

Measurement of Latrine Use in Rural India Final Report

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3ie evaluation report

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About 3ie

The International Initiative for Impact Evaluation (3ie) is an international NGO promoting evidence-informed development policies and programs. We are the global leader in funding, producing and synthesizing high-quality evidence of what works, for whom, how, why and at what cost. We believe that using better and policy-relevant evidence helps to make development more effective and improve people's lives.

About the Promoting Latrine use in Rural India Thematic Window

3ie's Promoting Latrine Use in Rural India Thematic Window supported five mixed-method impact evaluations in Gujarat, Odisha, Karnataka, and Bihar. Four of these studies employed a behavioural science approach to promote latrine use among households that already owned latrines. Evaluation teams identified key barriers to latrine use in their local context and developed targeted, behaviour science-informed interventions to address these barriers. The fifth study, referred to below as the measurement study, considered the challenges related to measuring latrine use by comparing responses to household and individual level questions about latrine use.

About this report

This report presents evidence from the measurement study on reported latrine use rates using alternative framing of questions. The report has five main sections. In the introduction, the measurement problem is presented and study objectives are identified. Study context, protocol, data handling procedures, and analysis are detailed in the evaluation section. Quantitative and qualitative analyses responding to the primary research questions are presented in the findings sections. The other implications section highlights the applications of this research to policy and program development. Challenges and lessons learned are discussed in this section as well. Finally, the report closes with a conclusion.

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The 3ie quality assurance team for this report comprises Neeta Goel, Charlotte Lane and Sayak Khatua, with overall supervision from Marie Gaarder.

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Executive Summary

Through this study, the attempt has been made to measure and compare the extent of open defecation (OD) as accurately as possible across four states in India using two methods of measuring OD and understand the use of latrines in comparison to the ownership of latrines. We intend to inform research on measurement of open defecation across varied contexts by – 1) emphasising improved questionnaire design that seeks to elicit truthful responses from respondents and removing biases in reporting OD behaviour, 2) using balanced, individual-level disaggregated questions for measuring OD and 3) following rigorous training modules for surveyors in measuring OD. Recent studies in India suggest that latrine ownership does not automatically indicate latrine use and also that measurement of latrine use is fraught with many challenges. This study aims to address these issues by conceptualising and developing robust reporting measures on latrine use that could be reliably embedded into large-scale household surveys.

There are two main objectives of this study. First, this study tests whether responses to household-level questions differ from responses to individual-level questions. Secondly, this study seeks to compare latrine use measurements across different settings in rural India using standardised methods and practices. Having multiple observations from the same village collected by different teams will also allow better estimation of the variance of estimates. Documenting the variation in estimation will hopefully provide insights into data collection processes, and will help to better understand the types of questions and ways of asking that work best to assess latrine use.

Open defecation, the primary outcome of interest, was measured across the study areas using two independent questionnaires, wherein half of the respondents were administered the Individual questionnaire (OD/latrine use estimated using a balanced question repeated for every individual within the household) and rest of the respondents were provided the Household-level questionnaire (OD/latrine use measured using the exact NFHS question on latrine access/use probed at the household level).

Study results show that reported OD is significantly different across the two survey instruments – individual question on latrine use finds 20 percentage points more reported OD than the household-level question. This difference is significant across the full sample as well as within project areas. An important inference from this measurement project entails that household-level questions may not be able to capture individual-level, intra-household variations in use. Based on our data, certain predictors such as gender, education, age (individuals over 60 years), type of latrine owned and whether latrine was self-financed or constructed with support from government/NGO emerged to be significantly correlated with reported OD and latrine use. This is consistent with previous evidence that have identified these variables as significant predictors of open defecation and latrine use.

With latrine coverage increasing under the SBM, these study findings emphasise the importance of making improvements to sanitation monitoring vis-à-vis existing official survey methods in better understanding the status of OD and latrine use practices among individuals in

rural India. Additional studies aimed at increasing the reliability and cost-effectiveness of survey and non-survey based latrine use measures are certainly warranted. In time, a reasonable mix of indicators and measurement methods can appropriately inform sanitation policy and practice.

Findings around individual- and household-level factors that determine open defecation also suggest that programmatic focus on increasing latrine ownership may be insufficient to drive use of sanitation facilities and may require interventions that target these specific drivers of behaviour change.

While our study did not find OD reductions from specific behaviour-led sanitation interventions to be significant at a policy-level, our evidence does suggest a continued need for policy attention to shifts behaviours and practices around both latrine use and child faeces disposal in rural India.

1. Introduction

At the onset of the Sustainable Development Goals, open defecation (OD) - a practice that carries serious public health and environmental implications - continues to be a problem globally. India has made remarkable progress on this front during the MDG period; political prioritization of sanitation through policy changes and public investments, most recently through Government of India's ongoing flagship sanitation programme, Swachh Bharat Abhiyan-Grameen (SBM-G) have aimed to improve access and use of sanitation across rural India where the OD challenge is most significant.¹

In realising its aim of eliminating OD in rural India by year 2019, SBM-G follows Gol's historical rural sanitation programmes in adopting a supply-led, subsidy-driven approach targeting latrine construction as a primary sanitation outcome. However, based on evidence that rural sanitation practices indicate a preference for OD, the programme also pursues behavioural strategies that target latrine use and elimination of OD as important outcomes. To this end, a key component of SBM-G is to monitor sanitation outcomes of latrine access, latrine use and OD (SBM-G Guidelines, 2014). This represents a notable shift from previous sanitation programmes in which outcome monitoring was limited to latrine access and coverage.

Historically, measurement of sanitation outcomes in India, within national sanitation programmes and through national population census or nationally representative sample surveys such as National Sample Survey Organisation (NSSO), National Family Health Survey (NFHS), was on the basis of household access to latrines and households without access to latrines were simply classified as practicing OD. But recent evidence from sanitation studies in India suggest that latrine ownership by households is not necessarily indicative of latrine use or OD as variations in use could be observed at the individual, intra-household level (Coffey & et.al, 2014) (Shah & et.al, 2013) (O'Connell, 2014) (Patil & et.al, 2014) (Sinha & et.al, 2016) (Sinha & et.al, 2017). This suggests that improvements to sanitation monitoring vis-à-vis existing survey methods is needed to better understand the status of OD and latrine use practices among individuals in rural India.

To this end, a number of recent studies have sought to improve sanitation monitoring by measuring latrine use as a distinct sanitation outcome. Results suggest that measurement of latrine use at household and individual levels is challenging in many ways - existing indicators and measurement methods for latrine use are inadequate and evolving. For instance, there was evidence to suggest that 48-hour recall may be the most reliable measure of assessing latrine use and OD through surveys (Sinha & et.al, 2016). But limitations to this measure were noted as its inadequacy to measure consistency in usage (Sinha & et.al, 2017); direct observations are expensive, likely to be unacceptable to households and even unreliable as it may trigger reactivity; spot-checks and latrine use indicators can only indicate household use and can be prone to reactivity; structured surveys can cause over-reporting of desirable behaviours such as latrine use; technology-based measurement (e.g. sensors) is likely to be impractical for large-scale surveys owing to cost and potential ethical considerations (Bartram & et.al, 2014) (Patil & et.al, 2014) (Scott & et.al, 2008) (Sinha & et.al, 2016). In as much as survey-based measurement of sanitation behaviours are popular and economical despite inherent limitations of reliability, studies

¹ Findings from the second National Annual Rural Sanitation Survey (NARSS 2018-19) conducted between November 2018 and February 2019, showed that 93.1 % of rural households had access to latrines and 96.5 % of these individuals having access to toilets reported using these latrines. 90.7% of villages previously declared and verified as ODF were confirmed as ODF through this NARSS round, and the remaining villages had a sanitation coverage of 93% (<http://pib.nic.in/PressReleaseIframePage.aspx?PRID=1567486> (Press release with regards to the NARSS 2018-2019).

have focused on evolving reported measures of latrine use and OD that are framed in a balanced manner, allow for individual-level disaggregation and referencing a specific time frame.

With this background, the primary aim of this study is to contribute to efforts in this direction and evolve robust reporting measures on latrine use that can be reliably embedded into large-scale household surveys.

1.1 Study objectives

The study measured latrine use over two different time periods. The main objective of the study, realised in the first time period, was to examine whether reported data on latrine use differed between household-level questions (as measured in official surveys such as NFHS) and balanced, individual-level questions.

Under 3ie's Promoting Latrine Use in Rural India Thematic Window, research grants were awarded to four independent teams for implementing and evaluating behavioural interventions that could be scaled-up with the resources available through the Indian government's programme, Swachh Bharat Mission (SBM) or Clean India Mission. These randomised control trials were conducted from late 2017 to early 2019 in rural areas of four Indian states – Bihar, Karnataka, Odisha and Gujarat. A secondary objective of the measurement study was to independently collect data on latrine use within these project areas wherein 3ie was supporting impact evaluations so as to examine shifts in latrine use behaviours across the two time periods in the intervention areas.

While not an immediate objective of the measurement study, independent collection of data by the impact evaluations and measurement study and use of the same standardised methods and practices for latrine use measurement, enables outcome comparison across different teams over the two time periods. Having multiple observations within the same study setting could allow for better variance estimation and hopefully provide insights into data collection processes that works best to assess latrine use outcomes.

Overall, this body of evidence could be useful in informing the SBM on context/state-specific interventions that could help promote latrine use in rural India and sustain these outcomes in the long run. In particular, while reported measures through household surveys are commonly used to measure sanitation progress, their reliability - particularly with respect to behavioural outcomes of latrine use and OD - are uncertain. Results from this study can help contribute to knowledge around methods in improving the reliability of reported latrine use.

2. Evaluation

2.1 Study context

This study was designed to be carried out within rural areas across four Indian states where 3ie grantee teams are carrying out impact evaluations of latrine use interventions. All study states have a rural population of over 50%, and their proportion of rural population below poverty line (BPL), literacy rates and worker participation rate (WPR) closer to the national averages on these measures. Agriculture is the primary sector of rural economy and employment across all four states. Construction of latrines was accelerated across these states under the SBM, with state government efforts focused on promoting latrine coverage and use primarily through subsidies and technical support on the supply-side and community mobilisation through IEC (information, education and communication) on the demand-side.

The NFHS-4 estimates² for Bihar showed that only 54.1% of the rural households had electricity, 98.2% of these households had access to improved drinking-water sources³, only 10.8% of rural households used clean fuel for cooking⁴ while only 20.7% of rural households had access to improved sanitation facilities⁵. The female population above 6 years' age who ever attended school in rural areas was only about 54.8% and only 19.5% of women (in the age group of 15-49 years) had around 10 or more years of schooling. 75.3% of the male population was literate, while only 46.3% of the female population was literate. Infant mortality rates (IMR) were around 50% while under-five mortality rates (U5MR) were 60%, 49.3% of children under 5 years were stunted. Only 27.3% of rural women aged 15-24 years used hygienic methods of protection during menstrual cycles⁶ and around 60.5% of women (age groups of 15-49 years) are anaemic.

NFHS-4 estimates from suggest that 83.8% of the rural households had access to electricity and 87.5% of the rural households had access to improved drinking water sources. Only 23% of rural households had improved sanitation facilities and only 10.7% rural households had clean fuel for cooking. 65.3% of female population (above 6 years) in rural areas had attended school, and only 23% women had 10 or more years of schooling. Among the rural populations, 81.9% men were literate, while only 64.5% women were literate. Infant mortality rates were 43%, under-five mortality rates were 52%, 35.3% of children under 5 years were stunted. Only 42.8% of women aged 15-24 years used hygienic methods of protection during menstrual cycles and around 51.9% rural women between 15-49 years were anaemic.

Estimates for Karnataka suggest that 97% of rural households had electricity, 88.9% of households had access to improved drinking water sources, only 42.6% households used improved sanitation facilities and only 32.1% households used clean fuel for cooking. 63.1% rural women above age 6 years had attended school, while only 35.1% women had 10 or more years of schooling. While 81.2% men were literate, only 63.8% women were literate among rural populations. Infant mortality rates were 32%, under five mortality rates were 37% and 38.5% children under 5 years were stunted. While 62.1% women aged 15-24 years used hygienic methods of protection during their menstrual cycles, and 46.1% women between 15-49 years were anaemic.

In Gujarat, 93.7% households had electricity, 89.4% households had access to improved drinking water sources, only 47% households had improved sanitation facilities and only 26.9% households had access to clean fuel for cooking. 64% of female population (6 years and above) in rural Gujarat had ever attended school, while only 23.1% had 10 or more years of schooling. 86.6% men were literate in rural areas, while only 64.4 percent women were literate. Infant mortality rates were 39%, under-five mortality rates were 51% and 42.9% children under the age of 5 were stunted. While 53.5% women aged 15-24 years used hygienic methods of protection during menstrual cycles, and 57.6% women aged 15-49 years were anaemic.

² Drawing mainly from the NFHS state factsheets, NFHS-4 State Fact Sheet for Bihar 2015-16.

³ Improved drinking water sources mean piped water to dwelling/yard/plot, public tap/standpipe, tube well or borehole, protected dug well or spring, rainwater, community RO plant according to NFHS definitions.

⁴ Clean fuel for cooking includes electricity, LPG/natural gas and biogas.

⁵ Improved sanitation facilities include those detailed in the NFHS modules as flush to piped sewer system, septic tank, pit latrines, ventilated improved pit/biogas latrine, pit latrine with slab, twin pit/composting toilet.

⁶ NFHS-4 provides estimates for menstrual protection methods only for women aged 15-24 years.

Table 1 Socioeconomic and Demographic indicators in study states

state	rural population (%)	rural bpl (%)	literacy rate (%)	rural wpr (%)	latrine ownership (%)	latrine use (%) NFHS estimates
Bihar	89	34.06	49	34	66.98	27
Odisha	84	21.54	61	43.2	63.21	28
Karnataka	59	24.53	62	49.4	97.20	48
Gujarat	55	21.54	60	44.9	100	52
India	69	25.70	58	41.8	92.60	46

Source: Census of India, SBM-G

SBM data suggests that in comparison to national average, latrine coverage was higher in the states of Karnataka and Gujarat but lower in Bihar and Odisha, but district-level variations are present in terms of coverage. Gujarat was declared as a ODF state in October 2017 and state government efforts here were oriented towards sustaining achievements under the SBM. Pit latrines (single and double pits) were predominant in rural areas of these states, similar to the rest of the country. Two-pit latrines were prevalent in Bihar, while the other three states mainly had single-pit latrines (illustrated through tables in the findings section).

Formative research undertaken by the impact evaluation teams suggest a prevalence of open defecation in study districts irrespective of the relatively higher levels of latrine coverage. Reported barriers to latrine use included: perceptions of latrines as a limited resource, aversion to self-emptying of latrine pits, misperceptions about how quickly pits fill, poor functionality of latrines, preference for open defecation (particularly among men). Social and personal norms were key determinants of latrine use. Households who built their own latrines, either self-financed or top-up on SBM subsidy, were more likely to be committed users of latrines.

State government activities under the SBM had ramped up across all study areas to meet the national ODF target by October 2019.

2.2 Evaluation questions and hypotheses

In line with the study objectives identified above, the study will test the following two research hypotheses:

- 1) H1: A balanced question on latrine use and OD which allows for disaggregation by individual and short term recall can find higher incidence of OD than a household-level question. This hypothesis was tested at time period 1 (baseline) using two different surveys, where one survey included the balanced, individual-level question on OD and latrine use while the second was the NFHS survey which had a household-level question on the practice of OD
- 2) H2: There would be a positive shift in latrine use outcomes among households owning latrines from time period 1 (baseline) to time period 2 (endline) in the treatment sample relative to the control sample. At endline, we estimated the open defecation outcomes across the entire sample only through the individual questionnaire, which included a disaggregated question probing all individuals within households on their defecation behaviour.

2.3 Primary outcomes and key indicators

The primary outcome corresponding to above two research hypotheses is open defecation (OD).

For hypothesis 1, this outcome was measured during baseline using two distinct survey instruments – the first instrument measured reported practice of OD at the individual-level, for every member in the household, and the second instrument measured it at a household-level. For households assigned the individual-level question, surveyors sought to normalise the context and remove any judgement around defecation practice by prefacing the question with: “I have seen that some people defecate in the open, and some people use the latrine. Now I want to ask about where you and your family members defecate.” Then, each individual in the household was asked the following question: “The last time [*name of household member*] defecated, did [*name of household member*] defecate in the open or use the latrine?”. Answer codes were “Latrine”, “Open” and “Somewhere else (potty, nappy, etc.)”. Individual responses were coded in a household roster. This instrument was administered to half of the study sample. The remaining households in the sample were assigned the household-level question used in India’s NFHS: “What kind of toilet facility do members of your household usually use?”. Answer codes were the same as in NFHS and did not require a household roster: flush to piped sewer system, flush to septic tank, flush to pit latrine, flush to somewhere else, flush to don’t know where, ventilated improved pit or biogas latrine, pit latrine with slab, pit latrine without slab or open pit, twin pit or composting toilet, dry toilet, and no facility or uses open space or field.

For hypothesis 2, latrine use and OD measures were estimated at endline for the entire study sample. The outcome measurement was based on the individual-level question used at baseline, to enable comparability both with – 1) baseline measurements within the measurement study and 2) outcome measurements by the impact evaluation studies. Survey questions around latrine use were standardized under the 3ie latrine use thematic window. Therefore, all studies under this window collected the same latrine use and OD measures.

2.4 Sampling

3ie’s Promoting Latrine Use in Rural India Thematic Window funded four independent research teams to undertake randomised control trials in the states of Bihar, Odisha, Karnataka and Gujarat. As these trials targeted latrine use as a primary outcome, the study areas comprised villages that had high latrine coverage at baseline.

Of the villages found to be eligible for the trials, 22-26 villages were randomly selected for the measurement study using village-level stratification by treatment status and latrine coverage. The sampling frame for the measurement study comprised the study areas of these trials. Sample households for the measurement study was drawn from the village census conducted by the research teams in the four states. Approximately 10-30 households were randomly selected from each village for inclusion in the study provided they had reported latrine ownership and were not part of the trial sample. r.i.c.e carried out the randomization using a random number generator in Stata and provided the random assignment of the type of latrine use question administered in the baseline survey at the household level. As noted earlier, at baseline, half of the households were assigned individual-level question on latrine use and the other half were assigned a household-level question. The individual-level question on latrine use was assigned to all households in the endline sample.

Eligible households were enrolled upon obtaining informed consent to participate in the study. Households were randomly assigned the two survey instruments (individual survey and NFHS survey). Table 2 and 3 provide details on the distribution of the sampled population across

the four states at baseline and endline. As noted earlier, the states are spread across India and have varying levels of rural latrine coverage and open defecation.

Table 2 State-wise distribution of sample during baseline

State	districts (#)	blocks (#)	villages (#)	households (#)	individuals (#)	hh size (mean)
Bihar	5	5	22	638	3,935	6.2
Odisha	1	3	24	599	3,124	5.2
Karnataka	1	5	24	601	3,306	5.5
Gujarat	1	3	25	636	3,508	5.5
Total	8	16	95	2474	13,873	5.6

Table 3 State-wise distribution of sample during endline

State	districts (#)	blocks (#)	villages (#)	households (#)	individuals (#)	hh size (mean)
Bihar	5	5	22	608	3,999	6.6
Odisha	1	3	24	572	3,124	5.5
Karnataka	1	5	24	554	3,215	5.8
Gujarat	1	3	25	612	3,598	5.9
Total	8	16	95	2346	13,921	5.9

2.5 Data collection

Baseline:

At baseline, we administered two survey instruments (individual and NFHS) which were each assigned to roughly half the sample households. Both instruments aimed to measure latrine use and OD through surveys and observations. Certain observation measures were similar across both instruments. For instance, both instruments included comparable questions on socioeconomic and demographic characteristics (gender, age, education, occupation, asset ownership, religion, caste). OD literature suggests that these are covariates that may be associated with latrine use. Both instruments included questions on latrine characteristics (ownership, age and type of latrine owned, pit dimensions, source of financing, pit emptying). Both instruments also included indirect and veiled questioning approaches to elicit truthful responses to sensitive questions such as on latrine use and OD behaviours.

The key difference between the two instruments was around outcome measurement, with the individual survey instrument measuring outcome at the individual-level while the NFHS instrument measured it at the household level. Specifically, the individual survey captured data on latrine use and OD with the question: “The last time [NAME] defecated, did [NAME] defecate in the open or use the latrine?” The survey then goes on to capture OD/latrine use data for each adult member of the household. The question is preceded by an introductory text that seeks to make the respondent comfortable and minimize bias in responses: “I have seen that some people defecate in the open, and some people use the latrine. Now I want to ask about where you and your family members defecate”. In the NFHS survey, the question on OD and latrine use in NFHS survey explores “what kind of latrine facility” the household “usually uses”. A response of “no facility/uses open space or field” serves as the measure for household-level OD.

In order to improve measurement quality and minimize response bias, respondents were randomly selected using defined criteria through survey CTO randomisation. Both instruments differed in the randomisation criterion used for respondent selection – the criterion was based on gender and age for the individual instrument and only age for the NFHS instrument.

During baseline, the instruments had to be adapted across two states. While piloting the instrument in Karnataka, households in certain areas of the study district were observed to speak Telugu rather than the state language of Kannada. The instrument therefore needed to be translated into both Kannada and Telugu languages and administered based on the spoken language in the household. In Gujarat, the survey timeline coincided with the annual monsoon seasons. As OD literature suggests variability in latrine use based on seasonality, two additional questions were included in the instrument to examine latrine use behaviour during non-monsoon seasons at the individual and village-levels.

Endline:

For the endline data collection, the entire sample of 2,436 households were surveyed using the Individual-level survey instrument unlike baseline, wherein half of the sample surveyed answered the household-level questionnaire and the other half of the sample were surveyed using the Individual survey instrument. The Individual-level survey instrument entailed a dis-aggregated, balanced question that probed about latrine use/open defecation outcomes for every individual within a household, while the household-level questionnaire probed about the type of latrine that the household used, and this was not dis-aggregated for individuals within the household.

Questions on seasonal variation in defecation behaviour that were included at baseline in Gujarat owing to monsoons in August 2018, were omitted from the endline. Endline data collection was done in May 2019 in Gujarat, and being peak summer this question on defecation behaviour in monsoons were of not much relevance for the endline.

The national elections in April 2019 had delayed our data collection efforts in Gujarat from April to May 2019.

Some other qualitative insights from the field included the extent of labour migration especially from the state of Bihar followed by Odisha to other states across India as well as Delhi. This is evident from the individual level attrition at endline, compensated by surveying individuals from households which were part of the baseline measurement team sample and were not surveyed during baseline due to different reasons. While few households across the survey sample and irrespective of any particular state, highlighted the presence of other survey teams collecting information on sanitation as well and expressed concerns about our affiliations to the above mentioned teams or government bodies or schemes such as the SBM. In instances as above, we clearly emphasised our disassociation with other survey teams that had worked in these villages in the past as well as the SBM or government bodies. However, these could be treated as isolated cases in our survey efforts, and there were no major political economy considerations or other concerns impacting our survey processes.

Secondary data from official sources⁷ such as SBM-G, NFHS-4 and NARSS were referred to for descriptive comparisons with observed data. SBM-G data enables comparison on latrine ownership while NARSS and NFHS-4 can be used for comparisons on latrine ownership and to a limited extent, latrine use/OD. Robust comparisons were not possible owing to certain data limitations – SBM-G provides village-level data on latrine ownership, limiting our comparisons to

⁷ http://sbm.gov.in/sbmreport/Report/Physical/SBM_TargetVsAchievementWithout1314.aspx; <http://rchiips.org/nfhs/NFHS-4Report.shtml>; <https://mdws.gov.in/documents/reports>

only this variable. NARSS’s de-identified datasets allow for comparisons both on latrine ownership and OD only at the state-level. As there is likely to be varying levels of rural latrine ownership and OD at administrative levels below the state (district/block/village), any state-level comparisons are not likely to be robust. Further, while NARSS gathers data on individual-level latrine use, the corresponding measures are not strictly comparable with this study (NARSS’s related question examines whether the individual uses latrine always/often/rarely/never). NFHS-4 gathers only household-level data on latrine ownership and OD.

2.6 Survey implementation

The training sessions for baseline and endline modules across each of these states comprised of 6 to 7 days in total (refer Table 4). Training sessions constituted two days of questionnaire training on paper and tablets, two days of piloting on field (endline training and pilots were limited to the Individual survey instrument, as the entire sample was administered only this module) followed by another two days of sharing feedback from the pilot sessions and classroom mocks, addressing surveyor concerns, and discussing other qualitative insights from the field instrumental to this study and data collection processes.

Table 4 Training Plan for Measurement Study details the training processes for the endline phase of the study, wherein surveyors had to be trained only on the Individual-level survey instrument.

Table 4 Training Plan for Measurement Study

Training Day	Training Session
Day 1	Introducing the Project and survey/research teams; Training on paper questionnaire for better comprehension of questions and improving familiarity with survey responses
Day 2	Tablet training, familiarises the surveyors with the digital data collection interface used , followed by one or two mock sessions in the afternoon
Day 3	Field Pilots mostly in ODF villages, which are not part of the actual survey sample
Day 4	Feedback from field pilots and accompaniments by supervisors, and discussion session with surveyors; followed by Classroom mocks amongst the surveyors
Day 5	Field pilots for the second time, improving surveyors’ familiarity with survey contexts and questionnaire.
Day 7	Preparations for baseline survey, arranging for survey logistics and planning for field travel, preparation of field calendars and tracker sheets.

Quality control measures: This included a *rigorous training session using both paper questionnaires and surveys integrated on tablets*, so that surveyors were thorough with the questions and options provided as well as familiarised with administering the surveys through tablets, including skip patterns, selecting answers for multiple/single entry questions, editing on tablet surveys, and saving survey forms on tablets.

Field pilots were an integral part of the training sessions, wherein each surveyor was accompanied by supervisors in the survey team and researchers (from rice and IFMR), noting local field characteristics and emerging patterns from the village in general regarding the questions concerned (a perfect example for this was the drainage system observed in few villages

in Gujarat spread across two blocks), identifying individual surveyor errors and observations from these accompaniments were discussed with the survey team at the end of the day. Through pilots, surveyors were exposed to an actual field experience and such insights were instrumental in training surveyors on the questionnaire within their state specific contexts as well as increasing researchers' awareness of the field.

Accompaniments by the research team and supervisors in the survey team facilitated a better understanding of local demographics and sanitation infrastructure within the village, identifying and correcting surveyor level mistakes while administering a survey, ensuring questions were read out the same manner as phrased given the sensitive nature of the study and facilitate surveyors understand the nature and intent of questions. Such accompaniments helped researchers recognise the context-specific nuances (questionnaires were translated to suit the local vernacular of the language) and train surveyors in eliciting sensitive information from the respondents, and reacting in a cautious, unbiased manner.

Quality control was of much significance to the study at hand, given the small window for training and data collection in every state. Within three weeks, training and data collection for a particular state had to be completed, and hence quality, efficiency and in-depth training was essential. While the quality of the surveyors assessed through their years of education, experience within IFMR networks and especially working in local contexts was something that *guided the recruitment process across states, strict training sessions followed by daily debriefs* helped monitor the data collection quality.

Exhaustive, differentiated training modules: This study includes sensitive questions on individual defecation behaviour (Individual questionnaire) and individual food habits such as vegetarian or non-vegetarian (NFHS questionnaire), observational questions for the surveyor (household wealth, latrine observational questions in Individual and NFHS instruments), questions on latrine pit dimensions and surveyors were trained on these different modules with much attention and detail. While questions on individual and community defecation behaviour, food habits etc. were framed in a manner, normalising varied choices of the respondents, surveyors were carefully trained in administering sensitive questions, explaining the rationale behind such question patterns in eliciting truthful, relevant responses. For latrine observation questions, surveyors were trained specifically during classroom as well as field pilots. Thus detailed and differentiated attention to each of the survey modules across both the instruments, laying down the differences and similarities across the NFHS and Individual tools, mock surveys during training, daily feedback session during field pilots and actual survey days ensured the quality of data collected.

To the extent possible, we tried ensuring that the training process remained standardised across the four states, closely following the training agenda detailed earlier.

Once the actual data collection started, a *proper dataflow process* was set up. On a daily basis, the supervisors were responsible for *scrutinising (checking for errors)* the completed survey forms saved on the tablets and this scrutiny process was done in the presence of the concerned surveyor. Supervisors consulted the surveyors on any doubts, errors in the saved survey form and forms were submitted by the supervisors only once these were rectified. Such issues were brought to the concern of the RA immediately, and the supervisors and *RA briefed surveyors individually about issues, areas of improvement etc.* The team met daily after surveying to share general feedback, concerns and plan for the next work day.

In cases where households could not be located with the provided address, unavailable or migrated respondents, duplicate households, difficult respondents who were not convinced of survey intentions etc., the *surveyors immediately informed their team supervisor* who ascertained

the situation and noted such cases. These cases along with the surveyed households were updated on a *field survey tracker on a daily basis by the Project Associate, and the RA monitored the data submissions* along with the field tracker regularly. Monitoring the productivity of surveys completed by surveyors on a daily basis and yet prioritising the quality of data submitted over the survey completion rate, and tackling field concerns on a daily basis ensured the data collection process was as efficient as possible.

2.7 Data Analysis

We analysed the study sample at baseline and endline using descriptive analysis to characterize latrine ownership, latrine use and OD behaviours as well as predictor variables of latrine use and present them as a straight summary.

At baseline, as cross-sectional data on latrine use was gathered from two independent samples using two distinct methods, independent t-tests and chi-square tests were carried out both to ascertain balance in sample distribution as well as to examine incidence of statistically significant differences in reported OD across the two methods.

At baseline and endline, we examined the association between covariates (individual and household-levels) and OD among the individual study sample using cross tabulations and binomial logistic regression analysis. For this purpose, key covariates were modelled in a manner that would allow capture of variations in open defecation within every variable. Individual-level covariates included - age which was modelled as a categorical variable, and grouped into categories such as 5-12 years, 13-20 years, 21-40 years, 41-59 years and 60+ years; education was modelled as a categorical variable, and grouped as those who have no education completed between 1-8 years of education and completed over 8 years of education; gender was a categorized variable, dichotomized as male and female; occupation was categorised into 10 groups, including those who did not work and students. Household-level covariates included - caste which was categorised along official caste groups (Brahmin, Other forward caste, Other backward caste, Scheduled Caste and Scheduled Tribe); type of latrine was categorized as no pit, single pit, two-pit, three-pit and septic tank; latrine age was a continuous variable; type of latrine financing was grouped into categories such as self-financed, received money from government or NGO, received material from government of NGO, received money and material, reimbursement pending and pending reimbursement/material; pit volume was computed based on pit dimensions obtained from households.

In addressing both hypotheses, consistent with recent literature (Bottomley & et.al, 2016). we adjusted standard errors and 95% confidence intervals of estimates at the higher, village level to account for the clustered nature of the data. In order to address hypothesis 2, we set-up cross-sectional time-series linear regression models in which the units of observation were number of individuals (i) per time period (t). difference-in-differences term or the independent variable was the interaction between pre-post intervention difference per individual (where baseline was 0 and endline was 1) and treatment-control difference (where control sample was 0 and individual sample was 1). The true effect of the treatment on the outcome was estimated by the β_3 coefficient for the difference-in-differences term. We also carried out paired-samples t-tests to examine incidence of statistically significant differences in reported OD in the panel data corresponding to the treatment sample.

Survey data was processed and analysed using Stata 15.

2.8 Dealing with incomplete or missing data

Dealing with missing data or incomplete observations in a consistent manner is significant to the data management processes, and performing meaningful analysis and interpretation of results.

Recoding and Imputation: Significant variables for the regression analysis were recoded into suitable categories, and such instances are detailed below.

castecategory: This variable was recoded for the endline regression analysis, wherein 2 cases coded as -888/Others (. f) and 74 instances coded as -999/ Do not know (. g) were recoded into suitable caste categories based on the baseline data. In the baseline dataset as well, instances wherein caste category information could not be provided by households were recoded into corresponding caste categories based on the official state-wise caste classifications. Comments and reasons detailed by the surveyors on caste categories were helpful in recoding the same and using the above for analysis.

In Gujarat, it was observed in two or three villages in Palitana and Taleja block, households did not have latrine pits of usual dimensions as observed in the other states, rather had smaller square pits of 2*2*2 (for air ventilation purposes) connected to a drainage pipe (managed by the panchayat) running across the entire village. These villages had rocky terrains and constructing usual pits into the ground were difficult especially for houses on the slope, and hence this village drainage system served the purpose. Surveyors had marked 'No pit or tank' for these cases, and had detailed in the comments about this system. For 50 such cases (across few villages in Gujarat) in the variable denoting shape of latrine pits ('no_latrinepits' and 'latrinepits' on the dataset), 'No pit/tank' were recoded into 'One pit' wherever such small pits existed and detailed in the comments for that household; variable 'firstpit_shape' (indicating if a square/circular shaped pit) for the same 50 households were recoded from blank/missing into 'square-shaped' (observations from field showed that such small pits were always square-shaped) and following which the latrine pit dimensions such as length, breadth and height/depth variables (first_length, first_width, first_depth) coded as missing/(.) for these 50 cases were imputed as 2*2*2. The reasons for imputing the dimensions as above were based on detailed field observations wherein respondents had provided first-hand information on the dimensions of such pits, comments detailed by the surveyors and pit dimensions across other households in the same village which shared the similar system of drainage.

For the baseline regression analysis, we did not impute individual-level OD from the household-level question as we felt the two question types were not strictly comparable. Latrine use and related determinants were examined only for the sample that was administered the individual-level question. However, the full sample was administered the individual-level question at endline. As it is essential that sample size is balanced across the two time periods to enable a reasonable assessment of latrine use and OD trends over time (hypothesis 2), we imputed individual OD estimates drawing on the household-level response for the open defecation variable for the baseline sample that was administered the household-level latrine use question. However, as there were challenges in interpreting the imputed latrine use/OD data (detailed further in section 3.2.2) and using it for comparison, the corresponding observations were not included in final latrine use analysis.

Untreated for analysis:

opendefecation_: The variable "opendefecation_" has 1,302 missing instances as this includes defecation behaviour only for individuals aged 5 years and above. For children below the age of five, a separate variable "childdefecatedlasttime_" has the corresponding data. This "opendefecation_" variable also has 472 cases of -666/"Not applicable" marked whenever

household members are no longer part of the endline roster (and recall about the last instance defecation behaviour is almost impossible) due to reasons such as individuals migrating away for study or work purposes (migration has been defined as being away from the household for continuous periods longer than six months), larger households in baseline splitting into separate households during the endline (states such as Bihar have 217 instances of not applicable, mostly observed amongst large-sized households in baseline that split into smaller ones during endline after marriage of sons etc.). Odisha had 159 cases of not applicable, mainly owing to reasons such as labour migration to other states, also applicable for Bihar. Other reasons for people being dropped out of the endline household roster and defecation roster included death of household members and marriage of women following which they moved out of their maternal homes. In cases wherein household members were travelling, out for work etc. and were not available during the survey to answer this question on defecation behaviour, surveyors collected defecation behaviour data for the respective individual as last observed by the survey respondent. The variable “opendefecation_” also had around 30 cases of -999/Do not know (. g) wherein respondents were genuinely unaware about the defecation behaviour of the respective household members, and another 37 cases of -888/Others (. f) wherein members did not defecate in the open nor use the latrine, rather resorted to using bedpan etc. due to health reasons, age etc. All the above cases were left untreated for analysis.

In questions on respondent perceptions (section c of questionnaires, whether roti or rice eating villages had healthier children etc.) there was another code included, -111 for ‘Respondent unable to understand the question’, and this was selected just in one instance.

2.9 Ethics

Prior to data collection, the measurement study was granted ethics approval by the Human Subjects Committee of the Institute for Financial Management and Research (Approval # IRB00007107). Approval for the study was also obtained from the Institutional Review Boards of the impact evaluation teams as the study areas were the same for both studies. The purpose of the study was withheld from participants in order to minimize response bias but participants were informed of the risks and benefits of participating in the study and informed consent was obtained from the respondents prior to data collection. Ethical considerations in good interview practices were applied such as building trust and rapport that generally make it difficult for participants to refuse or to withdraw. Measures to ensure participant confidentiality were taken at all stages of data collection, entry and management, including ensuring that only individuals specifically mentioned in the IRB application handled and accessed full data sets, including personal identifiers, which are encrypted and backed up. Survey data and the identifiable information were linked by a unique identity number. Field staff were required to sign a Data Handling and Protection contract prior to any collection or handling of personal identifiers. Personal identifiers stored electronically were removed at the time of analysis, saved as a separate file and were not used or shared with anyone other than the research team.

3. Findings

3.1 Results of research hypothesis 1

3.1.1 Description of baseline sample

The sample comprised 95 villages across 4 states (Bihar (23%), Odisha (25%), Karnataka (25%), Gujarat (26%)) in India. Of a total of 2473 eligible households, 42 were excluded from analysis owing to unavailability of respondents who met the eligibility criteria for providing information on several household level covariates corresponding to latrine ownership and use. The analysis for latrine ownership is based on 2432 households and 13,730 individuals in this study area. Table 5 **Error! Reference source not found.** provides information on characteristics of the study

households, including latrine ownership, at baseline, by the type of survey instrument used. The differences in means are not statistically significant on any variable, suggesting that the distribution of sample across the two survey instruments are balanced. Chi-square tests were also used to ascertain that there was no statistically significant relationship between type of survey instrument and household characteristics.

Table 5 Baseline sample characteristics

Variable	Sample unit	individual N(%)	NFHS N(%)	individual Mean(SD)	NFHS Mean(SD)	difference* Mean(SE)
Total households	Households	1,215	1,217			
Total households by state	Households					
Bihar		316	313			
Odisha		293	288			
Karnataka		297	296			
Gujarat		309	320			
Individuals	Individuals	6907	6823			
Individuals >=5 yrs included in latrine use study	Individuals	6268	-			
Household size	Households			5.684 (2.787)	5.606 (2.680)	0.078 (0.099)
Age >= 5 yrs	Individuals	6305	6251	32.249 (19.564)	31.364 (18.918)	0.885 (0.320)***
Gender of household head	Households					
Male		1,070 (88.07)	1,085 (89.15)	0.881 (0.324)	0.892 (0.311)	-0.011 (0.010)
Female		145 (11.93)	132 (10.85)	0.119 (0.324)	0.108 (0.311)	0.011 (0.010)
Gender	Individuals					
Male		3,515 (50.93)	3,482 (51.13)	0.508 (0.500)	0.509 (0.500)	-0.001 (0.007)
Female		3,387 (49.07)	3,328 (48.87)	0.492 (0.500)	0.491 (0.500)	0.001 (0.007)
Household head completed 8 years of education	Households	377 (31.02)	423 (34.75)	0.310 (0.463)	0.348 (0.476)	-0.037 (0.019)*
Religion	Households					
Hindu		1,175 (96.71)	1,168 (96.13)	0.967 (0.179)	0.961 (0.193)	0.006 (0.005)
Muslim		39 (3.21)	43 (3.54)	0.032 (0.176)	0.035 (0.185)	-0.003 (0.005)
Christian		1 (.08)	4 (.03)	0.001 (0.028)	0.003 (0.057)	-0.002 (0.003)
Owns latrine	Households	1,146 (94.32)	1,150 (94.49)	0.943 (0.231)	0.944 (0.228)	-0.002 (0.010)
Latrine appears used	Households	914 (79.76)	911 (79.22)	0.797 (0.401)	0.792 (0.405)	0.005 (0.018)

*SE adjusted for clustering at village-level, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.1.2 Latrine ownership and use at baseline

Latrine ownership at baseline

Table 6 and 7 provides summary statistics for latrines owned by households in the four states. Latrine ownership among sampled population is not necessarily representative of the rural areas of the study states, which is evidenced the difference in means in latrine ownership among study population and official data gathered through sources such as SBM, NARSS and NFHS-4.

Table 6 Latrine ownership at baseline

Variable	Full sample N(%)	Bihar N(%)	Odisha N(%)	Karnataka N(%)	Gujarat N(%)
Owns latrine					
Yes	2296 (94.41)	609 (96.82)	546 (93.98)	547 (92.24)	594 (94.44)
No	136 (5.59)	20 (3.18)	35 (6.02)	46 (7.76)	35 (5.56)

Table 7 provides characteristics of the latrines that are owned in study areas. Our sampling frame comprised households that own latrines as we hypothesize that reported data on open defecation could be higher among households that own functional latrines if measurement allows for disaggregation by each individual in the household. Accordingly, household latrine coverage is over 90% in our sampled populations across the four states. The majority are single-pit latrines in Odisha (72%), Karnataka (94%) and Gujarat (72%). Bihar, in contrast, has a higher prevalence of two-pit latrines (77%), because the research team focused on areas which had higher coverage of twin pits. The mean age of latrines in Bihar is 2.26 years and construction is predominantly with monetary and/or material support from the government (66%). The mean age of latrines is over 3 years in the remaining states, and highest in Gujarat at 6.63 years.

Pit volume was computed based on dimensions of the pits which was shared by households and the variable is an aggregate of the volumes of each pit in the household. The reported data on this parameter show wide variability in terms of distribution.

Less than 8% households in each state report having their latrine pits fill up, with Gujarat reporting the lowest figures (4.8%) despite recording the highest mean age of latrines. Gujarat also has the highest proportion of latrines that were self-financed (55%). In contrast, the proportion of latrines that were constructed with monetary or material support from the government or an NGO is higher in the remaining three states (Bihar (65%), Odisha (79%), Karnataka (72%)).

Table 7 Baseline latrine characteristics

Variable	Full sample Mean(SD)	Bihar Mean(SD)	Odisha Mean(SD)	Karnataka Mean(SD)	Gujarat Mean(SD)
Owens latrine*	N=2432	N=629	N=581	N=593	N=629
Sample	0.944 (0.229)	0.968 (0.175)	0.939 (0.238)	0.922 (0.267)	0.944 (0.229)
Type of latrine	N=2296	N=609	N=546	N=547	N=594
No pit/other	0.021 (0.144)	0.001 (0.040)	0.031 (0.173)	0.021 (0.146)	0.319 (0.176)
Single pit	0.652 (0.476)	0.152 (0.360)	0.719 (0.449)	0.937 (0.241)	0.841 (0.365)
Two pit	0.267 (0.442)	0.768 (0.422)	0.130 (0.336)	0.127 (0.112)	0.114 (0.318)
Three pit	0.005 (0.072)	0.013 (0.113)	0.001 (0.042)	0	0.005 (0.070)
Septic tank	0.053 (0.224)	0.064 (0.245)	0.117 (0.321)	0.027 (0.163)	0.006 (0.081)
Age of Latrine	N=2293	N=607	N=546	N=547	N=593
	4.072 (5.377)	2.395 (3.055)	3.79 (4.699)	3.720 (4.876)	6.373 (7.193)
Pit has filled up	N=2178	N=609	N=534	N=535	N=500
	0.059 (0.236)	0.072 (0.259)	0.065 (0.247)	0.050 (0.219)	0.048 (0.213)
Pit volume	N=2247	N=608	N=544	N=535	N=560
	163.153 (285.142)	169.689 (307.486)	125.5 (292.06)	95.96 (96.56)	256.824 (343.081)
Latrine financing	N=2296	N=609	N=546	N=547	N=594
Self	0.317 (0.465)	0.323 (0.468)	0.173 (0.379)	0.226 (0.419)	0.526 (0.499)
Money from govt/NGO	0.339 (0.473)	0.425 (0.494)	0.293 (0.455)	0.531 (0.499)	0.116 (0.320)
Material from govt/NGO	0.258 (0.438)	0.175 (0.380)	0.393 (0.489)	0.177 (0.382)	0.294 (0.456)
Money & material	0.034 (0.182)	0.021 (0.144)	0.071 (0.257)	0.012 (0.112)	0.033 (0.180)
Pending reimbursement	0.042 (0.201)	0.045 (0.209)	0.053 (0.224)	0.049 (0.216)	0.021 (0.146)
Pending reimb + material	0.007 (0.088)	0.008 (0.090)	0.014 (0.120)	0.001 (0.042)	0.006 (0.081)
Latrine appears used	N=2296	N=609	N=546	N=547	N=594
	0.794 (0.403)	0.921 (0.269)	0.706 (0.455)	0.658 (0.474)	0.872 (0.334)

*all estimates correspond to households that own latrines.

The study recorded latrine observations conducted by enumerators who were trained to assess the functionality and use of latrines based on the criteria such as *when there was an open pan, minimum hygiene standards and access to water facilities indicating use, such as functioning tap, the toilet pan and floor lying wet, toilet having a mug etc.* (see Table 8). Surveyors also reported a single observational measure on latrine use based on their overall assessment. Based on this overall assessment, latrines in Bihar (92%) and Gujarat (87%) appear to be better used than in Karnataka (65%) and Odisha (70%). In these latter states, a relatively higher proportion of households appear to be using the latrines for other purposes (Karnataka (33.27%), Odisha (18.68%)) (see last row in Table 5).

Table 8 Latrine observations at baseline

Variable	Full Sample Mean(SD)	Bihar Mean(SD)	Odisha Mean(SD)	Karnataka Mean(SD)	Gujarat Mean(SD)
	N=2,296	N=609	N=546	N=547	N=594
Seems used for other purposes	0.162 (0.369)	0.062 (0.242)	0.186 (0.390)	0.332 (0.471)	0.087 (0.282)
Pan sealed	0.108 (0.310)	0.016 (0.127)	0.194 (0.395)	0.175 (0.380)	0.060 (0.238)
Mug	0.753 (0.431)	0.857 (0.350)	0.595 (0.491)	0.652 (0.476)	0.883 (0.320)
Presence of slippers	0.221 (0.415)	0.026 (0.160)	0.324 (0.468)	0.157 (0.364)	0.385 (0.487)
Cleaning supplies	0.556 (0.496)	0.415 (0.493)	0.454 (0.498)	0.541 (0.498)	0.809 (0.392)

Latrine use at baseline

Table 15 shows main findings at baseline with regards to reported open defecation across project areas by the type of survey instrument. Results under the individual column correspond only to the individual-level question. Results from NFHS column correspond only to the household-level question. We did not impute individual-level OD from the household-level question as we felt the two question types were not strictly comparable.

The evidence suggests that reported OD is considerably different between the two survey instruments – the individual question on latrine use finds 20 percentage points more reported OD than the household-level question. The difference is significant across the full sample as well as within project areas.

Table 9 Reported OD by type of survey instrument, state at baseline

Variable	Total N	individual* N(%)	NFHS** N(%)	individual Mean(SD)	NFHS Mean(SD)
Reported OD (Full sample)	6,268	2031 (32.40)	148 (12.32)	0.324 (0.468)	0.123 (0.328)
Reported OD by state					
Bihar	1,718	262 (15.25)	8 (2.57)	0.152 (0.359)	0.025 (0.158)
Odisha	1,473	639 (43.38)	60 (20.83)	0.433 (0.495)	0.208 (0.406)
Karnataka	1,471	821 (55.81)	57 (19.32)	0.558 (0.496)	0.193 (0.395)
Gujarat	1,606	309 (19.24)	23 (7.49)	0.192 (0.394)	0.074 (0.263)

*individual-level estimates; **household-level estimates

Reported OD across the two samples are higher in the states of Odisha and Karnataka in comparison to Bihar and Gujarat. According to NFHS-4, reported OD for rural Bihar was around 73.2 percent, 48.1 percent for Gujarat, 52.1 percent for Karnataka and around 72.4 percent for Odisha. Gujarat was also declared an ODF state in February 2018. The correlation coefficient between reported latrine use (from Individual questionnaire) and observed use is 0.63, while that between reported latrine use (from NFHS questionnaire) and observed use is 0.51.

Awareness of the health benefits of latrine use was high across both samples (over 80%) and was lowest in Karnataka (63.64% in individual survey and 59.80% in NFHS survey). Reported OD at a village-level was comparable across both samples but was higher in comparison to individual and household level behaviours. Reported village-level OD was highest in Karnataka (76.09% in individual survey, 73.56% in NFHS survey), followed by Odisha (46.02% in individual survey and 41.46% in NFHS survey).

As data collection in the state of Gujarat was conducted during monsoon season, data was also gathered to understand seasonal variation in latrine use. Results indicate a significant difference in reported OD at the last time of defecation ($M=.192$, $SD=.394$) and during summer season ($M=.229$, $SD=.4204$), $t(1605)=-4.74$, $p=0$.

In summary, a key observation that emerges from the individual survey is that individuals living in households that own latrines do not always use the facilities. This finding is consistent with previous evidence that latrine ownership does not always translate to latrine use (Sinha & et.al, 2017) (Clasen & et.al, 2014) (Coffey & et.al, 2014) (Patil & et.al, 2014). An important inference from this is questions that ask about household-level behaviour, grouping all household members together, may not capture individual-level, intra-household variations in use.

Determinants of latrine use at baseline

As noted earlier, this study gathered data on individual and household-level covariates that are commonly identified in OD literature as associated with latrine use. Table 10 presents results of binomial regression model of the association between reported OD and potential predictors of OD at baseline. This analysis was carried out on the individual survey sample which allows for disaggregation at an individual, intra-household level.

Gender – The analysis suggests that men are more likely to report practising OD than females in the full sample (OR=1.278, 95% CI=1.079,1.515, $p=.005$) as well as across states.

Age - In this analysis, the age group 21-40 years as modelled as the reference group. Evidence suggests that the age group of 60 years and above showed a 44% increased likelihood of reported OD (OR=1.447, 95% CI=1.061,1.973, $p=.020$) when compared to the reference group; none of the remaining age categories showed a statistically significant effect on OD in comparison

Education - OD literature suggests that the level of education is positively associated latrine use (Leshargie & et.al, 2018). In line with this hypothesis, evidence from this study suggests that individuals who have received no schooling show a 63% increased likelihood of reporting OD practice (OR=1.636, 95% CI=1.211, 2.210, $p=.001$) in comparison to the reference group of individuals who have received more than 8 years of education. The effect is statistically significant among the study samples in all states except Gujarat.

Occupation – In this analysis, in comparison to the reference group of individuals who did not work, individuals holding occupations in agriculture (landowners), agricultural and non-agricultural labour reported significantly higher practice of OD.

Caste – All caste categories showed a significantly higher reported OD in comparison to the reference group of Brahmins; the effect was most significant among the ST caste category (OR=47.62, 95% CI=16.35, 138.7, $p<.001$)

Age of latrine – Evidence suggest that increasing age of latrine was associated with a lower likelihood of reported OD (OR=0.868, 95% CI=0.820, 0.919, $p<.001$). A statistically significant effect of this variable on OD can be observed in Karnataka where the reported incidence of OD is the highest.

Type of latrine – OD literature also suggests that the type of latrine and number of latrine pits have a strong association with practice of latrine use and OD, with individuals having access to improved sanitation facilities more likely to use a latrine in comparison to individuals accessing basic sanitation facilities. Evidence from this analysis on the study sample suggests that households that own latrines without a pit are considerably more likely to report OD (OR=34.89, 95% CI= 7.669,158.7, $p<.001$) in comparison to the reference group of households owning latrines with septic tanks. The effect is not statistically significant among the remaining latrine types.

Latrine financing – OD literature in India also suggests households owning latrines constructed with government support are less likely to use the same. In this analysis, household owning self-financed latrines was modelled as the reference group. Consistent with literature, reported OD was higher among all latrine financing categories in comparison to the reference group.

In summary, based on our data, certain individual and household-level variables were strong predictors of latrine use. Gender, education, age (individuals over 60 years), type of latrine owned and whether latrine was self-financed or constructed with support from government/NGO were all associated with reported OD and latrine use.

Table 10 Model showing association of predictors on OD at baseline

	Full sample	Bihar	Odisha	Karnataka	Gujarat
male_	1.278** (0.005)	1.467** (0.008)	1.765*** (0.000)	1.558* (0.034)	1.132 (0.628)
Age					
– 0.5–12 years	1.168 (0.400)	1.057 (0.838)	0.956 (0.922)	1.716 (0.168)	0.546 (0.255)
– 1.13-20 years	0.875 (0.377)	0.998 (0.994)	1.450 (0.228)	1.293 (0.487)	0.406** (0.006)
– 2.21-40 years	Ref	Ref	Ref	Ref	Ref
– 3.41-59 years	1.056 (0.656)	1.508 (0.186)	1.079 (0.716)	0.519* (0.047)	0.761 (0.215)
– 4.Above 60 years	1.447* (0.020)	1.801** (0.008)	1.540 (0.064)	0.778 (0.402)	1.653 (0.249)
Education					
– 0.No schooling	1.637** (0.001)	2.398*** (0.000)	3.703*** (0.000)	3.536*** (0.000)	1.141 (0.776)
– 1.1-8 years	1.083 (0.456)	1.090 (0.556)	1.424 (0.082)	1.999*** (0.000)	0.960 (0.899)
– 2.More than 8 years	Ref	Ref	Ref	Ref	Ref
Occupation					
– 0.Does not work	Ref	Ref	Ref	Ref	Ref
– 1.Agriculture	1.843** (0.005)	1.393 (0.318)	3.242** (0.004)	2.869** (0.008)	7.742** (0.002)
– 2.Animal Husbandry	0.690 (0.271)	0.953 (0.952)	5.090 (0.075)	453.0 (0.719)	7.334*** (0.001)
– 3.Govt. Job	0.963 (0.906)	0.847 (0.833)	0.618 (0.269)	1.846 (0.400)	1.501 (0.649)
– 4.Agricultural labour	2.110** (0.002)	1.064 (0.903)	1.412 (0.628)	5.798*** (0.000)	11.59** (0.004)
– 5.Non-agricultural labour	2.298*** (0.000)	1.266 (0.629)	2.538 (0.107)	4.323*** (0.000)	7.898** (0.002)
– 6.Independent/skilled work	1.138 (0.647)	1.672 (0.145)	2.303 (0.200)	3.411 (0.149)	2.594 (0.196)
– Own shop/business	1.707* (0.032)	0.507 (0.506)	1.920 (0.108)	4.053** (0.002)	1.604 (0.667)
– Salaried job	0.996	1.123	1.069	1.640	1.880

	Full sample	Bihar	Odisha	Karnataka	Gujarat
	(0.984)	(0.692)	(0.869)	(0.281)	(0.361)
– Household work	0.944 (0.759)	0.697 (0.313)	1.712 (0.170)	0.741 (0.384)	3.045* (0.046)
– Student	1.147 (0.446)	0.974 (0.916)	1.118 (0.784)	1.176 (0.674)	14.43*** (0.000)
Caste					
– 0.Brahmin	Ref	Ref	Ref	Ref	Ref
– 1.General/Other high caste	4.013** (0.002)	0.0252** (0.002)	4.286* (0.015)	0.110*** (0.000)	17.34* (0.018)
– 2.Other Backward Classes (OBC)	5.219*** (0.000)	0.0145*** (0.000)	6.383*** (0.000)	0.262** (0.009)	21.81** (0.006)
– 3.Scheduled Caste(SC/Dalit/Harijan)	15.00*** (0.000)	0.0457* (0.022)	15.07*** (0.000)	0.800 (0.662)	17.83* (0.018)
– 4.Scheduled Tribe (ST/Adivasi)	47.62*** (0.000)	1 (.)	20.59*** (0.000)	1 (.)	37.48* (0.012)
Latrine age	0.868*** (0.000)	0.948 (0.400)	0.909 (0.065)	0.791*** (0.001)	0.894 (0.092)
Type of latrine					
– 0.No pit/tank	34.89*** (0.000)	1 (.)	1 (.)	1 (.)	72.68* (0.017)
– 1.One	2.030 (0.084)	5.286 (0.075)	1.749 (0.332)	1.418 (0.775)	2.261 (0.647)
– 2.Two	0.424 (0.079)	2.824 (0.262)	0.462 (0.236)	0.676 (0.755)	1.784 (0.742)
– 3.Three	0.459 (0.527)	3.048 (0.208)			1 (.)
– 4. Septic tank	Ref	Ref	Ref	Ref	Ref
Latrine financing					
– Nothing	Ref	Ref	Ref	Ref	Ref
– Money	1.703* (0.015)	0.432 (0.073)	0.783 (0.644)	1.240 (0.483)	0.360* (0.028)
– Material	4.230*** (0.000)	2.849** (0.005)	2.220* (0.041)	8.935*** (0.000)	5.574*** (0.000)
– Money and material	1.918* (0.021)	1.078 (0.847)	0.945 (0.920)	1 (.)	1.781 (0.451)
– Reimbursement pending	1.882 (0.060)	1.983 (0.127)	2.332* (0.044)	0.456 (0.292)	1.383 (0.723)

	Full sample	Bihar	Odisha	Karnataka	Gujarat
– Reimbursement pending and material	6.604** (0.002)	3.731 (0.182)	1 (.)		5.633 (0.068)
Observations	5920	1640	1334	1298	1503

Exponentiated coefficients; p -values in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3.2 Results of research hypothesis 2

3.2.1 Description of endline sample

Endline villages were the same as baseline. The analysis for latrine ownership and use is based on 2,346 households and 13,921 individuals in this study area. Table 11 provides information on characteristics of the study households, including latrine ownership and use (assessed via interviewer observation) at endline.

Table 11 Endline sample characteristics

Variable	Sample unit	Full sample N(%)	Full sample Mean(SD)
Total households	Households	2,346	
Total households by state	Households		
Bihar		608	
Odisha		572	
Karnataka		554	
Gujarat		612	
Individuals	Individuals	13,921	
Individuals >=5 yrs.	Individuals	12,620 (90.65)	
Household size	Households		5.955 (2.883)
Age >= 5 yrs.	Individuals	12,620	0.315 (0.191)
Gender of HH head	Households		
Male		2,082 (88.75)	0.887 (0.316)
Female		264 (11.25)	0.112 (0.316)
Gender	Individuals		
Male		7,081 (50.87)	0.508 (0.499)
Female		6,840 (49.13)	0.491 (0.499)
HH head completed 8 years of education	Households	786 (33.5)	0.335 (0.472)
Religion	Households		
Hindu		2,266 (96.71)	0.967 (0.178)
Muslim		75 (3.20)	0.032 (0.176)
Christian		2 (0.09)	0.001 (0.029)
Owns latrine	Households	2,263 (96.46)	0.964 (0.184)
<i>Latrine appears used</i>	<i>Households</i>	<i>1,779 (78.61)</i>	<i>0.786 (0.410)</i>

3.2.1 Latrine ownership and use at endline

Latrine ownership at endline

Table 12 and 13 provides summary statistics for latrines owned by households in the four states. Latrine ownership among sampled population is not necessarily representative of the rural areas of the study states, which is evidenced in the difference in means in latrine ownership among study population and official data gathered through sources such as SBM, NARSS and NFHS-4.

Table 12 Latrine ownership at endline

Variable	Full sample N(%)	Bihar N(%)	Odisha N(%)	Karnataka N(%)	Gujarat N(%)
Owns latrine					
Yes	2263 (96.46)	599 (98.5)	548 (95.8)	527 (95.1)	589 (96.2)
No	83 (3.53)	9 (1.5)	24 (4.2)	27 (4.9)	23 (3.8)

Table 13 provides characteristics of the latrines that are owned in study areas. Our sampling frame comprised households that own latrines as we hypothesize that reported data on open defecation could be higher among households that own functional latrines if measurement allows for disaggregation by each individual in the household. Accordingly, household latrine coverage is over 90% in our sampled populations across the four states. The majority are single-pit latrines in Odisha (72%), Karnataka (96%) and Gujarat (80%). Bihar has a higher prevalence of two-pit latrines (80%) as the independent research team in this state deliberately chose to include all households with twin pits in their sample. The mean age of latrines in Bihar is 3.11 years and construction is predominantly with monetary and/or material support from the government (75.5%). The mean age of latrines is over 4 years in the remaining states, with the mean age of latrines in Gujarat being the highest at 6.3 years.

Pit volume was computed based on dimensions of the pits which was shared by households and the variable is an aggregate of the volumes of each pit in the household. Also as detailed in the section above, for 50 endline households in Palitana and Taleja block, the pit dimensions were imputed as 2*2*2 in place of no pit in latrines. Surveyors had selected this option for households which had a comparatively smaller, square pit for air ventilation purposes (further connected to a village drainage system which opened near a river source) and based on close observations during field we imputed the above dimensions. The reported data on this parameter shows wide variability in terms of distribution.

Less than 9% households in each state reported having their latrine pits filled up, with Gujarat reporting the lowest figures (3.6%) despite recording the highest mean age of latrines. Gujarat also has the highest proportion of latrines that were self-financed (60%). In contrast, the proportion of latrines that were constructed with monetary or material support from the government or an NGO is higher in the remaining three states (Bihar (75.5%), Odisha (79%), Karnataka (78%).

Table 13 Latrine characteristics at Endline

Variable	Full sample Mean(SD)	Bihar Mean(SD)	Odisha Mean(SD)	Karnataka Mean(SD)	Gujarat Mean(SD)
Owens latrine	N=2346	N=608	N=572	N=554	N=612
Sample	0.964 (0.184)	0.985 (0.120)	0.958 (0.200)	0.951 (0.215)	0.962 (0.190)
Type of latrine	N=2263	N=599	N=548	N=527	N=589
No pit/other	0.031 (0.174)	0.001 (0.040)	0.027 (0.163)	0.001 (0.043)	0.091 (0.288)
Single pit	0.642 (0.479)	0.138 (0.345)	0.718 (0.449)	0.960 (0.195)	0.799 (0.400)
Two pit	0.269 (0.443)	0.796 (0.403)	0.111 (0.314)	0.017 (0.129)	0.105 (0.307)
Three pit	0.003 (0.055)	0.008 (0.091)	0.001 (0.042)	0	0.001 (0.041)
Septic tank	0.053 (0.225)	0.055 (0.228)	0.140 (0.347)	0.020 (0.143)	0.001 (0.041)
Age of Latrine	N=2251	N=599	N=548	N=527	N=577
	4.467 (5.016)	3.117 (3.622)	4.378 (4.145)	4.086 (4.553)	6.301 (6.635)
Pit has filled up	N=2263	N=599	N=548	N=527	N=589
	0.058 (0.234)	0.071 (0.258)	0.082 (0.274)	0.043 (0.204)	0.035 (0.185)
Pit volume	N=2168	N=596	N=536	N=508	N=528
	163.802 (262.997)	150.187 (178.972)	116.119 (211.887)	86.069 (91.777)	302.365 (408.638)
Latrine financing	N=2263	N=599	N=548	N=527	N=589
Self	0.278 (0.448)	0.178 (0.383)	0.156 (0.364)	0.178 (0.383)	0.584 (0.493)
Money from govt/NGO	0.430 (0.495)	0.580 (0.493)	0.385 (0.487)	0.635 (0.481)	0.137 (0.344)
Material from govt/NGO	0.253 (0.434)	0.165 (0.371)	0.425 (0.494)	0.174 (0.379)	0.252 (0.435)
Money & material	0.010 (0.102)	0.015 (0.121)	0.009 (0.095)	0.005 (0.075)	0.011 (0.108)
Pending reimbursement	0.025 (0.156)	0.060 (0.237)	0.021 (0.146)	0.005 (0.075)	0.010 (0.100)
Pending reimb + material	0.001 (0.036)	0	0.001 (0.042)	0	0.003 (0.058)
Latrine appears used	N=2263	N=599	N=548	N=527	N=589
	0.786 (0.410)	0.904 (0.293)	0.731 (0.443)	0.707 (0.455)	0.786 (0.410)

*all estimates correspond to households that own latrines.

The study recorded latrine observations conducted by enumerators who were trained to assess the functionality and use of latrines. Latrines were observed as used by the surveyors based on the criteria such as *an open pan, minimum hygiene standards and access to water facilities indicating use, such as functioning tap, wet toilet pan and floor surfaces, mugs within the latrines, smell and footmarks on floor indicating use etc.*, also listed in Table 14. Based on this observed data (referring to the last row in Table 13) Table 13 Latrine characteristics '**Latrine appears used**' (this is a single measure as observed by the surveyor that the latrine appears used based on the indicators listed above), latrines in Bihar (90%) appears to be better used through surveyor observation compared to latrines in Gujarat (79%), Karnataka (71%) and Odisha (73%). In these latter states, a relatively higher proportion of households appear to be using the latrines for other purposes as well (Karnataka (25.4%), Odisha (14.8%)).

Table 14 Latrine observations at endline

Variable	Full Sample Mean(SD) N=2,263	Bihar Mean(SD) N=599	Odisha Mean(SD) N=548	Karnataka Mean(SD) N=527	Gujarat Mean(SD) N=589
Seems used for other purposes	0.121 (0.326)	0.046 (0.211)	0.147 (0.355)	0.254 (0.435)	0.052 (0.223)
Pan sealed	0.091 (0.288)	0.030 (0.170)	0.145 (0.353)	0.168 (0.375)	0.035 (0.185)
Mug	0.761 (0.426)	0.886 (0.317)	0.604 (0.489)	0.660 (0.474)	0.872 (0.333)
Presence of slippers	0.273 (0.445)	0.041 (0.200)	0.244 (0.430)	0.349 (0.477)	0.468 (0.499)
Cleaning supplies	0.585 (0.492)	0.524 (0.499)	0.405 (0.491)	0.616 (0.486)	0.789 (0.408)

Latrine use at endline

Table 15 shows main findings with regards to reported OD across the entire sample at endline.

Table 15: Endline Reported OD by state (Individual-level estimates)

Variable	Total sample in Endline N	Reported OD across Endline sample* N(%)	Full samples Mean(SD)
Reported OD (Full sample)	12,080**	3,445 (28.52)	0.285 (0.451)
Reported OD by state			
Bihar	3,294	494 (14.9 %)	0.149 (0.357)
Odisha	2,738	994 (36.3 %)	0.363 (0.480)
Karnataka	2,805	1,288 (45.9 %)	0.459 (0.498)
Gujarat	3,243	669 (20.6 %)	0.206 (0.404)

**individual-level estimates **not including children who were below the age of five years as well as those individuals who were not part of the endline roster (due to reasons detailed earlier such as migration, death of the concerned member, households splitting into more than one and marriage of a female member etc.)*

Reported OD rates are higher in Karnataka (45.9 %) and Odisha (36.3%) compared to Bihar and Gujarat. According to NFHS-4 estimates, reported OD for rural Bihar was around 73.2 %, 48.1 % for Gujarat, 52.1 % for Karnataka and around 72.4 % for Odisha. Gujarat was also declared an ODF state in February 2018. The correlation coefficient between reported latrine use at an Individual level and observed latrine use (as estimated through surveyor observation) is 0.55.

Awareness of the health benefits of latrine use was high across sample households (over 80% across Bihar, Odisha and Gujarat), while this was the lowest in Karnataka (65%)⁸. Reported village-level OD was highest in Karnataka (54.62%), followed by Odisha (31.22%), Bihar (20.62%) and Gujarat reported the lowest rate of village-level OD (13.25%)⁹.

In summary, a key observation that emerges from the study is that individuals living in households that own latrines do not always use the facilities. This finding is consistent with previous evidence that latrine ownership does not always translate to latrine use (Sinha & et.al, 2017) (Clasen & et.al, 2014) (Coffey & et.al, 2014) (Patil & et.al, 2014). An important inference that could be drawn here is that household-level surveys may not be equipped to capture individual-level, intra-household variations in use (discussed in detail in the baseline report, comparing reported OD statistics reported across individual-level and household-level/NFHS question), and balanced, dis-aggregated questions probed at an individual level could result in improved, truthful estimates on open defecation.

Determinants of latrine use at endline

As noted earlier, this study gathered data on individual and household-level covariates that are commonly identified in OD literature as associated with latrine use. Table 16 presents results of binomial regression model of the association between reported OD and potential predictors of OD at endline. This analysis was carried out on the individual survey sample which allows for disaggregation at an individual, intra-household level.

Gender – The analysis suggests that men are more likely to report practising OD than women in the full sample (OR=1.574, 95% CI=1.364,1.816, p=0.000) as well as across states.

Age - In this analysis, the age group 21-40 years is modelled as the reference group. Evidence suggests that the age group of 60 years and above showed a 32% increased likelihood of reported OD (OR=1.325, 95% CI=1.060,1.655, p=.013) when compared to the reference group; the age group of 5 to 12 years showed a 70% increased likelihood of reported OD in comparison to the reference group (OR=1.708, 95% CI=1.338, 2.182, p=.000), while the age group between 13-20 years showed a 28% increased likelihood of reported OD (OR=1.283, 95% CI=1.063,p=.009) with respect to the comparison group.

Education - OD literature suggests that the level of education is positively associated latrine use (Leshargie & et.al, 2018). In line with this hypothesis, evidence from this study suggests that individuals who have received no schooling show a 46% increased likelihood of reporting OD practice (OR=1.462, 95% CI=1.146, 1.865, p=.002) in comparison to the reference group of individuals who have received more than 8 years of education. The effect is statistically significant among the study samples in all states except Gujarat.

Occupation – In this analysis, in comparison to the reference group of individuals who did not work, individuals holding occupations in agriculture (landowners), agricultural and non-agricultural labour reported significantly higher practice of OD. Individuals engaged in own agricultural

⁸ These reported statistics are drawn from the question, wherein respondents are provided situations of two villages, in one village everyone uses the latrine and in the other everyone in the village defecates in the open, and respondents are probed about as to in which village do they think the children would be healthier. This awareness about what could be the healthier environment for children out of the two provided village situations should act as a reasonable and objective proxy for awareness of health benefits of using latrines.

⁹ This estimate draws from the survey question, “Where do you think people in this village defecate, and the responses included mostly go out in the open, mostly use the latrines and half of the villagers used the latrine while the other half went out in the open?” The estimates reported in this sentence refer to the option, mostly go out in the open.

activities (cultivation on owned land, contract or rented land) had a 92% increased likelihood of reporting OD (OR=1.924, 95% CI=1.437,2.574, p=.000), as well as individuals involved in agricultural labour had a 105% increased likelihood of reported OD (OR=2.052, 95% CI=1.474, 2.858, p=.000) and individuals in non-agricultural labour had an 86% increased likelihood of reporting OD practice (OR=1.863, 95% CI=1.391, 2.494, p=.000).

Caste – All caste categories showed a significantly higher reported OD in comparison to the reference group of Brahmins; the effect was most significant among the ST caste category (OR=20.623 95% CI=10.37,40.99, p=.000)

Age of latrine – Evidence suggest that increasing age of latrine was associated with a lower likelihood of reported OD (OR=0.888, 95% CI=0.845, 0.933, p=000). A statistically significant effect of this variable on OD can be observed in Karnataka where the reported incidence of OD is the highest.

Type of latrine – OD literature also suggests that the type of latrine and number of latrine pits have a strong association with practice of latrine use and OD, with individuals having access to improved sanitation facilities more likely to use a latrine in comparison to individuals accessing basic sanitation facilities. Evidence from this analysis on the study sample suggests that households that owned latrines without pits were considerably more likely to report OD (OR=4.66, 95% CI=1.665,13.076, p=.003) in comparison to the reference group of households owning latrines with septic tanks. The effect is not statistically significant among the remaining latrine types.

Latrine financing – OD literature in India also suggests households owning latrines constructed with government support are less likely to use the same. In this analysis, household owning self-financed latrines was modelled as the reference group. Consistent with literature, reported OD was significantly higher in latrines constructed through government support (wherein government provided the materials or constructed latrines for respective households) (OR=3.27, 95% CI=2.174,4.941, p=.000)

In summary, results across the two time periods (baseline and endline) are consistent in finding certain individual and household-level variables to be strong predictors of latrine use. Gender, education, age (individuals over 60 years), caste categories, occupation practiced, type of latrine owned and whether latrine was self-financed or constructed with support from government/NGO were all associated with reported OD and latrine use. Results are also consistent with previous evidence which have identified these variables as significant predictors of open defecation and latrine use (Coffey & et.al, 2014) (Sinha & et.al, 2017) (O'Reilly & et.al, 2014) (Routray & et.al, 2015) (Ghosh & et.al, 2014) (O'Loughlin & et.al, 2006).

Table 16 Model showing association of predictors on OD at endline

	Full sample	Bihar	Odisha	Karnataka	Gujarat
male_	1.566*** (0.000)	1.909** (0.002)	1.758*** (0.000)	1.769*** (0.000)	1.400* (0.053)
Age					
– 0.5–12 years	1.654*** (0.000)	2.305** (0.010)	1.348 (0.262)	1.457 (0.090)	1.776 (0.072)
– 1.13-20 years	1.256* (0.022)	1.484 (0.105)	1.676** (0.003)	1.291 (0.148)	1.214** (0.446)
– 2.21-40 years	Ref	Ref	Ref	Ref	Ref
– 3.41-59 years	1.141 (0.154)	1.065 (0.666)	1.624*** (0.000)	0.797 (0.127)	0.880 (0.419)
– 4.Above 60 years	1.362** (0.007)	1.148 (0.426)	2.024*** (0.000)	1.032 (0.854)	1.197 (0.420)
Education					
– 0.No schooling	1.399** (0.006)	2.085*** (0.000)	1.706*** (0.000)	1.950** (0.001)	1.309 (0.392)
– 1.1-8 years	0.902 (0.268)	1.022 (0.892)	0.990 (0.945)	1.081 (0.614)	0.893 (0.691)
– 2.More than 8 years	Ref	Ref	Ref	Ref	Ref
Occupation					
– 0.Does not work	Ref	Ref	Ref	Ref	Ref
– 1.Agriculture	2.001*** (0.000)	1.766 (0.099)	1.823** (0.005)	2.640*** (0.000)	2.906* (0.022)
– 2.Animal Husbandry	1.317 (0.429)	1.498 (0.518)	0.279* (0.030)	2.681 (0.506)	3.891** (0.005)
– 3.Govt. Job	1.085 (0.717)	0.534 (0.344)	0.672 (0.183)	1.844 (0.196)	1.018 (0.987)
– 4.Agricultural labour	2.097*** (0.000)	1.743 (0.171)	2.494 (0.050)	2.724*** (0.000)	2.596* (0.038)
– 5.Non-agricultural labour	1.938*** (0.000)	1.067 (0.814)	1.480 (0.103)	2.979*** (0.000)	2.145 (0.133)
– 6.Independent/skilled work	0.950 (0.776)	1.266 (0.302)	0.703 (0.273)	1.663 (0.244)	1.287 (0.617)
– Own shop/business	1.303 (0.180)	0.727 (0.648)	0.892 (0.696)	1.674 (0.065)	2.396 (0.112)
– Salaried job	1.093 (0.622)	0.535 (0.072)	0.840 (0.507)	2.506* (0.010)	1.444 (0.567)
– Household work	1.154 (0.310)	1.124 (0.614)	0.938 (0.781)	1.163 (0.487)	1.583 (0.314)

	Full sample	Bihar	Odisha	Karnataka	Gujarat
– Student	0.955 (0.772)	0.559 (0.077)	0.662 (0.086)	1.642* (0.045)	1.724 (0.222)
Caste					
– 0.Brahmin	Ref	Ref	Ref	Ref	Ref
– 1.General/Other high caste	5.839*** (0.000)	1.571 (0.82)	5.914*** (0.001)	0.350*** (0.000)	8.999** (0.002)
– 2.Other Backward Classes (OBC)	3.736*** (0.000)	1.270 (0.65)	3.704** (0.004)	0.306*** (0.000)	8.514** (0.001)
– 3.Scheduled Caste(SC/Dalit/Harijan)	7.418*** (0.000)	2.466* (0.028)	8.338*** (0.000)	0.642 (0.231)	6.585* (0.016)
– 4.Scheduled Tribe (ST/Adivasi)	20.79*** (0.000)	0.933 (0.953)	1 (.)	1 (.)	20.154** (0.007)
Latrine age	0.887*** (0.000)	1.015 (0.768)	0.888*** (0.000)	0.845*** (0.000)	0.849** (0.014)
Type of latrine					
– 0.No pit/tank	4.463** (0.005)	1 (.)	24.90*** (0.000)	1 (.)	5.877** (0.006)
– 1.One	1.329 (0.388)	1.861 (0.248)	1.306 (0.92)	6.778* (0.035)	1.146 (0.752)
– 2.Two	0.631 (0.208)	6.193*** (0.001)	0.826 (0.497)	1 (.)	1 (.)
– 3.Three	0.383 (0.195)	4.897* (0.041)	1 (.)		1 (.)
– 4. Septic tank	Ref	Ref	Ref	Ref	Ref
Latrine financing					
– Nothing	Ref	Ref	Ref	Ref	Ref
– Money	1.020 (0.922)	0.448* (0.044)	0.376** (0.007)	0.571* (0.043)	0.441 (0.173)
– Material	3.237*** (0.000)	1.859 (0.176)	0.735 (0.416)	3.406* (0.022)	4.464*** (0.000)
– Money and material	0.816 (0.640)	0.197 (0.053)	0.192* (0.050)	1.342 (0.329)	1.344 (0.701)
– Reimbursement pending	1.262 (0.551)	0.972 (0.961)	0.443 (0.276)	1.013 (0.989)	1.381 (0.612)
– Reimbursement pending and material	3.713 (0.326)		1 (.)		7.290 (0.288)
Observations	11,244	2,992	2,554	2,575	3,041

Exponentiated coefficients; *p*-values in parentheses; * *p* < 0.05, ** *p* < 0.01, *** *p* < 0.001

3.2.2 Shifts in latrine use patterns over time

In order to address hypothesis 2, we sought to compare reported OD/latrine use outcomes across the two time periods using a difference-in-differences estimation. We examined the incidence of statistically significant differences in reported OD across these two groups (see Table 22). As a next step, the household-level OD observations were omitted both from the baseline and endline samples such that shifts in latrine use/OD patterns can be examined only on the sample that was administered the individual questionnaire during the entire course of the study. In addition, baseline households that could not be followed up at endline were omitted and individuals within households who were missing at either time period were also omitted.

We are estimating the balance across the household panel; 2,160 households surveyed both in baseline and endline. While we surveyed around 2,432 households in the baseline, due to reasons of attrition we followed around 2,346 households in the endline. Major reasons for household-level attrition during endline included households travelling for work opportunities to major cities or seasonal migration for employment (especially households surveyed in Bihar travelled to Delhi for work, or households surveyed in Bhavnagar travelled to Surat and other neighbouring districts to work in the diamond-cutting and bangle-making industries), households on travel for personal reasons (included visiting relatives in other villages etc. as our surveying schedules coincided with the summer vacations for children in these households etc.) and provided the time and budget constraints for our survey operations, revisits could be conducted only within a gap of one or two days. The detailed split-up of households as well as individuals surveyed across treatment and control areas in the respective states are shown in the balance tables.

This report details the second hypothesis by attempting to analyse the impact of the treatment exposure across states through a DID analysis and the validity of the DID is ascertained if differences across the treatment and control groups have been stable over time, and outcome changes in the treatment group are not associated only with changes in certain covariates. The DID provides an effective and quasi-experimental alternative to interpret and explore causal relationships within public health research domains (Coady Wing, 2018) and the balance tables 17, 18, 19 and 20 show the balance across the DID analysis panel of households. In these balance tables we have accounted only for those households which were surveyed using Individual-level instruments in baseline, and were followed through the endline. This is because the difference-in-difference analysis within the report corresponds only to households which were included in the panel sample, as they were surveyed using the Individual-level instrument across the baseline and endline rounds. All analyses were clustered at the village level.

Table 17: Balance tables for latrine owning households (Bihar)

Variable	Sample unit	control N(%)	treatment N(%)	control Mean(SD)	Treatment Mean(SD)	difference* Mean(SE)
Total households	Households	166 (57.64%)	122 (42.36%)			
Individuals	Individuals	1,019 (57.8%)	744 (42.2%)			
Individuals >=5 yrs included in latrine use study	Individuals	918 (58.47%)	652 (41.53%)			
Household size	Households	165	120	6.467 (2.819)	6.675 (3.068)	0.208 (0.416)
Age >= 5 yrs	Individuals	918	652	27.535 (18.898)	29.322 (19.056)	1.787 (1.040)

Gender of household head	Households					
Male		151(91.52)	110 (91.67)	0.915 (0.280)	0.917 (0.278)	0.002 (0.020)
Female		14 (8.48)	10 (8.33)	0.085 (0.280)	0.083 (0.278)	-0.002 (0.020)
Gender	Individuals					
Male		477 (51.96)	345 (52.91)	0.520 (0.500)	0.529 (0.500)	0.010 (0.015)
Female		441 (48.04)	307 (47.09)	0.480 (0.500)	0.470 (0.500)	-0.010 (-0.015)
Household head completed 8 years of education	Households	61 (36.97)	54 (45.0)	0.370 (0.484)	0.450 (0.500)	0.080 (0.071)
Religion	Households					
Hindu		148 (90.24)	117 (99.15)	0.902 (0.298)	0.992 (0.092)	0.089 (0.053)
Muslim		16 (9.76)	1 (0.85)	0.098 (0.298)	0.008 (0.092)	-0.089 (0.053)
Owns latrine	Households	165 (99.4)	120 (98.36)	0.994 (0.078)	0.984 (0.128)	-0.010* (0.010)

Table 18: Balance tables for latrine owning households (Odisha)

Variable	Sample unit	control N(%)	treatment N(%)	control Mean(SD)	treatment Mean(SD)	difference* Mean(SE)
Total households	Households	131 (49.43%)	134 (50.57%)			
Individuals	Individuals	669 (48.2%)	719 (51.8%)			
Individuals >=5 yrs included in latrine use study	Individuals	632 (48.54%)	670 (51.46%)			
Household size	Households	123	131	5.545 (2.622)	5.672 (2.650)	0.127 (0.305)
Age >= 5 yrs	Individuals	632	670	35.747 (19.574)	36.236 (19.932)	0.489 (1.093)
Gender of household head	Households					
Male		116 (94.3)	121 (92.37)	0.943 (0.233)	0.924 (0.267)	-0.019 (0.034)
Female		7 (5.69)	10 (7.63)	0.057 (0.233)	0.076 (0.267)	0.019 (0.034)
Gender	Individuals					
Male		330 (52.22%)	344 (51.34%)	0.522 (0.500)	0.513 (0.500)	-0.009 (0.020)
Female		302 (47.78%)	326 (48.66%)	0.485 (0.500)	0.475 (0.500)	-0.010 (-0.016)

Household head completed 8 years of education	Households	63 (51.22)	49 (37.4)	0.512 (0.502)	0.374 (0.486)	-0.138* (0.068)
Religion Hindu	Households	123 (100)	131 (100)	1.00(0.00)	1.00 (0.000)	0.00 (0.000)
Owns latrine	Households	123 (93.89)	131 (97.76)	0.939 (0.240)	0.978 (0.148)	0.039 (0.028)

Table 19: Balance tables for latrine owning households (Karnataka)

Variable	Sample unit	control N(%)	treatment N(%)	control Mean(SD)	treatment Mean(SD)	difference* Mean(SE)
Total households	Households	108 (38.74 %)	159 (61.26 %)			
Individuals	Individuals	558 (39.46%)	856 (60.54%)			
Individuals >=5 yrs included in latrine use study	Individuals	524 (40.59%)	767 (59.41%)			
Household size	Households	102	153	5.578 (2.386)	5.810 (2.726)	0.232 (0.314)
Age >= 5 yrs	Individuals	524	767	31.683 (18.588)	32.240 (18.408)	0.557 (1.240)
Gender of household head	Households					
Male		86 (84.31)	128 (83.66)	0.843 (0.365)	0.837 (0.371)	-0.007 (0.049)
Female		16 (15.69)	25 (16.34)	0.157 (0.365)	0.163 (0.371)	0.007 (0.049)
Gender	Individuals					
Male		266 (50.76)	371 (48.37)	0.508 (0.500)	0.484 (0.500)	-0.024 (0.023)
Female		258 (49.24)	396 (51.63)	0.492 (0.500)	0.516 (0.500)	0.024 (0.023)
Household head completed 8 years of education	Households	29 (28.43)	31 (20.26)	0.284 (0.453)	0.203 (0.403)	-0.082 (0.063)
Religion Hindu	Households	94 (92.16)	148 (96.73)	0.922 (0.270)	0.967 (0.178)	0.046 (0.027)
Muslim		8 (7.84)	5 (3.27)	0.078 (0.270)	0.033 (0.17)	-0.046 (0.02)
Owns latrine	Households	102 (94.69)	153 (95.38)	0.944(0.230)	0.962 (0.191)	0.018 (0.019)

Table 20: Balance tables for latrine owning households (Gujarat)

Variable	Sample unit	control N(%)	treatment N(%)	control Mean(SD)	treatment Mean(SD)	difference* Mean(SE)
Total households	Households	146 (59.59%)	99 (40.41 %)			
Individuals	Individuals	788 (58.20%)	566 (41.80%)			
Individuals >=5 yrs included in latrine use study	Individuals	721 (57.54%)	532 (42.46%)			
Household size	Households	144	92	5.701 (2.831)	6.359 (3.143)	0.657 (0.418)
Age >= 5 yrs	Individuals	721	532	33.024 (19.755)	33.024 (20.151)	0.001 (1.467)
Gender of household head	Households					
Male		120(83.3)	81 (88.0)	0.833 (0.374)	0.880(0.326)	0.047 (0.034)
Female		24 (16.7)	11 (12.0)	0.167(0.374)	0.120(0.326)	- 0.047 (0.034)
Gender	Individuals					
Male		369(51.2)	258(48.5)	0.512(0.500)	0.485(0.500)	-0.027(0.026)
Female		352(48.82)	274(51.50)	0.488(0.500)	0.515(0.500)	0.027(0.026)
Household head completed 8 years of education	Households	19 (13.2)	24 (26.1)	0.132(0.340)	0.261(0.442)	0.129 **(0.051)
Religion	Households					
Hindu		140 (97.2)	90 (97.8)	0.972 (0.165)	0.978 (0.147)	0.006 (0.023)
Muslim		4 (2.8)	2 (2.17)	0.028 (0.165)	0.022 (0.147)	-0.006 (0.023)
Owns latrine	Households	102(98.6)	153(92.9)	0.986(0.117)	0.929(0.258)	-0.057(0.028) *

The adjusted difference-in-differences estimation showed statistically significant reductions in reported OD in Bihar ($p < .05$). These results correspond only to the sub-sample of households who answered the individual-level questionnaire both at baseline and endline.

Table 21 Adjusted difference-in-difference estimates of the impact of sanitation interventions on OD, by state

Reported OD	N	B	SE	R ²
Bihar (pre-Control)	897	0.067		
Bihar (pre-Treated)	639	0.200		
Diff (T-C)	1536	0.133**	0.060	
Bihar (post-Control))	855	0.097		
Bihar (post-Treated)	597	0.157		
Diff (T-C)	1452	0.060	0.061	
Diff-in-Diff	2988	-0.073**	0.032	0.02
Odisha (pre-Control)	606	0.373		
Odisha (pre-Treated)	638	0.439		

Diff (T-C)	1244	0.066	0.095	
Odisha (post-Control))	589	0.341		
Odisha (post-Treated)	627	0.352		
Diff (T-C)	1216	0.011	0.076	
Diff-in-Diff	2460	-0.055	0.062	
Karnataka (pre-Control)	488	0.520		0.01
Karnataka (pre-Treated)	752	0.508		
Diff (T-C)	1240	-0.013	0.119	
Karnataka (post-Control))	513	0.481		
Karnataka (post-Treated)	753	0.414		
Diff (T-C)	1266	-0.067	0.107	
Diff-in-Diff	2506	-0.055	0.051	0.01
Gujarat (pre-Control)	694	0.163		
Gujarat (pre-Treated)	540	0.133		
Diff (T-C)	1234	-0.029	0.091	
Gujarat (post-Control))	697	0.194		
Gujarat (post-Treated)	519	0.166		
Diff (T-C)	1216	-0.028	0.102	
Diff-in-Diff	2450	0.002	0.051	0.00

Abbreviation: SE, standard errors were clustered at the village level *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

3.2.5 Reported Child Defecation Statistics

We examined child faeces disposal patterns through two questions – 1) question on where the child defecated the last time (options including on ground outside compound, on ground inside compound, on ground in latrine cubicle, in pants/clothing, on bed, latrine etc.) and 2) follow-up question as to how the faeces was disposed (options including rinsed/flushed in latrine, rinsed in open field/drains, thrown in garbage, rinsed into pond/surface water, buried, left in open etc.). Cross tabulations on the individual survey sample of baseline households followed in endline indicated that the overall reported latrine use for children (below age 5 years) was 28.27 % in endline, an increase from 16.9% at baseline. Analysing the child faeces disposal statistics for the same sample, safe disposal of child faeces in latrines has increased overall from 36.69 percent (in baseline) to 45.63 percent (in endline). Table 22 details safe child faeces disposal at baseline and endline for the Individual survey sample.

Table 22 Patterns of safe disposal of child faeces during study period

	Bihar	Odisha	Gujarat	Karnataka
Safe disposal of child faeces (Baseline)	51.0 %	28.7%	55.6 %	5.2 %
Safe disposal of child faeces (Endline)	63.2 %	48.4 %	53.7 %	14.9 %

3.3 Qualitative field insights

The study design did not emphasise qualitative data collection and therefore, qualitative insights could not be gathered in any systematic manner during the course of the study. That said, after completion of surveys, the research and field teams did attempt to elicit some qualitative field insights from households mainly to expand our understanding around local context and practices related to latrine use.

In Karnataka, such interactions were crucial in understanding the gravity of the escalating water crisis especially within few blocks in Raichur district (survey sample included households across the five blocks within Raichur district). Two blocks in Raichur district did not face these water concerns, with the local river source providing ample water resources to meet the villager's needs. Villages situated near such river sources showed signs of improved prosperity such as cultivated farmlands, well-irrigated fields and access to water for household and sanitation purposes. Households in these areas did indicate availability for water to meet their daily

requirements, including for latrine use. Water scarcity emerged as a serious concern in the remaining blocks in Karnataka, and survey respondents without any prompts from our surveyors reported scarcity of water as one of the major reasons for defecating in the open. These anecdotes included women having to walk several miles in the early hours of the day to neighbouring villages or travelling as far as 20 kms. on their husband's motor cycles with pots to fetch water from other villages and their daily decision-making burdens of prioritising household needs such as cooking and drinking over sanitation purposes, underscoring the severity of water crisis within these blocks. Individuals in these areas seemed compelled to practise open defecation despite their intent to use their latrines as water was a severe constraint.

During field visits in Gujarat, we observed that few villages in Palitana and Taleja blocks had a latrine pit system quite different from the usual designs found elsewhere in Gujarat or across other states. Especially in villages located at higher altitudes, digging latrine pits into the rocky ground was a tedious process, and in such situations the latrines were connected to a smaller pit for air ventilation purposes. Also known as “kadkuvas”, these mostly 2*2*2 dimension pits opened into a village drainage line running through the stretch of the village, which opened somewhere near the river, as quoted by few villagers.

4. Other Implications

4.1 Policy and programme relevance: evidence uptake and use

- One of our major study findings relate to the measurement of latrine use itself. Our study assessed the methodological advantages of asking individual-level questions over household-level questions to estimate open defecation. The results present strong evidence to suggest that household-level questions underestimate open defecation among households owning latrines. Our results suggest that a balanced question on latrine use and OD which allows for disaggregation by individual and short term recall can find higher incidence of OD than a household-level question as it enables capturing variations in use at the individual, intra-household level. This finding becomes important as official estimates of open defecation in India obtained through sources such as Census, NFHS, DHS, still rely on household-level estimates of open defecation. With latrine coverage increasing under the SBM, our study findings on this front underscore the importance of making improvements to sanitation monitoring vis-à-vis existing official survey methods to better understand the status of OD and latrine use practices among individuals in rural India
- Findings around individual- and household-level factors that determine open defecation also suggest that programmatic focus on increasing latrine ownership may be insufficient to drive use of sanitation facilities and may require interventions that target these specific drivers of behaviour change
- While the adjusted difference-in-differences estimations indicate reductions in OD in Bihar, Odisha and Karnataka related to the sanitation interventions, the size of reduction does not appear significant enough for meaningful policy influence and impact
- Prevailing practices around safe disposal of child faeces are poor, particularly in the states of Odisha and Karnataka. Considering the nutrition and health linkages of disposal practices, our finding underscores the need for policy attention to improve knowledge and practices for improved disposal of child faeces
- Lastly, qualitative insights from our field visits suggest access to water to be an important barrier for sustained use of latrines. This also appears to be an area for policy attention

4.2 Challenges and lessons

We experienced a few implementation challenges at baseline, with a particular challenge being coordination with the independent research teams and having to adjust our field plans according

to their timelines and implementation constraints. There was also only a short window available for the measurement study data collection between the census and baseline of the research teams and intervention rollout. We did not encounter this challenge at endline as our data collection took place once research teams' field activities are completed. However, as overall endline timelines under this window was delayed, we had to delay our data collection efforts in Gujarat owing to national elections in April 2019.

As in baseline, we encountered areas where household recall on OD reporting was higher owing to other sanitation studies in these areas. We tried to address this by ensuring that the sampled households were different from the trials (this approach was possible in all states except Odisha) and by allowing an appreciable time lag between the data collection rounds of the measurement study and the trials. We also emphasized dissociation with other sanitation studies.

There are also limitations associated with the interpretation of results. Reported OD at the last time of defecation was considered the primary measure of OD. This may not be adequate to represent consistency of practice nor does the study take into consideration other unidentified variables that may be associated with this reported OD measure. The outcome measure is based on reported data which allows a potential for reporting bias. Specific measures were taken to minimize this bias including – framing questions in a manner that normalizes behaviours of both latrine use and OD; including survey questions that deemphasize the focus on sanitation behaviours so as elicit truthful responses on sensitive questions around OD. Efforts were also made to address reactivity arising from interviewers as potential sources of bias by investing significantly in training enumerators to conduct latrine observations and adopt a sensitive approach to survey administration.

4.2.1 Lessons learned about the measurement of latrine use

Significance of rigorous training: A sensitive study of a qualitative nature requires focussed training and differentiating the concerned study from the surveyor's previous experiences, facilitating them unlearn previous methods of questioning and fully comprehend the purpose of framing questions in a certain manner, minimising biases and respectful to responses. The challenge for researchers was in transferring our intentions of remaining unbiased as possible and capturing the reality in an objective manner as possible to the survey team. Exhaustive training with the survey teams to ingrain this learning into their surveying, and instructing them towards paying attention to the minutest of details and staying aware of their facial expressions such as avoiding smiling, unnecessary expressions that could influence survey responses.

Latrine Use question (Minimising biases, improving recall): As the question eliciting data on the defecation behaviour of individuals within the survey household formed the crux of the study, training surveyors on this particular question and monitoring its implementation on field formed a major part of the challenge. This question framed with its opening statement ("We have observed that some people use the latrine, and some go out in the open") helped reduce respondent biases as much as possible, normalise responses and surveyors were to be extremely cautious in not forgetting or rephrasing this line before the actual question. We elaborated on the purpose of this opening line to the whole question in concern during our training sessions, and our accompaniments ensured that surveyors followed this rule closely while surveying. From our field pilots, the research team noted that 'last time' could be confusing at times and surveyors were asked to clarify last time as the last time the individual defecated that particular day since morning. Surveyors had to remain careful while repeating the questions for better respondent understanding, and ensure that nothing was omitted nor added from the manner the question was phrased. Enquiring about the 'last time' defecation behaviour showed an increased recall and lesser response time on the part of the respondents, and this was a significant learning from the study.

Local expressions for latrine use/OD in Vernacular: Surveyors were trained to ask questions slowly and clearly, and stay away from unwanted facial expressions, smiles and unnecessary

repetitions acknowledging interviewee responses. It was observed across states, that whenever the language in which the question was framed (written language) matched with the locally spoken words for latrine use/OD this improved clarity and survey responses, reduced surveyor-level errors and general trust across respondents. During field pilots and interactions with villagers, the research team invested much efforts and time in capturing closely local words in the vernacular denoting 'using the latrine' and 'going out in the open' which were later modified in the translated questionnaires and avoided the usual narratives, words employed in government campaigns and common discourse. This facilitated better comprehension and remain as close to the colloquial expressions, 'distance' our research process from other state campaigns, activities etc. and not draw upon the respondent's or community's past experiences,

Extrapolating true responses: This question had welcomed varied responses, with respondents feeling awkward, smiling and in certain cases when in groups breaking into laughter, at the 'appropriateness' of the question. In this question, surveyors were trained to ask questions as objectively as possible, staying conscious to common reactions and calmly explain to respondents that the 'question was just another part of their research questionnaire'. Surveyors detailed to respondents, that they could fully gauge the awkwardness surrounding the topic, but as a research project it was much helpful if individuals could co-operate and provide the required information. In cases where the individuals present felt uncomfortable or shy, surveyors provided them the option to answer in private. Wherein the concerned individuals were not present, the respondent answered the question on behalf of the other household members'

Women Surveyors: Having an all women survey team did come with its logistic challenges while planning for survey operations and movement on field, but facilitated improved responses, especially for this measurement of latrine use question. Familiarity with local contexts, past research and field observations have shown that while women were more comfortable opening up about such private affairs with women and embarrassed to discuss such questions with male interviewers, rural men did not show such discomfort in sharing this information with women interviewers. This could also reflect upon the existing social and gender norms and those specially with regards to defecation behaviour (open defecation for men as socially acceptable manifesting their masculinity, freedom to access spaces and mobility, women using latrines associated with protecting their honour and dignity).

5. Conclusions

There is growing evidence to suggest that improvements to sanitation monitoring vis-à-vis existing survey methods is needed to better understand the status of OD and latrine use practices among individuals living in high OD areas. Our study assessed the methodological advantages of asking individual-level questions over household-level questions to estimate open defecation in rural India. We find evidence to suggest that household-level questions underestimate open defecation among households owning latrines. Our results suggest that balanced questions on latrine use and OD which allows for disaggregation by individual and short term recall can find higher incidence of OD than a household-level question as it enables capturing variations in use at the individual, intra-household level. This finding becomes important even as official estimates of open defecation in India obtained through sources such as Census, NFHS, DHS, continue rely on household-level estimates of open defecation.

With latrine coverage increasing under the SBM, our study findings on this front underscore the importance of making improvements to sanitation outcome measurement vis-à-vis existing official survey methods to better understand the status of OD and latrine use practices among individuals in rural India and to understand the sustainability of progress made under largescale sanitation programmes targeting latrine ownership and use. Additional studies aimed at increasing the reliability and cost-effectiveness of both survey and non-survey based latrine use measures are certainly warranted. In time, a reasonable mix of indicators and measurement methods can appropriately inform sanitation policy and practice.

Findings around individual- and household-level factors that determine open defecation also suggest that programmatic focus on increasing latrine ownership may be insufficient to drive use of sanitation facilities and may require interventions that target these specific drivers of behaviour change.

While our study did not find OD reductions from specific behaviour-led sanitation interventions to be significant at a policy-level, our evidence does suggest a continued need for policy attention to shifts behaviours and practices around latrine use and child faeces disposal in rural India.

Appendix 1: Latrine Use Measurement in Official Surveys

Dataset	Question	Response Options/ Source for estimates
NARSS	<p>Question on Toilet Ownership (Table 12 Latrine ownership) Whether you and your family members have access to a toilet, if yes what kind of toilet facility? (<i>q1_hh</i> is the variable concerned on the NARSS dataset) *** Of the response options, latrine ownership is estimated using options 1 and 2, indicating latrine ownership.</p>	<p>1. Yes- We have access to toilet Exclusively used by our family 2. Yes- We have access to toilet used by multiple families 3. Yes- We have access to a Public toilet facility 4. No- Our family doesn't have access to any toilet</p>
SBM-G	<p>IHHL Coverage: <i>Swachh Bharat Mission Target Vs Achievement On the Basis of Detail entered</i></p>	<p>The estimates on the SBM-G website as of this day would vary from the numbers provided in the Table 12 Latrine ownership, as these refer to that particular date. https://sbm.gov.in/sbmReport/Report/Physical/SBM_TargetVsAchievement/Without1314.aspx</p>
NFHS-4	<p>NFHS-4 India and respective State Reports What kind of toilet facility do members of your household usually use?</p> <p>Open defecation is estimated using the option "No facility/uses open space or field", while the others would be regarded as latrine ownership (as in Table 12 Latrine ownership).</p>	<p>Toilet flush to piped sewer system Toilet flush to septic tank Toilet flush to pit latrine Flush to somewhere else Flush, don't know where Pit latrine ventilated improved pit (vip)/biogas latrine Pit latrine with slab Pit latrine without slab/ open pit Twin pit/composting toilet Dry toilet No facility/uses open space or field Others specify</p>

Appendix 2: Measurement Study Endline Questionnaire

Interviewer Note: The following is to be read exactly to the respondent prior to conducting the interview.

Interviewer Read: Hello. My name is _____. I am doing a study on rural life with a college IFMR (Institute for Financial Management and Research) in Chennai. We wish to know about you, your family, and your village. We are not from the government. We are asking for your consent to talk to you about life in the village and habits of people in your village and household. Your household has been randomly selected for this survey. We would like to spend 15 minutes with you.

We are talking to several people in this and other villages. Talking to us or not is your decision. There are no benefits or harms accruing to you from talking to us. If you talk to us, we will be able to write a book.

If I have answered all your questions, can I talk to you for 15 minutes? If you want to talk to anyone about this study or you have any other questions about the study in the future, you may speak to Ms. Divya Mary at 044- 40101308 at IFMR.

A	Consent		
A.1	Interviewer Code	[][]	
A.2	Household code	[][][][][][][][][][]	
A.3	Can I talk to you for 15 minutes?	Yes.....1 No.....2	→ END
A.4	STATE	[]	
A.5	District	[][]	
A.6	Village	[][]	
A.7	Date	[][]/[][]/[][][][] Day /month /year	
A.8	Time start	[][]:[][] AM / PM Hour/ minutes	
A.9	What kind of crops do people in this village usually grow?		
A.10	What does your household usually grow?		
A.11	How old is your house? Was it built in your generation, or your parents (or in-laws) or before that?	1. Self-build 2. Parents or in-laws build 3. Older than that	

CAPI gives questions B.1.1 to B.1.6 (first part of the household roster) after Section A, and come back to the roster in F.2.1 to F.2.3 later.

B										
Sr. No.	B.1.1 Name of the person (All)	B.1.2 Sex (All)	B.1.3 Relationship with the household head	B.1.4 Age y=year m=month (all)	B.1.5 Years of education completed (age 5+)	B.1.6 Occupation (age 5+)	Fill later			
							G.1(age 5+) Some people defecate in the open, and some people use the latrine. The last time [NAME] defecated, did [NAME] defecate in the open or use the latrine?	G.2 (age <5) Some people defecate in the open, and some people use the latrine. The last time [NAME] defecated, where did the child go?	G.3(age <5) What was done to dispose of the stools?	G.4 latrine use question (G.1/G.2) self-reported or someone else respond?
1	HH head: _____			y: m:						
2				y: m:						
3				y: m:						

B.1.2 Sex (all)	male = 1 female = 2		
B.1.3 relationship with household head	head = 1 husband/wife = 2 son/daughter = 3 daughter-in-law/ son-in-law = 4 grandfather /grandmother = 5	Granddaughter/ Grandson = 6 Father/mother = 7 Brother/sister = 8 Father-in-law/ Mother-in-law = 9 Nephew/niece = 10	Brother-in-law/sister-in-law = 11 Adopted son/daughter = 12 Any other relative = 13 Neighbour = 14 Other = 15
B.1.5 Years of education completed (for members of age 5 and above)	No schooling = 0 classes : 1-12	Bachelors / Undergraduate 1st-3rd yr. :13-15 Masters = 16 Any other diploma = 17	Madrasa study = 18 Vocational education = 19 Unofficial Education = 20

B.1.6 Occupation (for members of age 5 and above)	Does not work = 0	Agricultural labour = 4	Household work = 9
	Agriculture = 1	Non-agricultural labour = 5	Student = 10
	Animal	Independent/skilled work = 6	Other = -888
	Husbandry = 2	Own shop/business =	Don't know = -999
	Govt. Job = 3	7	
		Salaried job =	
		8	

G.1(age 5+) The last time [NAME] defecated, did [NAME] defecate in the open or use the latrine?	Latrine= 1 Open = 2 Somewhere else (potty, nappy, etc.) = 3	
G..2 (age <5) The last time [NAME] defecated, where did the child go?	On ground outside compound1 On ground inside compound.....2 On ground in latrine cubicle.....3 In potty.....4 In cloth nappy/diaper5	In pants/clothing.....6 On bed.....7 In bedpan.....8 In latrine9 Other10
G.3 (age <5)What was done to dispose of the stools?	Put/rinsed into toilet/latrine.....1 Put/rinsed into drain/ditch/open field2 Thrown into garbage ...3 Put/rinsed into pond/other surface water4 Buried5	Buried.....5 Washed (water ends up somewhere else) 6 Left in open.....7 Other8
G.4 Was the latrine use question (G.1/G.2) self-reported or did someone else responded for this person's latrine use behaviour?	Self-reported= 1 Someone else= 2	

B.2	Respondent Selection		
B.2.1	Interviewer note: Select the members who gave information about the household (Multiple selection)	Survey CTO reproduces names of all adult household members and surveyor marks all those who gave information. SurveyCTO	
	Survey CTO randomly selects the respondent based on respondent selection criteria in the study.		
B.2.2	Interviewer: Is <Randomized respondent 1> available to talk?	Yes.....1 No.....2	→ C.1
B.2.3	Interviewer: Is <Randomized respondent 2> available to talk?	Yes.....1 No.....2	→ C.1
B.2.4	Interviewer: Is <Randomized respondent 3> available to talk?	Yes.....1 No.....2	→ C.1 → END

C.1	Consent from the main respondent		
C.1.1	<p>Interviewer Read: Hello. My name is _____. I am doing a study on rural life with a college in Chennai. We wish to know about you, your family, and your village. We are not from the government. We are asking for your consent to talk to you about life in the village and habits of people in your village and household. Your household has been randomly selected for this survey. We would like to spend 15 minutes with you.</p> <p>We are talking to several people in this and other villages. Talking to us or not is your decision. There are no benefits or harms accruing to you from talking to us. If you talk to us, we will be able to write a book. Can I talk to you for 15 minutes?</p>	<p>Yes.1 No.....2</p>	→ END
C.2	For the next few questions, I will ask you to think about two kinds of villages, and would like to ask you, in which kind of village will children be healthier, or would they be similar in both villages.		
C.2.1	Imagine that there are two villages: In one, people usually eat wheat rotis, while in the other one, people usually eat rice. In which village would children be healthier; one in which people usually eat wheat rotis or the one in which people usually eat rice or would they be similar in both villages?	<p>Rice.....1 Rotis.....2 Similar.....3 Respondent unable to understand-111</p>	
C.2.2	Imagine that there are two villages: In one, people use cow dung to cook food, and in the other, people use LPG. In which village would children be healthier; the one in which people use cow dung or the one in which people use LPG or would they be similar in both villages?	<p>Cow-dung.....1 LPG.....2 Similar.....3 Respondent unable to understand-111</p>	
C.2.3	Imagine that there are two villages: In one village, everyone uses a latrine to defecate, while in the other, everyone goes out in the open. In which village would children be healthier; the one in which everyone uses a latrine to defecate or the one in which everyone goes out in the open, or would they be similar in both villages?	<p>Latrine.....1 Open.....2 Similar.....3 Respondent unable to understand-111</p>	

D.	Now I would like to ask you about yesterday. We want to understand: What kind of things do people do in a day? Now, I will first ask you about what all did you do before afternoon and then I would ask the same for post-afternoon.		
	Interviewer note: SurveyCTO assigns D.1 and D.2 to women respondents, and D.3 and D.4 to male respondents.		
D.1	Yesterday, before 2 o'clock in the afternoon did you do any of these things?	a) Wash clothes	Yes1 No2
		b) Cook Food	Yes1 No2
		c. Cleaning dishes	Yes1 No2
		d. Make cowdung cake/collect wood	Yes1 No2
		e. Meet other people in the village	Yes1 No2
		f. Take care of animals	Yes1 No2
		g. Get things from a shop or market	Yes1 No2
D.2	Yesterday, after 2 o'clock in the afternoon did you do any of these things?	a) Wash clothes	Yes1 No2
		b) Cook food	Yes1 No2
		c) Cleaning dishes	Yes1 No2
		d) Make cowdung cake/collect wood	Yes1 No2
		e) Meet other people in the village	Yes1 No2
		f) Take care of animals/	Yes1 No2
		g) Get things from a shop or market	Yes1 No2
D.3	Yesterday, before 2 o'clock in the afternoon did you do any of these things?	a) Wash clothes	Yes1 No2
		b) NREGA work	Yes1 No2
		c) Go outside the village?	Yes1 No2
		d) Meet other people in the village	Yes1 No2
		e) Farm or manual labour	Yes1 No2
		f) Taking care of animals	Yes1 No2
		g) Get things from a shop or market	Yes1 No2
D.4	Yesterday, after 2 o'clock in the afternoon did you do any of these things?	a) Wash clothes	Yes1 No2
		b) NREGA work	Yes1 No2
		c) Go outside the village?	Yes1 No2
		d) Meet other people in the village	Yes1 No2

	e) Farm or manual labour	Yes1 No2
	f) Taking care of animals	Yes1 No2
	g) Get things from a shop or market	Yes1 No2

E		Household wealth	
E.1	Interviewer observation: how are the walls of this house mostly like?	Kachhi.....1 Somewhat Kachhi, Somewhat Pakki.....2 Pakki.....3 No walls.....4	
E.2	Interviewer observation: how is the roof of this house mostly like?	Kachhi.....1 Somewhat Kachhi, Somewhat Pakki.....2 Pakki.....3 No roof.....4	
E.3	Interviewer observation: how is the floor of this house mostly like?	Kachha.....1 Somewhat Kachha, Somewhat Pakka.....2 Pakka.....3	
E.4	How many pakka rooms does your house have?	[][]	
E.5	How many kaccha rooms does your house have?	[][]	
E.6.1	Do you have a traditional cook stove that uses wood or cow-dung?	Yes.....1 No.....2	
E.6.2	Do you have a stove that uses kerosene?	Yes.....1 No.....2	
E.6.3	Do you have a cook stove that uses LPG?	Yes.....1 No.....2	
E.6.4	What do you use most for cooking food?	Electricity.....1 LPG.....2 Kerosene.....3 Wood/Cow-dung.....4 No cooking in house.....5 Other (specify).....888 _____ Don't know.....-999	

F		Latrine Observation	
F.1	Is there a latrine in this house (whether it is broken, incomplete, or not in use?)	Yes.....1 No2	→G.1
	Interviewer read out: Now I want to ask a few questions about your latrine. But I want to see it first. This is very important for this study. Can you show it to me? Interviewer note: (Interviewer to go see the latrine. Write answers to the questions below outside the latrine.)		
F.2	Interviewer observation: Is the latrine being used for some other purpose?	Yes1 No.....2 Could not see inside.....3	
F.3	Interviewer observation: Is the latrine pan sealed (blocked) using a cloth, leaves, stone, wood, soil/sand, etc.?	Yes.....1 No.....2 Could not see inside.....3	
F.4	Interviewer observation: Is there a mug, lota, container, or coke bottle (for cleaning after poop) in the latrine?	Yes1 No.....2 Could not see inside.....3	
F.5	Interviewer observation: Are there slippers kept outside or inside the latrine?	Yes1 No.....2 Could not see inside.....3	

F.6	Interviewer observation: Are any supplies to clean the latrine pan (such as brush, harpic or acid) visible?	Yes1 No.....2 Could not see inside.....3	
F.7	Interviewer observation: From seeing the latrine, does it look like that the latrine is being used?	Yes1 No.....2 Could not see inside.....3	

G	Individual behavior		
	<p>Interviewer read: Now I want to ask you about some habits of members of your family. Interviewer note: (For every household member that is currently present and participating in the interview, ask the latrine use questions to the individual her/himself. For household members that are not participating in the interview, or are not present, ask the main respondent or household head about the defecation behavior of these household members.) Record whether each response is self-reported or reported by someone else. For children under 5, ask the child's mother or main caregiver where the child defecates)</p>		
G.1	(Interviewer: Ask if the age of the person is equal to or greater than 5 years) "Some people defecate in the open, and some people use the latrine. Now I want to ask about where you and your family members defecate. The last time [NAME] defecated, did [NAME] defecate in the open or use the latrine?	Write the respondent's answer in the household roster. If there is a latrine in the house, then ask one by one. If there is no latrine, then you can ask about everyone together. Do not ask about children below two years.	→ HH roster
G.2	(Interviewer: Ask if the age of the person is less than 5 years.) Some people defecate in the open, and some people use the latrine. The last time [NAME of child under 5] defecated, where did [NAME of child under 5] defecate?	On ground outside compound...1 On ground inside compound....2 On ground in latrine cubicle.....3 In potty.....4 In cloth nappy/diaper.....5 In pants/clothing.....6 On bed.....7 In bedpan8 In latrine9 Other10	→ HH roster
G.3	(Interviewer: Ask if the age of the person is less than 5 years and if child went somewhere other than "9, latrine.) What was done to dispose of the stools?	Put/rinsed into toilet/latrine.....1 Put/rinsed into drain/ditch/open field.....2 Thrown into garbage.....3 Put/rinsed into pond/other surface water.....4 Buried5 Washed (water ends up somewhere else)6 Left in open7 Other.....8	→ HH roster

H	Latrine construction		
H.1	Did you receive any money or material from the government or an NGO for the construction of this latrine?	Money.....1 Material.....2 Money and material.....3 Reimbursement pending.....4 Reimbursement pending and material.....5 Nothing.....0	→H.3
H.2	(if received material)Did the government or NGO give you the material, or did they built the latrine themselves?	Gave material.....1 Themselves build it.....2 Constructed part of the latrine....3	

	Survey CTO will move on to section I if household does not have a latrine (F.1 has code 2).		
H.3	How long ago was this latrine constructed? (If the latrine was constructed in the last year, fill in months box)	G.3.1.1 Years [][] G.3.1.2 Months [][] G.3.1.3 Days Don't know.....-999	
H.4	How many pits are there in the latrine?	One1 Two2 Three3 Septic Tank.....4 No pit or tank.....5	→ H
H.4.1.	What is the shape of the pit/pits?	Cylindrical.....1 Square-shaped.....2	
H.5	How big is the pit/tank? (For pits that are cylindrical, either record the number of rings if rings have been used, or record the diameter and depth. If the latrine has a septic tank, record the dimensions of the tank under first pit and leave second pit blank.)	P.1.2.1 First pit: a. Length [][] FT. b. Width/Diameter [][] FT. c. Depth [][] FT. Don't know.....999 P.1.2.2 Second pit: a. Length [][] FT. b. Width/Diameter [][] FT. c. Depth [][] FT. Don't know.....999 P.1.2.2 Three pit: a. Length [][] FT. b. Width/Diameter [][] FT. c. Depth [][] FT. Don't know.....999	
H.5.1	Did you use rings to construct the pit?	Yes.....1 No.....2 If yes, then ask : e. Number of rings f. Depth of each ring g. Diameter of a ring	
H.6	Has the latrine pit ever filled?	Yes.....1 No.....2	→ I
H.7	What did you do when the pit got filled? Did you get it emptied, did you dig a new pit or start using second pit, or did some people stop using?	Emptied it.....1 Got a new pit built.....2 Started using the second pit.....3 Everyone started defecating in open....4 Only a few members in the family use it.....5	→I →I →I →I
H.8	How was it emptied?	Paid someone to empty the latrine pit.....1 Got a honey sucker to do it.....2 Some family member emptied it3	

I	Social participation		
	Interviewer read: Now I will like to ask you some questions about your society and village. I have never been to your village before.		
I.1	What religion do you follow?	Hindu1 Muslim2 Christian3 Sikhism4 Buddhism5 Adivasi6 Other (specify).....888 Don't know.....-999	

		Refused to answer..... -777	
I.2	Which caste category do you belong to?		
I.3	Which category does this caste belong to? (What does that come in?)	Brahmin.....1 General/Other high caste.....2 Other Backward Classes (OBC).....3 Scheduled Caste (SC/Dalit/Harijan).....4 Scheduled Tribe (ST/Adivasi).....5 Other (specify).....888 Don't know.....-999	
I.4	Do people in this village mostly use latrines or do they mostly defecate in the open?	Mostly open.....1 Mostly latrine.....2 Half latrine, Half open.....3 Don't know.....-999	

J.	Now I will ask you about a few things, and you have to tell me whether you have them in your house or not. Do you have a _____?	Have	Don't have
a.	Mobile	1	2
b.	Electricity	1	2
c.	Radio	1	2
d.	Television	1	2
e.	Fan	1	2
f.	Mosquito-net	1	2
g.	Bicycle	1	2
h.	motorcycle/scooter	1	2
i.	Car	1	2
j.	pair of shoes for everyone	1	2
k.	Chair	1	2
l.	gas stove	1	2
m.	pressure cooker	1	2
n.	Pacca kitchen	1	2
o.	Pacca bathroom	1	2

R	Questions to the interviewer		
R.1	Interviewer Question: According to you, did this family know before you came that this interview was about toilets?	Yes, I am certain.....1 Yes, but I am not sure... ..2 No, but I am not sure.....3 No, I am sure.....4	
R.2	Were you alone with the respondent? (Interviewer note: If there are neighbours present or the Pradhan of the village etc. during this interview, the respondent is not alone)?	Yes1 No2	
R.3	Did the respondent understand all your questions?	Yes, I am certain.....1 Yes, but I am not sure... ..2 No, but I am not sure.....3 No, I am sure.....4	
R.4	Accompanied by Team Leader	Yes1 No2	
R.5	Accompanied by PI, RA, r.i.c.e., 3ie?	Yes1 No2	

Appendix 3: Adjusted difference-in-difference estimates of the impact of sanitation interventions on OD based on imputed data

It must be noted that latrine use outcome was estimated at the household level (via NFHS question) on half the baseline sample. Hence, the endline sample has a higher number of individual respondents compared to the baseline sample (wherein the individual survey was administered to only half of the sample). Therefore, individual-level OD needed to be imputed from the household-level question for the corresponding baseline sample in order to ensure a balanced sample for comparison across the two time periods, in order to analyse the changes in OD/latrine use outcomes from baseline to endline. We imputed individual-level values for OD outcomes drawn from the household-level/NFHS modelled question (this imputation is done only for households who were administered the household-level instrument during baseline). This imputation was done such that, for households who responded that they usually defecated in the open for the household-level/NFHS modelled question on what type of latrine does the household usually use, the individual OD variable was substituted with 1 for all members within the household.

Table 23 shows the adjusted difference-in-differences estimation for the imputed sample across Bihar and Odisha (imputed for the baseline sample of households who administered the household-level (NFHS modelled question on latrine use), which was around 50% of the baseline sample). Results from the difference-in-difference analysis are reported in the table 22 below:

Table 23: Adjusted difference-in-difference estimates of the impact of sanitation interventions on OD, by state (with imputations for households who administered the household-level(NFHS modelled) questionnaire at baseline.

Reported OD ¹⁰	N	B	SE	R ²
Bihar	5,974	-0.043	0.038	0.02
Odisha	4,897	-0.036	0.039	0.01
Karnataka	5,015	-0.062	0.068	0.02
Gujarat	5,026	-0.051	0.045	0.02

Abbreviation: SE, standard errors clustered at the village level

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

We conducted a paired-samples t-test on the treatment sample comparing reported OD at pre-(baseline) and post (endline) intervention. Here, Bihar showed a highly significant increase in reported OD from baseline (M=0.112, SD=0.316) to endline (M=0.156, SD=0.363); $t(=)3.820$, $p=0.0001$), even Odisha estimates showed a less significant increase in reported OD between baseline (M=0.305, SD=0.460) and endline (M=0.327, SD=0.469); $t(=)1.611$, $p=0.107$. Karnataka also showed a highly significant increase in reported OD from baseline (M=0.345, SD=0.475) to endline (M=0.426, SD=0.494); $t(=)5.939$, $p=0.000$). This increase in reported OD as observed between baseline to endline (shown above in the paired t-test results) for both the states may be due to the underreporting of OD among baseline households who were surveyed using the household-level (NFHS-modelled) questionnaire (a significant baseline finding corresponding to hypothesis 1). Further, this analysis of full sample (including households that answered individual-level or household-level questions at baseline) found conflicting results between adjusted difference-in-difference estimates and paired t-test (treatment sample only) with regards to reported OD. It is therefore not possible to make any meaningful inferences on shifts in latrine use and OD patterns from these results deriving from the imputed OD data as it is likely to be misleading.

¹⁰ The reported OD estimate was calculated across all households in baseline, including those households who answered the household-level (NFHS modelled question) survey instrument. In baseline, half of the households surveyed administered the Individual-level survey instrument, while the other half were surveyed using the household-level questionnaire. For the later households, we imputed the individual-level OD estimates (either 1 or 0) based on the household-level questionnaire, for responses such as defecated in the open for the household-level (NFHS modelled) question, we impute open defecation variable at the individual-level as 1 for all household members, and for all other responses selected for the household-level question, we imputed 0 as the value for the open defecation variable.

Appendix 4: Adjusted difference-in-difference estimates of the impact of sanitation interventions on OD

DIFFERENCE-IN-DIFFERENCES ESTIMATION RESULTS (Bihar)

Number of observations in		the DIFF-IN-DIFF: 2988			
	Before	After			
Control:	897	855		1752	
Treated:	639	597		1236	
	1536	1452			
Outcome var.	OD	S. Err.	t	P>t	
Before					
Control	0.067				
Treated	0.200				
Diff (T-C)	0.133	0.060	2.23	0.037**	
After					
Control	0.097				
Treated	0.157				
Diff (T-C)	0.060	0.061	0.99	0.333	
Diff-in-Diff	-0.073	0.032	2.25	0.035**	

DIFFERENCE-IN-DIFFERENCES ESTIMATION RESULTS (Odisha)

Number of observations in		the DIFF-IN-DIFF: 2460			
	Before	After			
Control:	606	589		1195	
Treated:	638	627		1265	
	1244	1216			
Outcome var.	OD	S. Err.	t	P>t	
Before					
Control	0.373				
Treated	0.439				
Diff (T-C)	0.066	0.095	0.69	0.497	
After					
Control	0.341				
Treated	0.352				
Diff (T-C)	0.011	0.076	0.15	0.884	
Diff-in-Diff	-0.055	0.062	0.88	0.388	

DIFFERENCE-IN-DIFFERENCES ESTIMATION RESULTS (Gujarat)

Number of observations in		the DIFF-IN-DIFF: 2450			
	Before	After			
Control:	694	697		1391	
Treated:	540	519		1059	
	1234	1216			

Outcome var.	OD	S. Err.	t	P>t
Before				
Control	0.163			
Treated	0.133			
Diff (T-C)	-0.029	0.091	-0.32	0.749
After				
Control	0.194			
Treated	0.166			
Diff (T-C)	-0.028	0.102	0.27	0.787
Diff-in-Diff	0.002	0.051	0.03	0.976

DIFFERENCE-IN-DIFFERENCES ESTIMATION RESULTS (Karnataka)

Number of observations in the DIFF-IN-DIFF: 2506

	Before	After		
Control:	488	513	1001	
Treated:	752	753	1505	
	1240	1266		
Outcome var. OD S. Err. t P>t				
Before				
Control	0.520			
Treated	0.508			
Diff (T-C)	-0.013	0.119	-0.11	0.917
After				
Control	0.481			
Treated	0.414			
Diff (T-C)	-0.067	0.107	0.63	0.535
Diff-in-Diff	-0.055	0.051	1.08	0.293

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