever collective action is required.

We conducted a cluster-randomized controlled trial in rural Mali in order to evaluate health and non-health program impacts. Study communities were randomly selected from a census of 402 villages in the Koulikoro regions of Mali. To be included in the study population, the community had to be relatively small (between 30-70 households), have low latrine coverage (less than 60% of households with access to a private latrine), and could not have been previously enrolled in a CLTS program. An algorithm was used to ensure a buffer of 10 km between each study village to prevent contamination between treatment and control villages. We collected baseline data in 121 villages in April-June 2011. The CLTS intervention program was then implemented in 60 of these villages between September 2011 and June 2012 by the government and UNICEF. We again collected follow-up data in April-June 2013, approximately 1 year after the end of program operation, in both intervention and control villages.

The main research questions addressed by this evaluation are as follows:

Primary outcomes:
1. What is the outcome of CLTS on hygiene and sanitation practices, including open defecation rates, use of private latrines and practice of handwashing with soap? Are these outcomes sustainable over time?
2. How does CLTS affect the quality of hygiene and sanitation conditions: cleanliness of the housing environment, availability of latrines and hand washing stations, latrine cleanliness, satisfaction, and drinking water microbial quality?
3. What is the impact of CLTS on under-five child health, specifically on child diarrhea and child growth? Does CLTS affect diarrhea-related mortality?

Secondary outcomes:
4. How does CLTS affect educational and labor outcomes, social attitudes, socio-psychological indicators such as the feeling of privacy and security among women, and the capacity for collective action?

In the next section, we present the study site and sample. In section 3, we discuss program implementation. In section 4, we present our main evaluation findings on sanitation, hygiene and children’s health. Findings on other outcomes and impacts are discussed in the appendix.

2. Enrollment

A full census was completed of each village by the field team. Census and baseline household survey data collection occurred between April and July in 2011. 4,532 households with at least one child under ten years of age were invited for an interview at baseline.
At follow up, all 4,532 households that were visited at baseline were targeted for interview, as well as any new households in study villages with at least one child less than 10 years of age. As a result, a total of 5,206 households were interviewed (Table 1). Among these, 4,031 households could be matched with the ones visited at baseline and 1,175 households were new. The new households could fall into one of three categories: 1) a household that migrated into the study community since baseline, potentially due to the violence in other areas of the country\(^1\); 2) a household in which new children were born since baseline; or 3) a household that was present at baseline, but was not able to be matched up with baseline data because the head of household changed or the household merged with another household in the village. Table 1 presents the number of “new” households that reported they were not interviewed at baseline (N=897). Households that could be followed from baseline through follow-up make up the study population for the primary analyses presented in this report. There were a total of 6,413 children under five and 2,700 children under two at follow up (among those households enrolled at baseline).

Table 1 Number of households enrolled in baseline and follow up survey

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Control</th>
<th>CLTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total households</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>2166</td>
<td>2366</td>
</tr>
<tr>
<td>Follow up</td>
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<td>2536</td>
<td>2660</td>
</tr>
<tr>
<td>Matched</td>
<td>4031</td>
<td>1911</td>
<td>2120</td>
</tr>
<tr>
<td>New</td>
<td>897</td>
<td>486</td>
<td>411</td>
</tr>
<tr>
<td><strong>Total children &lt;5 years with health data</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
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<td>3354</td>
<td>3508</td>
</tr>
<tr>
<td>Follow up</td>
<td>7603</td>
<td>3710</td>
<td>3893</td>
</tr>
<tr>
<td><strong>Total children &lt;5 with anthropometric measurements</strong></td>
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<td></td>
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</tr>
<tr>
<td>Baseline</td>
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<td>3153</td>
<td>3267</td>
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<tr>
<td>Follow up</td>
<td>7328</td>
<td>3564</td>
<td>3764</td>
</tr>
<tr>
<td>Matched</td>
<td>2449</td>
<td>1158</td>
<td>1291</td>
</tr>
</tbody>
</table>

Randomization occurred after baseline data collection was complete. Table 2 shows baseline characteristics of treatment and control groups. The majority of socioeconomic characteristics were balanced between groups at baseline, with the exception of the control group having a slightly higher proportion of households owning a mobile phone. Access to sanitation and an improved water source were also balanced across groups, as was soap and water observed in the latrine and water treatment practices. The percent of latrines observed to have flies or feces visible on the floor were significantly higher in CLTS villages.

Table 2 Baseline characteristics of treatment and control groups

\( ^1 \) The March 2012 military coup destabilized the country and allowed Tuareg separatists and Islamic militants to seize much of Mali’s northern regions until 2013. The percentage of households indicating migration due to the conflict is 0.98%.
3. CLTS implementation

The CLTS program is run by the Direction Nationale de l’Assainissement (National Sanitation Directorate, Ministry of Environment and Sanitation) with the support of several partners, notably UNICEF. It heavily relies on community mobilization as a way to foster collective action and achieve a cleaner environment. Community mobilization works through three stages. First, CLTS facilitators gather the community with the objective of triggering commitments to adopt good sanitation practices. Second, CLTS staff closely monitor the realization of these commitments (building or repairing latrines, stopping open defecation). Finally, after a standardized verification process, upon successful completion of their commitments, villagers are invited to a party to celebrate their achievement, in the presence of officials, the media and members of neighboring communities.

Program implementation rolls out as follows:

1. Pre-triggering visit: CLTS-trained staff convene with village leaders to collect basic data on the village and request a date to meet with the community

2. Triggering visit: A key moment for mobilizing the community is triggering; it consists in a series of activities that aim to raise awareness on the risks associated with open defecation, using mapping and observation exercises, and lead community members to commit to ending OD. Details on commitments are

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2 The whole session is usually facilitated by 3 or 4 CLTS-trained staff. They start by inviting community members to express their views on sanitation in their village. They request participants to take a tour of the village in order to map the open defecation areas and pick a sample to show how contamination to food and water occurs. Other activities include prompting villagers to estimate the quantity of feces produced per year, assess out-of-pocket health expenditures, observe flies landing on fresh feces and food, make the community observe and declare that lack of sanitation induces ingestion of feces, then prepare a time bounded action plan to end open defecation.
written down in a registry and the whole session usually lasts for 3-4 hours and is videotaped.

3. Poo fair: Representatives from all triggered villages gather so that they get to know each other and can compare what they have learnt so far and what they committed to do. A competition is organized between triggered villages. Participants are informed of the parameters of the competition such as open-defecation free standards to be met, awards for the first village that will reach the open defecation free status etc. A timeframe for building/repairing latrines is set by the participants with the assistance of CLTS facilitators.

4. Monitoring: Following the poo fair, CLTS staff return to the communities to follow-up on commitments. Frequent visits (up to bi-weekly) take place for a period of 1 to 3 months in average.

5. Inspection and possibly certification: Government officials visit the community to check if each household is equipped with a private latrine (equipped with a bucket of water, and ashes or soap) and if the village is free of open defecation (OD) areas. If these conditions are met, CLTS facilitators organize a ceremony to celebrate the achievement of the community. Members of neighboring communities, officials and the media are all invited to participate in the certification ceremony in the first village reaching ODF status.

During the follow-up survey, we asked respondents in treated villages about their experience with CLTS program implementation (only households that were present at baseline data collection are included in this analysis). The main findings are summarized below.

More than 99% of households in CLTS villages identified their village as a CLTS program beneficiary. A total of 77% of respondents in treatment villages reported having attended the triggering event held by the CLTS facilitators. Females were over-represented among participants: 91% reported at least one female household member attended, 77% reported at least one male. Interestingly, 77% report that children participated to triggering.

Not only did most households recall participating in a CLTS triggering session, but they also remembered specific activities. Not surprisingly, the activity most acutely recalled is a demonstration of flies moving from fresh stool to food (87% remembered this activity). It is closely followed by recollection of other activities: mapping of open defecation areas (82%), private commitments to build latrines (82%), the fact that everything was videotaped (81%), the tour of open defecation areas in the village, known as the walk of shame (78%), and estimating amounts of feces produced and related health costs (70%). Two thirds of households (64%) report to have committed during triggering: among these, 92% committed to build latrines and 83% to stop open defecation (OD). When asked if they fulfilled their commitments, 76% report completing the construction of a latrine and 80% report they stopped open defecation (and 16% report that they cut open defecation in half).

Monitoring visits were conducted in the treatment villages at various frequencies. Heterogeneity is expected here as communities may take more or less time to honor their
commitments. A total of 76% of households reported that a CLTS facilitator had inspected their household; the mean number of inspections was 3.

Almost all households who reported being inspected identify their village as a certified OD-free village. Most recall that certification took place between March and June in 2012. According to the Ministry of Environment and Sanitation, open defecation free (ODF) status was achieved in 59 villages out of the 60 assigned to receive the program.

One might be concerned that other sanitation programs promoting the use of latrines may have been conducted at the same time in treatment and/or control villages. We documented that: when asked if any organization had come to promote the building of latrines, 94% of households in CLTS villages responded positively, while 10% responded positively in control villages. Notably, the majority (92%) of respondents in control villages identified an organization other than the CLTS program, UNICEF, or the government as the promotional organization. In CLTS villages, 82% of respondents identify CLTS, UNICEF, or the government as the promoter.

*Political situation during study implementation*

The political situation during the study period was of concern with respect to the program implementation and the field team’s safety. The Malian government was overthrown by a military coup in March 2012, about six months prior to the original follow-up period. Due to the conflict, we postponed the collection of follow-up data. The international community severely condemned the coup and some actions were taken to assemble an interim government and call for elections. The situation was institutionally very fragile and soon after, Islamist extremists occupied the Northern region claiming for independence from the national government. This situation lasted for 10 months, but suddenly deteriorated when the rebels seized the city of Mopti, allowing access to Bamako, the country capital. This prompted a coordinated international response launched in January 2013, commanded by French and Malian troops and supported by most West African countries and the UN.

The North was recovered from the rebels in approximately a month. The situation has since been relatively calm (with isolated incidents in the Kidal zone) and a new democratic government was elected in October 2013. As of today, peace has been reestablished, but the situation is still fragile. The Northern region remains a hostile territory with guerrilla terrorists still in the area.

With respect to the CLTS project under evaluation, the Direction Nationale de l’Assainissement, with support from UNICEF, continued with the implementation of CLTS as planned originally. As can be observed in Figure 1, the region where CLTS was being implemented (Koulikoro, with capital Bamako) did experience the conflict by registering a higher than usual internal migration from people coming from the Northern zones and by having security issues in the Northern region.

We would like to note that the calendar for ODF certification was altered due to the higher security requirements for the program staff traveling to rural areas.
Fortunately, there were no major disruptions with the implementation of the program other than a slower process for final ODF certification, and a delay in data collection for the follow up survey. Originally the follow up survey was scheduled for November 2012, but it was postponed until the research team felt it was safe to resume data collection activities. The timing of the follow-up (April-June 2013) ended up being ideal in terms of matching the same season as the baseline survey, exactly two years post-baseline data collection.

4. Main findings

Sanitation
Access to a private latrine is 65% in the treatment group, compared to 35% in the control group at follow up. CLTS is responsible for an increase of 30 percentage points (p.p.) in the percent of households with access to a private latrine. Access to a private latrine almost doubled as a result of the program (an increase of 85%). Village-level latrine access ranged from 7%-93% in treatment villages and from 0%-70% in control villages.

Figure 2 Mean level of access to a private latrine by treatment group at follow up versus baseline levels of access

The usage of private latrines as the main defecation location also increased with access in CLTS villages. When a household had access to a private latrine, it was almost always the prime defecation location. In both CLTS and control villages, 98% of adult men and 98% of adult women reported the latrine as their main defecation location. In CLTS villages, children over the age of 5 years were significantly more likely to use a private latrine when it was available; 89% of girls and boys used the latrine in CLTS villages compared to 57% of boys and 62% of girls in control villages. Although younger children do not directly use latrines (because of safety reasons), they were significantly more likely to use a child potty as their main defecation location in CLTS villages (51%) than in control villages (15%). There is also an 18 p.p. drop in the percent of households that share their latrine in CLTS villages. In CLTS villages, shared latrines (where they exist) are used by a mean of 2.7 households, compared to a mean of 3.1 households in control villages.
In addition to increased use of private latrines, self-reported open defecation rates fell by 70% among adult women and men, by 46% among older children (age 5-10), and by 50% among children under five (Figure 3).

Figure 3 Proportion of households reporting open defecation as main defecation location for specified demographic by treatment status at follow up.

Latrines (both existing and built as a result of the program) are primarily pit latrines without a concrete slab (79%) - meaning with a platform made of locally available construction material; only 19% of latrines have a concrete slab. Latrines are newer by 1.6 years on average in treated communities (mean is 5.4 years old in control communities compared to 3.8 years old in treatment communities). A total of 70% of latrines in CLTS villages were located within 10 meters of the household, compared to 54% in control villages.

The CLTS program improved the quality of sanitation facilities. Households ranked their primary defecation location as better in terms of cleanliness, functionality, privacy, and comfort in CLTS communities (Table 3). For example, households in CLTS villages ranked the cleanliness of their latrines as good 65% of the time versus only 38% of the time in control villages.

Table 3 Rating of primary defecation location by treatment group (%)
Latrines in the CLTS households were 3 times more likely to have soap present (PR: 3.17, 95% CI: 2.18-4.61) and 5 times more likely to have water present (PR: 5.3, 95% CI: 3.49-8.05) (Figure 4). Latrines at CLTS households were more than twice as likely to have a cover over the hole of the pit (PR: 2.78, 95% CI: 2.24-3.44), and 31% less likely to have flies observed inside the latrine (PR: 0.79, 95% CI: 0.68-0.93).

Figure 4 Latrine cleanliness by treatment group at follow-up

<table>
<thead>
<tr>
<th>Cleanliness</th>
<th>CLTS</th>
<th>Control</th>
<th>Functionality</th>
<th>CLTS</th>
<th>Control</th>
<th>Privacy</th>
<th>CLTS</th>
<th>Control</th>
<th>Comfort</th>
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<th>Control</th>
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<td>Good</td>
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<td>69</td>
<td>51</td>
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<tr>
<td>Fair</td>
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<td>Poor</td>
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<td>15</td>
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<td>20</td>
<td>9</td>
<td>20</td>
<td>20</td>
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</tr>
</tbody>
</table>

CLTS households were about half as likely to have piles of human feces observed in the courtyard (PR: 0.54, 95% CI: 0.37-0.79). Animal feces were 11% less likely to be observed in the courtyards of CLTS households (PR: 0.89, 95% CI: 0.84-0.87).

Overall satisfaction with sanitation is higher in CLTS communities and there is evidence that the program improved the defecation experience for women. Households in CLTS villages were more likely to report being satisfied (70%) with their overall sanitation situation than households in control villages (50%). Women in CLTS villages were significantly more likely to feel as though they had privacy when defecating (PR: 1.14, 95% CI: 1.02-1.27) and to feel safe defecating at night (PR: 1.12, 95% CI: 1.03-1.22). People view their village as cleaner in CLTS villages; respondents in CLTS villages were more likely to classify their village as “very clean” compared to control villages (31% vs. 25%).

Overall satisfaction with sanitation is higher in CLTS communities and there is evidence that the program improved the defecation experience for women. Households in CLTS villages were more likely to report being satisfied (70%) with their overall sanitation situation than households in control villages (50%). Women in CLTS villages were significantly more likely to feel as though they had privacy when defecating (PR: 1.14, 95% CI: 1.02-1.27) and to feel safe defecating at night (PR: 1.12, 95% CI: 1.03-1.22). People view their village as cleaner in CLTS villages; respondents in CLTS villages were more likely to classify their village as “very clean” compared to control villages (31% vs. 25%).
Households in treated communities were more likely to find it shameful to practice OD, (86% versus 72%) and more likely to have the view that most people in their village use latrines. Indeed, half (49%) of respondents in control villages agreed with the statement “the majority of people in my community do not use latrines for defecation,” while only 14% of respondents in CLTS villages agreed with the statement.

CLTS villagers are also more likely to report that people get sick with diarrhea (i) by being in contact with other sick individuals (+7.2 p.p. from 54%), (ii) because of lack of personal hygiene (+8.1 p.p. from 79%), (iii) when there are bad odors (+9.5 p.p. from 62%), (iv) due to a dirty environment (+9.6 p.p. from 76%). CLTS villagers are also more likely to report that diarrhea prevention involves washing hands and bathing children (+2.4 p.p. from 20%). Few households across both groups mentioned that using latrines help prevent diarrhea.

On average, respondents reported that it took 6 days to build their latrine (SD 5) and 71% reported that the latrine did not cost anything to build. Latrines (and houses) in Mali are primarily constructed from mud brick (a mixture of clay, water, and binding material such as straw), which can be made at no cost, and wood. Respondents reported that household members constructed themselves 89% of latrines; 34% of households obtained help from other community members, and 16% hired someone to built the latrine or assist. Interestingly, children were more likely to have participated in building private latrines in CLTS villages than in control villages. In CLTS villages, households were less likely to think latrines are too expensive to build (21% in CLTS villages compared to 35% in control).

Notably we did not find any evidence that the impacts of the intervention on sanitation access declined over time. Figure 5 demonstrates that the proportion of households with access to a private latrine was not associated with months since the village received ODF certification.

Figure 5 Mean level of access to a private latrine at the village level versus mean months since ODF certification.
Female respondents in CLTS villages report a higher daily frequency of hand washing with soap (mean 2.3 times per day) compared to respondents from control villages (mean 1.9 times per day, p<0.001, linear regression with clustered standard errors). However, there were no significant differences in the presence of visible dirt on respondent hands between groups (p>0.1). Respondent hands were observed to have visible dirt 70-85% of the time in both groups. Knowledge of critical times to wash hands with soap improved in CLTS villages. For instance, we found a 15 p.p. increase in the fraction of respondents answering that it is important to wash hands after defecation (unprompted) over 35% in control villages.

Very few respondents mentioned that human waste is what makes water unsafe for drinking. CLTS households were 1.3 times more likely to report treating their drinking water (Poisson regression, 95% CI 1.4-1.8). Among those households treating their water, the predominant method was straining through a cloth (88%). This method was more common in CLTS villages (51.5%) than in control villages (42%). There is also a statistically significant 6 p.p. effect of CLTS on using chlorine to treat water. However, on average, chlorine is not commonly used (only 8% of households in control villages). CLTS households reported using slightly higher quantities of water (46.8 vs. 45.9 liters per capita per day), but the difference was not statistically significant (p=0.10).

Source water and household stored water were sampled at baseline and at follow up. On average, 3 source water samples and 7 household drinking water samples were collected per village, resulting in a total of 796 source water and 1733 stored drinking water samples.
Samples were processed by the IDEXX most probable number method to enumerate *E. coli* bacteria per 100mL of water sample. Levels of bacterial contamination were reduced in treatment villages, but the reductions were not statistically significant (Figure 6).

Figure 6 Levels of fecal indicator bacteria in household stored water and source water at baseline and follow up, by treatment status.

*Child health*

The primary outcomes of this analysis include prevalence of diarrhea using a 2-day recall period, height-for-age Z-scores, weight-for-age Z-scores, stunting, and proportion
underweight among children under-five in study households. We also report the impact of the intervention on the prevalence of respiratory illness. We include only those children in households that were enrolled at baseline. Table 4 shows the unadjusted means of health outcomes at baseline and follow up by treatment status. Notably, both gastrointestinal and respiratory illness symptoms were higher at baseline in treatment communities.

Table 4 Unadjusted mean prevalence of gastrointestinal and respiratory illness symptoms and anthropometric status among children five years and younger at baseline and follow-up, by treatment group. Mean proportions shown for illness symptoms reported by respondent for two-day and two-week recall periods. Mean and standard deviation (SD) shown for anthropometric z-scores at baseline and follow up for children under five years. Mortality estimates show number and % of households reporting a death of a child less than 60 months old in the past 12 months.

<table>
<thead>
<tr>
<th>Two-day recall</th>
<th>Baseline</th>
<th></th>
<th>Follow up</th>
<th></th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Control</td>
<td>CLTS</td>
<td>Control</td>
<td>CLTS</td>
</tr>
<tr>
<td>Case definition of diarrhea Φ</td>
<td>0.18</td>
<td>0.21</td>
<td>0.24</td>
<td>0.22</td>
</tr>
<tr>
<td>Loose stool, by chart β</td>
<td>0.28</td>
<td>0.29</td>
<td>0.16</td>
<td>0.14</td>
</tr>
<tr>
<td>Blood in stool</td>
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<td>0.02</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Vomiting</td>
<td>0.04</td>
<td>0.05</td>
<td>0.05</td>
<td>0.04</td>
</tr>
<tr>
<td>Fever</td>
<td>0.17</td>
<td>0.23</td>
<td>0.21</td>
<td>0.21</td>
</tr>
<tr>
<td>Congestion</td>
<td>0.20</td>
<td>0.29</td>
<td>0.35</td>
<td>0.36</td>
</tr>
<tr>
<td>Cough</td>
<td>0.19</td>
<td>0.27</td>
<td>0.26</td>
<td>0.27</td>
</tr>
<tr>
<td>Difficulty breathing</td>
<td>0.03</td>
<td>0.06</td>
<td>0.04</td>
<td>0.02</td>
</tr>
<tr>
<td>Wheezing</td>
<td>0.02</td>
<td>0.06</td>
<td>0.05</td>
<td>0.03</td>
</tr>
<tr>
<td>Ear ache</td>
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<td>0.03</td>
<td>0.03</td>
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<tr>
<td>Bruising Θ</td>
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<td>-</td>
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<td>0.02</td>
</tr>
<tr>
<td>Two-week recall</td>
<td>N=3362</td>
<td>N=3508</td>
<td>N=2903</td>
<td>N=3164</td>
</tr>
<tr>
<td>Case definition of diarrhea</td>
<td>0.25</td>
<td>0.29</td>
<td>0.32</td>
<td>0.31</td>
</tr>
<tr>
<td>Blood in stool</td>
<td>0.04</td>
<td>0.05</td>
<td>0.03</td>
<td>0.02</td>
</tr>
<tr>
<td>Vomiting</td>
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<td>0.10</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>Fever</td>
<td>0.26</td>
<td>0.31</td>
<td>0.29</td>
<td>0.28</td>
</tr>
<tr>
<td>Congestion</td>
<td>0.46</td>
<td>0.46</td>
<td>0.44</td>
<td>0.45</td>
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<tr>
<td>Cough</td>
<td>0.27</td>
<td>0.35</td>
<td>0.34</td>
<td>0.35</td>
</tr>
<tr>
<td>Difficulty breathing</td>
<td>0.04</td>
<td>0.08</td>
<td>0.05</td>
<td>0.03</td>
</tr>
<tr>
<td>Wheezing</td>
<td>0.04</td>
<td>0.08</td>
<td>0.07</td>
<td>0.05</td>
</tr>
<tr>
<td>Anthropometrics</td>
<td>N=3153</td>
<td>N=3269</td>
<td>N=2848</td>
<td>N=3118</td>
</tr>
<tr>
<td>Height-for-age z-score (SD)</td>
<td>-1.18 (1.6)</td>
<td>-1.18 (1.6)</td>
<td>-1.44 (1.5)</td>
<td>-1.38 (1.4)</td>
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<tr>
<td>Weight-for-age z-score (SD)</td>
<td>-1.27 (1.4)</td>
<td>-1.26 (1.4)</td>
<td>-1.29 (1.2)</td>
<td>-1.27 (1.2)</td>
</tr>
<tr>
<td>Stunted</td>
<td>0.30</td>
<td>0.30</td>
<td>0.35</td>
<td>0.32</td>
</tr>
<tr>
<td>Underweight</td>
<td>0.28</td>
<td>0.28</td>
<td>0.26</td>
<td>0.25</td>
</tr>
<tr>
<td>Mortality</td>
<td>N=3494</td>
<td>N=3715</td>
<td>N=3131</td>
<td>N=3361</td>
</tr>
<tr>
<td>All-cause mortality</td>
<td>237 (6.8%)</td>
<td>236 (6.4%)</td>
<td>162 (5.2%)</td>
<td>167 (5.0%)</td>
</tr>
<tr>
<td>Diarrhea-related mortality</td>
<td>22 (0.6%)</td>
<td>22 (0.6%)</td>
<td>23 (0.7%)</td>
<td>11 (0.3%)</td>
</tr>
</tbody>
</table>

Φ Defined as three or more loose or watery stools per 24 hour period
β Image selection of 6 or 7 on stool chart, not including exclusive breastfeeding children
Θ Not measured at baseline
We use Poisson regression to generate relative risk of children under five in the intervention group compared to the control group for all acute illness outcomes. All models include robust standard errors to account for clustering. There were no statistically significant impacts of the program on diarrheal or respiratory illness symptoms using a two-day recall period. We also measured all illness symptoms using a two-week recall period (Figure 7); the CLTS intervention reduced the risk of bloody stool by 32% (RR: 0.68, 95% CI: 0.48 – 0.97). Ear ache and bruising serve as negative control variables that would not be expected to be affected by the intervention; notably we do not see an impact on these outcomes, suggesting that reporting bias is likely not an issue. Controlling for child age in months does not change these results.

Figure 7 Relative risk of gastrointestinal and respiratory illness symptoms in treatment group compared to the control. Error bars show 95% confidence intervals generated by Poisson regression models with robust standard errors (unadjusted). Two-day recall period is shown on left; two-week recall period is shown on right.

There was a strong trend at baseline of diarrheal and respiratory illness symptoms being of higher prevalence in villages assigned to the CLTS intervention (Table 4). The differences were statistically significant (p<0.05) for the following symptoms: fever, cough, congestion, difficulty breathing, wheezing, and ear ache. The differences for the following
symptoms were marginally significant at p<0.01: case definition of diarrhea and loose stool as classified by the stool chart. The prevalence of vomiting and blood in the stool were not significantly different at baseline between groups. Randomization occurred after baseline data collection was complete, so these differences cannot be explained by differential bias during surveys. Considering these differences in illness prevalence at baseline, we also ran difference-in-difference models that took into account baseline prevalence levels. These modeling results are displayed in Figure 8. Using this modeling approach, we find a statistically significant decrease in the risk of loose or watery stool as classified by the stool chart not including exclusively breastfeeding children (RR 0.80, 95% CI 0.64-1.00). We also find reductions in the risk of a number of respiratory illness symptoms including congestion (RR 0.70, 95% CI: 0.55-0.89), cough (RR 0.73, 95% CI: 0.58-0.91), and difficulty breathing (RR: 0.24, 0.12-0.50).

Figure 8 Relative risk of gastrointestinal and respiratory illness symptoms in treatment group compared to the control using a difference-in-difference modeling approach. Error bars show 95% confidence intervals generated by Poisson regression models.

To assess the impact of CLTS on child growth outcomes, we control for baseline height-for-age Z-scores (HAZ) and weight-for-age z-scores (WAZ), thus limiting the sample to those children that were present both at baseline and follow up. We find a statistically significant improvement of 0.16 in HAZ among children under five in treatment communities. We also find a marginally significant decrease in stunting by 13%. Improvements in WAZ and a reduction in the proportion of children underweight were
observed but were not statistically significant. CLTS also significantly reduced the risk of severe stunting by 26% (CI: 0.56-0.98) and being severely underweight by 35% (CI: 0.46-0.92).

Table 5 Impact of CLTS on child growth among children under five years of age. Models with matched children include individuals measured at baseline and at follow up (mean age in months 39.6, SD 24). Models with all children include individuals born into study households (mean age 30 months, SD 17) and only use follow up data. Height-for-age z-scores and weight-for-age z-scores are modeled with linear regression; stunting and underweight are modeled with Poisson regression. All models include robust standard errors to account for clustering at the village level.

<table>
<thead>
<tr>
<th></th>
<th>Matched children with baseline values</th>
<th>All children</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>β</td>
</tr>
<tr>
<td>Height-for-age z-score</td>
<td>2418</td>
<td>0.16</td>
</tr>
<tr>
<td>Weight-for-age z-score</td>
<td>2453</td>
<td>0.09</td>
</tr>
<tr>
<td>Stunted</td>
<td>2418</td>
<td>0.87</td>
</tr>
<tr>
<td>Severely stunted</td>
<td>2418</td>
<td>0.74</td>
</tr>
<tr>
<td>Underweight</td>
<td>2453</td>
<td>0.85</td>
</tr>
<tr>
<td>Severely underweight</td>
<td>2453</td>
<td>0.65</td>
</tr>
</tbody>
</table>

Mortality

We measured self-reported all-cause and cause-specific mortality among the study population at follow-up. Each household was asked to report the age and gender of any household member that had died in the past 12 months and the cause of death. A total of 632 deaths were reported (303 in control villages, 329 in treatment villages); 16% of all households reported at least one death in the past 12 months. The most common cause of death was malaria (31% of all deaths); diarrhea was reported as the cause of 7% of all deaths. About half of all deaths were children under five (52%). There was no significant difference in all-cause mortality between control and treatment arms (RR: 0.98, CI: 0.83-1.15). We found a 54% reduction in the risk of death by diarrhea in CLTS villages compared to control villages (RR: 0.46, Robust Std. Err. 0.14, 95% CI: 0.26-0.83). When considering only diarrhea deaths among children under five, the risk was reduced by 57% (RR: 0.43, Robust Std. Err. 0.16, 95% CI: 0.21-0.88; N=23 child diarrheal deaths in control villages, N=11 child diarrheal deaths in CLTS villages).

Analysis of secondary data

This section presents secondary data analysis showing important correlations between different indicators related to the intervention. Given the nature of this analysis, the results do not have a causal interpretation, but they are still useful in shedding light about the relationship between CLTS and sanitation practices. All the data reported in this section uses information of households both present in baseline and follow up.

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3 These results are based on matched households for baseline and follow up.
CLTS contributed to a reduction in the use of shared latrines and an increase in the use of more private latrines, which means better access and actual use of improved household latrines. CLTS communities experimented a reduction of 18.3 percentage points in latrine sharing. However, the utilization of neighbor’s latrines is still common practice in rural Mali, amounting to 54% of latrine use in control communities.

The quality of the CLTS interventions can be considered to be an important factor in both achieving and sustaining ODF status and also in impacting health and child growth. To that end, the follow up survey included a module that asked some key aspects related to the quality of CLTS. 76% (67%) of interviewed adult women (men) recall having participated in the triggering. The recall figure is also similar for the several components of the triggering ceremony (ODA map, amount of stools, walk of shame, etc.). Children participation in triggering was also recalled by 80% of the households. Finally, 92% of the households reported having built or rehabilitated a latrine, and 84% having stopped ODF practices.

One important aspect of CLTS is its sustainability. As mentioned previously in the report, communities that participated from CLTS have cleaner latrines, and soap and water is found to be more present in treated communities. See “Main Findings” for detailed data analysis. Moreover, as mentioned previously in the report, CLTS did cause a substantial increase in the use of children potties. There is a high correlation between the use of potties and the presence of human feces in households’ courtyards.

Finally, CLTS can also be associated with a reduction in the percentage of women experiencing any sort of harassment. While the figure is low compared to other countries in the region, (95% of women reported never to have been harassed at baseline), there is still a 2 percentage point increase in this indicator and it is statistically significant.

5. Discussion

This study provides rigorous evidence that a pure behavioral intervention with no monetary subsidies substantially increased access to sanitation facilities in rural Mali. Access to a private latrine almost doubled among households in CLTS villages (coverage increased to 65% in CLTS villages compared to 35% in control villages). Self-reported open defecation rates fell by 70% among adult women and men, by 46% among older children (age 5-10), and by 50% among children under five. The success of the campaign in promoting latrine construction is higher than other community-led sanitation programs that have been evaluated in India that have increased latrine access by 20-33 p.p. (Pattanayak et al. 2009; Arnold et al. 2010; Patil et al. 2014).

Although the program led to dramatic improvements in sanitation access, quality of latrines, and improved hygiene behaviors (such as keeping soap and water in the latrine), villages did not reach open defecation free was not fully eradicated and villages did not
reach status or universal access as intended by the program. Although certification was awarded prematurely in all villages, universal access would most likely have been infeasible. The fact that follow-up data was collected a full year after village certifications indicate that the CLTS intervention is sustainable, but longer-term studies would also shed light on how long improvements in sanitation access persist through time.

Statistically significant impacts on child diarrheal or respiratory illness were not observed among children under five years of age when analyzing follow-up data only. Illness symptoms were higher in CLTS villages at baseline. This is surprising considering that control and CLTS communities were well balanced in terms of socio-economic characteristics, sanitation access, and child anthropometrics. However, randomization occurred after baseline, so field staff were blinded to treatment status at baseline. If we consider the baseline differences in illness symptoms to be true (i.e. unobserved variables contribute to higher levels of infectious disease in CLTS villages), a difference-in-difference modeling approach can be used to account for baseline differences. Using a difference-in-difference estimator, we find a significant reduction in loose or watery stool among non-exclusive breastfed children in CLTS villages (children that are exclusively breastfed are excluded since their stool is always loose and watery).

The difference-in-difference modeling approach also yields significant reductions in the risk of respiratory illness. Although we would have hypothesized larger reductions in diarrhea over respiratory illness, improved hand hygiene behavior in CLTS communities may have prevented the transmission of respiratory pathogens. Self-reported rates of handwashing with soap increased in CLTS communities, as did the practice of keeping soap and water available for hand washing in the latrines.

The CLTS program reduced stunting by 13% among children under five, and reduced the risk of severe stunting by 26% and being severely underweight by 35%. The observed improvement in child height (+0.16 HAZ) is less than the 0.3-0.4 increase in HAZ found in Madhya Pradesh, India during an evaluation of India’s total sanitation campaign (Hammer and Spears 2013). Considering that nutritional supplement interventions typically improve HAZ by 0.3 (Dewey and Mayers 2011), our finding seems biologically plausible. There was no impact on height-for-age among children under two years of age (data not shown). Children under two in the follow-up survey were not alive at baseline; without baseline measurements we had less power to assess the impact of the intervention on growth in this age group. Notably, children aged two to four years in the follow-up survey were less than two years old at baseline, the ideal age range for preventing growth faltering (Victora et al. 2010).

Our study is the first to evaluate the impact of sanitation on child mortality using an RCT design; we found the CLTS program reduced the risk of diarrhea-related under-five child mortality by 57%. One important limitation of our study was that we did not use verbal autopsy to measure cause-specific mortality (the WHO recommended verbal autopsy instrument can take 40-60 minutes to complete). Therefore, some diarrheal deaths may have been misclassified, however we would not expect differential misclassification between groups.
The improvements in child growth and diarrhea-related mortality were observed despite the fact that the program did not significantly reduce diarrheal illness among children under five. One explanation for this finding is that the CLTS program reduced child exposure to fecal contamination, through reduction in open defecation and/or improvements in hand hygiene behavior. Lower levels of environmental fecal contamination could potentially contribute to less environmental enteropathy among children, a subclinical condition characterized by poor nutrient absorption in the gut and associated with stunting in children (Lunn 2000; Campbell, Elia, and Lunn 2003). Environmental enteropathy has been shown to be associated with a contaminated environment; a study in rural Bangladesh found that children from households with improved sanitation and a cleaner household were less likely to have biomarkers indicative of environmental enteropathy (Lin et al. 2013). It’s also possible that less environmental enteropathy could have provided some protection against children dying from diarrheal disease. Further research is needed to better understand the causal mechanisms underlying the impact of the CLTS program on child growth and whether or not improved sanitation can reduce child environmental enteropathy.
References


Appendix: Additional findings

Schooling and labor

Table A - 1 shows the impact on school attendance and labor supply. The first column shows that there is an increase in school attendance for children between 5 and 12 years. The effect is marginally significant at a p-value of 0.10. There are no statistically significant effects on missing days at school, except for children between 10 and 13 years old who miss an average of 1.4 and 1.9 fewer days as a result of the program. Children are less likely to work (-7 p.p. from 70% incidence among 8-18 years old) but the difference is not statistically significant. Adults who work spend more hours; they work 0.39 additional hours over the mean 32 hours worked among those who work in control villages, but the difference is not statistically significant.

Table A - 1 Schooling and labor outcomes

<table>
<thead>
<tr>
<th>Treatment Status</th>
<th>School</th>
<th>School days</th>
<th>Child labor</th>
<th>Child labor 1</th>
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<th>Work hours</th>
<th>Work hours</th>
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<tr>
<td></td>
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<tr>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

SE in brackets clustered at the village level
* significant at 10%; ** significant at 5%; *** significant at 1%
(1) Between 5 and 12 years old; (2) Between 5 and 12 years old; (3) Between 4 and 12 years old; (4) Between 4 and 15 years old; (5) More than 14 years old; (6) More than 14 years old; (7) Between 5 and 14 years old.

Collective action

In section 5, we documented the extent to which CLTS may be an informational intervention, leading villagers to more accurately perceive risks associated with poor sanitation and learn about preventive measures. In this section, we investigate the role of collective action in generating the observed impacts.

Although eliminating open defecation is mostly an individual decision that requires a personal effort and change of cultural behavior, the consequences of one’s open defecation affect the rest of the community through various means. Contamination through human contact, contact with water sources and food manipulation offer physical pathways through which one’s decision affect the rest of the community. Unfortunately, individual benefits from eliminating open defecation are probably smaller that the private cost of better sanitation practices unless the vast majority of other neighbors engage in the same health practices. Other pathways have a social basis: individuals may derive pleasure from adopting a practice when others do; they may learn from others about how to build or maintain latrines, about the benefits from ending open defecation; they may feel pressured to change behavior and fear punishment if they do not comply. In very simple terms, the reduction of open defecation is a classical problem of collective action: each group member bears the private costs of contributing by practicing hand washing and latrine use, but the
benefits through better health outcomes will depend on what the rest of the group do in the same regard.

We designed a series of experimental games to measure how cooperation may depend on specific features of the triggering process which sanitation experts consider to be crucial (Kar and Chambers 2008). We conducted these games over all 121 communities included in the study sample and at both baseline and follow-up. About one half of households in each community were randomly invited to participate to the games. All games were incentivized using valued items (rather than cash).

Our games allow us to test some of the links in the causal chain from the program to its impact. There are two reasons for that. One is that participants are drawn from the pool of villagers in the communities targeted by the program. The second is that the experiments, although only mildly framed as a community activity with no mention to sanitation, are designed to replicate some features of a community-based intervention. Community mobilization requires facilitating communication between village members and between community leaders and the rest of the group. Is communication an effective device through which mobilization may foster collective action? Does informing the community on how to reach a better social outcome key? Should we expect the effectiveness of the program to depend on the quality of leadership in the community? Beyond making the exercise policy-relevant, having the experiments played on the field rather in the lab is a necessary feature of our protocol. In this sense, the field provides the relevant context in which the effect of leader quality on cooperation can be assessed.

We first measure cooperation when no communication between participants is allowed. We then investigate the role of communication: does unmonitored open discussion between villagers playing the game lead to higher cooperation? Does letting a game participant advise other villagers on the actions needed to reach the socially desirable outcome make a difference? How does this effect depend on the leadership skills of the person designated to convey the message to the rest of the group? One can expect that unobserved factors both explain leader quality and levels of cooperation within villages. For instance, previous mismanagement of public resources may affect the ability of villagers to contribute to the public good and to have good leaders. In order to address this issue, we exogenously manipulate the quality of the leader who is chosen. We do so by randomly selecting the person in charge of leading the discussion in each village.

We find that, as in all cooperation games, people do cooperate instead of playing the Nash Equilibrium, which is to not cooperate. Social preferences can explain such result (reciprocity, trust, altruism). Cooperation in base game was actually found high compared to findings from previous lab and field experiments (71% contribute to a public fund). This can be explained by the fact that, in our context, players know each other quite well, and may be acting as in a repeated game. The game is framed as a familiar situation of decision and interaction, similar to what they usually do, e.g.: agree on a public good problem, a new roof for the school, etc.
We find, consistent with other findings in the lab, that communication between villagers improves cooperation. The proportion of players contributing to the public game increases by 8 percentage points compared to a base of 71%. On a conceptual level, this finding is consistent with two (non-exclusive) types of changes: a change in beliefs and a change in preferences. Beliefs may change because communication sheds light about what others are going to do. Conditional cooperators would be more likely to cooperate if they believe others will as well. As we also collected information on players’ beliefs over others’ actions, we are able to show evidence that change in cooperation is mediated through changes in beliefs. Besides, when we instruct a participant to tell all other players that the socially efficient outcome requires them to all contribute, cooperation also improves. Compared to the gains from open discussion, improvement is higher by 2 percentage points.

Interestingly, the leadership attributes of the person passing the advice matter. Because we randomly pick the person who acts as a “leader”, we can identify the causal effect of leadership attributes. First, we ask players to rank each other in terms of their capacity to be good community representatives, good conciliators and with respect to their height. We find that relative height has positive and significant effect on group cooperation.

Some leader personal attributes, as measured in the household survey, also matter for cooperation. There is a statistically significant difference according to gender, as male leaders have a strong positive effect on group cooperation. Cooperation increases with the age of the leader. Using an index of social capital, we find that cooperation is greater the higher social capital of the leader is. We find that literacy, in our pool of players where literacy rate is very low (15%), has a negative and significant effect.

Finally, cooperation, as measured by game outcomes, has improved as a result of the program. We find a positive and statistically significant impact of the community-based sanitation intervention on game contributions. We found a 4.5-5 p.p. gain in cooperation that can be attributable to the intervention. In comparison, the gains from open discussion and leader treatments are respectively 8 and 10 p.p. This suggests that both fostering open discussion and the position of the leader are key feature in community-based approaches such as CLTS (Alzua, Cárdenas, and Djebbari 2014).