Usman Talat[1], Navneet Aujla[2], Luke Ravenscroft[3], and Ivo Vlaev[1]

[1]Warwick Business School
[2]Warwick Medical School
[3]Behavioural Insights Team, Singapore

October 7, 2020

Abstract

Background. Open defecation is widespread in rural India and causes serious diseases and increases

Introduction

The practice of open defecation (OD) is widespread in rural parts of India where latrine use is alarmingly low. Globally, India has the highest number of people defecating in open fields, waterways and trenches, which causes serious disease in society by exposing populations to human excreta that has not been disposed of properly [1, 2]. Disease raises infant mortality, whilst damaging human capital [3, 4]. Defecating in the open also poses sanitation challenges for women in rural India. Psychosocial stress is experienced due to risk of physical attacks including rape, molestation, the danger of snakebites and mosquitos, as well as foot injury because many of them have no shoes [5-7]. Latrine use is a safer alternative that improves sanitation conditions and curbs the spread of disease in populations.

Despite efforts by the Indian government in concert with international aid, it is estimated that 569 million people practice OD in India. Some do not have access to latrines, whilst those with access to latrines, still prefer defecating in the open[8]. India's government launched the Total Sanitation Campaign that was relaunched as Nirmal Bharat Abiyan in 2012 and as Swach Bharat Abhiyan in 2014. The purpose was to improve coverage by building infrastructure (i.e. latrines and access) and providing incentives for the population. The term coverage is defined as number of households in a community that have access to latrines and sewerage[9] and does not necessarily mean increased use of latrines by the population. Moreover, reporting the number of latrines installed, notwithstanding their quality, is simpler than recording behaviour of the population and shown to be highly variable across India [10-12]. In some areas like rural Kerala there has been 100% latrine coverage reported. However, in Bihar 48% coverage has been reported. Similarly, in rural Odisha despite coverage, less than 50% households with latrines reported using them at all times [1, 13]. However, infrastructure to motivate latrine use does not always work in rural areas without cultural and attitudinal commitment from the population. Therefore, initiatives have resulted in limited uptake in rural areas.

Given government subsidized programs and NGOs, studies highlight dysfunctional infrastructure as a barrier to latrine use [5, 9, 12, 14]. Latrines should work and be well maintained to encourage use [1, 15]. Poor construction of latrines effects their quality and appeal. Studies also highlight poor water quality and availability as a barrier. People may avoid latrines that do not provide sufficient water supply, are not connected to septic tanks, where pits are not covered and induce disease[16]. Other structural features include the presence of a roof and side walls to provide privacy, a drainage system and accessible location of the latrine[17].

But despite available infrastructure, uptake of latrine use has not been on track in rural India. A major factor is culture [9]. Practising OD instead of using latrines is influenced by longstanding habits, rituals,

caste one belongs to, lifestyle routines, gender, age, and marital status[5]. In rural areas of India upper caste individuals usually have better access to latrine facilities and water, compared to lower class individuals. In tandem, individuals and families of lower caste prefer defecating outdoors because it can be more practical and convenient [5, 8]. The implementation of the Total Sanitation Campaign in India also highlighted the importance of caste. An example is the building of school latrines in villages where lower caste Dalit students were forced to clean the toilets[18, 19]. Thereby, discouraging latrine use because of negative perceptions. It has been noted that if women had decision-making power across households, more latrines would be likely be used[20]. Some women eat less so they do not have to go out at night to defecate[21]. This has dire effects for health. Studies found that men are often not responsive to the challenges women face in practicing OD[22]. Marital status is also a factor in latrine use and OD. A study reported that in parts of rural India before agreeing to marry a husband, women showed a strong preference for the ownership of latrines[23].

Education and awareness is noted as another crucial behavioural factor underlying adherence to latrine use over OD. A study in rural Timor found that educated individuals and families were most likely to use latrines[24]. The assumption is that these individuals are aware of harms of OD and benefits of latrine use. A study of rural coastal Odisha in India reported that during their formal education those who stayed in hostels were exposed to latrines and were likely to take up the habit. They were also more likely to be high caste individuals who were financially better off and thus able to get a formal education [5]. Despite the strength of education, OD may persist because in cases it can be deeply embedded as a social practice in rural communities.

In north India's rural areas, despite access to latrines, some villagers preferred OD because they saw it as more comfortable, pleasurable and convenient[3]. Another reason to explain preference for OD was found by a study in a village in Nepal where the practice enabled socialization. Friends had used open fields growing up; it was a time in the morning to share stories, neighbourhood gossip and to plan the day [25]. Literature shows that some interventions to improve adherence target infrastructure, some target socio-cultural behaviour and some interventions aim to target a combination of these two factors [5, 9, 11, 25].

A study commissioned by the World Health Organization found that most interventions designed to increase latrine use had a modest effect [9]. Complex intervention involving the infrastructure improvements and education to the locals about disease transmission and benefits of latrine has been known to be effective.

We implemented a pilot intervention in Udaipur, Rajasthan. The aim was to develop and conduct a formative evaluation of our intervention to improve latrine use. The following questions guided our study:

1. What are the barriers to latrine use?
2. How informed is the community about the hazards of open defecation?
3. What solutions could help increase latrine use?
4. Can we co-design a theory-driven behavioural intervention and does a preliminary examination show that the intervention is feasible and acceptable?

Methods

Study Design

We developed and conducted an intervention that was formatively evaluated for its effectiveness. A survey and focus groups were conducted to understand barriers to latrine use. This was followed by the development of a theory-driven intervention through evidence and expert consultation. The intervention was refined using expert feedback. Feasibility and acceptability of the intervention was evaluated.

Study population and sample

We worked with an implementation agency *Seva Mandir* , which has a long presence in the intervention area; purposive sampling was done based on their experience of the area. Seva Mandir worked with local partners against the backdrop of the Swacch Bharat Abhiyan (SWB), India's sanitation initiative. Villages with a larger tribal population with some already declared ODF by the government based on toilet construction

data were selected as part of the sample. This was because despite high number of household level toilets, the use of latrines in these villages was still low.

To identify the intervention we conducted a quantitative and a qualitative survey. The survey was conducted using tablets, on which surveyors were trained. Guidance was given for queries the surveyors faced in the field.

The quantitative survey covered all individuals across a total of 497 households across 4 villages and their adjoining hamlets. 404 households were from tribal community. It was found that houses were semi-pukka or pukka in the main village, however, most houses in the hamlets were kutcha. 228 out of 497 sample households were below poverty line and 20 per cent of the total sample covered did not have latrines. Despite the fact that nearly 80 per cent households had latrines, the observed latrine use was only 37 per cent11Some contributing factors identified for low latrine use was poor water availability, incomplete construction, complete but poor construction and attitudinal barriers.

The qualitative survey included observations, focussed group discussions with women and children in groups of 8-10 and in-depth interviews with women. Village leaders including the Sarpanch, and influencers such as ASHA workers and Anganwadi workers were also met with to understand their efforts towards ending OD. Data was also collected on landholding patterns, water source and availability and cost-sharing for latrine construction. Questions were also posed around perceptions of latrine use, reasons for OD preference, perception of extent of latrine use by others in the community and so on (see appendix 3)

Inclusion and exclusion criteria

- The sample selected was representative of demographic indicators such as caste, economic status (whether APL/BPL) and religious demographics in Udaipur.
- Villages where defecation in the Open is high and latrine use is low, including villages declared OD free by the government.
- All willing members of the HH will be included.
- Kucha and Pukka HH.

Study setting and Data Collection

The main forms of livelihood in the area include agriculture, farm labour, livestock rearing, dairy, skilled work and private businesses. Levels of access to water vary and while some households have their own water sources through tube-wells or wells, others depend on public sources. Hand pumps are available though they tend to run dry during peak summers. Eco-san, septic tank and twin pit latrines are prevalent in the area. Most of the latrines have been constructed in the last two years. The (SBM) is being anchored by the Department of Rural Development and Panchayati Raj in Rajasthan.

A team of 4 male and 4 female researchers were recruited for data collection in the 4 villages selected for intervention. The team was selected from the existing pool of surveyors with Seva Mandir as they had prior experience in conducting HH surveys. A two day training was conducted in Seva Mandir office in presence of BIT and Sutra team, where researchers were trained on survey questionnaire. As the survey was conducted using tablet, the surveyor was also trained on tablet based survey on the final day. The piloting of the tool was conducted to finalise it and clarify doubts and queries the surveyors faced in the field.

Measurement of Latrine Use

The team used observation of latrine and individual response, to measure the latrine use. As the member may feel shy to admit that HH members go outside for defecation, the observation of latrine was made right after basic information of HH. If the member was reluctant to show the latrine, the interview terminated there and sample was rejected (See appendix observation questions). The sample respondents were divided into three categories: all the members use latrine all the time, all the members go for OD all the time and mix of use of latrine and going for OD by family members. Data collection was followed by an intervention

brainstorming workshop. Team members deliberated on various approaches that could be adopted. The team measured latrine use through a combination of the following -

1. **Paint:** This will be used around the latrine pit where people put their feet then revisit after regular intervals of 3 months to see how worn it is.
2. **Dipsticks:** That fit around toilet pipes which would be used as a measurement tool at the start and end of a definite period (roughly 6 months)
3. **Toilet Soaps / Scrubbing Bubbles:** These wear away as people use the toilet, thus reflecting extent of use

Data was also collected on landholding patterns, water source and availability and cost-sharing for latrine construction. Questions were also posed around perceptions of latrine use, reasons for OD preference, perception of extent of latrine use by others in the community and so on (see appendix 3). A team of 4 male and 4 female researchers were recruited for data collection in the 4 villages selected for intervention. The team was selected from the existing pool of surveyors with Seva Mandir as they had prior experience in conducting HH surveys. A two day training was conducted in Seva Mandir office in presence of BIT and Sutra team, where researchers were trained on survey questionnaire.

Intervention Design

The intervention had two components. One addresses the psychological aspects of behaviour change through a commitment/pledge by the family against the practice of OD. Seven focus groups were conducted and 38 HH were randomly selected. The second involves provision of small incentives based on barriers identified in the sample villages to promote latrine use. The list of items includes buckets with mugs, soap, brushes, toilet fresheners, solar lights and windows and ventilation for toilet. The intervention was undertaken with informed consent, thereby eliciting full cooperation and willing participation.

Each selected household had a fully constructed toilet, which was not being used. Prior to implementing the intervention, a formative group discussion (FGD) was conducted with families in each village, where the intention of the intervention was discussed. The barriers identified through the qualitative survey were discussed to corroborate findings and new barriers if any, were noted. The FGD also elicited responses on whether small improvements such as buckets, soap and cleaning equipment would encourage latrine use. The acceptability and feasibility of the pledge (i.e. including poster see appendix 5) was also discussed. This feedback facilitated learning about how well the intervention worked, so that future interventions can be refined.

Once the family was fully informed about the intervention and consent was obtained, the intervention was implemented. A key assumption is that with informed consent in households, there is a basic willingness adopt changes in sanitation behaviours. Another assumption is that the SBM programme provides an enabling environment in favour of the intervention. The APEASE (Affordabiilty, Practicality, Effectiveness/cost-effectiveness, Acceptability, Side-effects/safety & Equity) criteria was used in this process. Shortlisted interventions were run past sample respondents from the community and based on their reactions the final intervention was selected.

Analysis

For the initial survey to identify barriers the collected data was analysed in SPSS. Logistic Regression tested relationships between predictor variables and our binary dependant outcomes – the dependent variable encoding was 0 for “other than only latrine” and 1 for “Only Latrine”. The Omnibus Tests of Model Coefficient was used to assess improvements (difference in log-likelihoods) due to independent variables. The Hosmer and Lemeshow test indicated the Nagelkerke T Square value. Data from the focus groups was analysed using thematic analysis.

Results

Barriers for using the latrine

The logistic regression baseline model for the dependant variables indicated "Only latrine" use likely to be correct 53.3% of the time. The Omnibus test looking for effects of our independent variables in the new model, provided Chi Square=443.279, df=45 shown to be highly significant at (.000). The model summary therefore confirms that the model is significant and using the Nagelkerke's R suggests that the model fits 89.7% to actual results. This explains a high percentage of variation in results. The Hosmer and Lemeshow Test suggests the new model is a good fit to the data (p=0.89). Our new model correctly classified outcomes of 95% of the cases. An improvement on the null model. Survey results show BPL families are more likely to use latrine compared with APL families. In terms of infrastructure barriers, the presence of latrine inside the house (Latrine Location) increased likelihood of use. Increase in cost of constructing the latrine and monthly expense per household, both likely increase use of latrine. Comfortable latrines increased likelihood of latrine use, whilst villagers who saw latrines as less convenient were less likely to use it.

Variable	*B*	*Exp(B)*	*P* 0.02 0.05 0.33 0.00 0.00 0.00 0.17 0.45 0.94 0.01 0.00
APL/BPL	-.1.58	0.20	
HHE	1.71	5.56	
Latrine Location	1.69	5.46	
Construction Cost	-1.98	0.13	
Comfort	2.36	10.62	
Convenience	5.28	197.31	
Social Pressure	1.67	0.18	
Perception	-.851	0.42	
Happy	1.50	4.50	
Safety	2.93	18.78	
Relief	5.49	242.80	

Table 1. Logistic Regression Analysis Result (significant variables)

Notes: ABL/BPL=Identifies economic status, caste and religious demographic, HHE=Monthly Household expense on latrine, Latrine Location=Position of latrine in Household, Construction Cost=Construction cost of latrine, Comfort=place of defecation family members found most comfortable, Convenient=Find latrine use convenient, Social Pressure=Social pressure to use latrine, Perception= Perception of villagers use of latrines, Happy=Happiness in thinking about latrine, Safety=Feeling safe thinking about latrine. Relief=Feeling relief thinking about latrine. Cut off for Significance p<0.10

In terms of social influences, HH without latrines were facing pressure by others in the village to use this new technique. Villagers who perceived that a high proportion of HH use latrines, were less likely to use latrines. We also found that villagers who felt happiness, relief and safety when thinking about latrines, were more likely to use the. Despite toilets present in HH, women in the villages found it difficult to haul enough water, a task men will not do. For example, in the Magwas Village and tekra Hamlet, a women said whilst toilets are convenient and safer, lack of water was a key constraint affecting latrine use. She would practice OD given shortage of water.

Through fieldwork in the villages, focused group discussions and commitment engendering visits to HH for interviews, we identified a range of barriers and behaviours. These impeded the use of toilets and provided reasons for the continuing practice of OD. Scarcity of water was a barrier in all four villages.

Village	Barriers (water related)
(A)	Water scarcity, only women bring water, so less available. Water supply was an issue, only improved in the past year. Water storage was identified as an issue. Insufficient storage.
(B)	Scarcity of water discouraged latrine use, and led to OD. Only women brought the water and managed latrines. They often could not manage.
(C)	The toilet structure impractical for storing water and hard to use. Village well and other water sources dried up due to heat. For some households a toilet in the household was a sign of upward mobility, but this was curtailed by scarce water availability
(D)	Sanitation duties including hauling water was too to manage. Hand pumps near households encouraged latrine use of residents.

Table 1. Water related Barriers

As a result of problem in table 1, some Eco-San toilets were found in the two villages. In some villages there were design flaws in toilets. In the Jogiyon Guda Village quality of latrines was especially poor when private contractors had constructed toilets.

To construct toilets villagers were told to use their own funds reimbursable by the government. But many ran out of funds, and were left with incomplete latrines. This left them without government reimbursement, obtainable only by completing toilet construction. Also, age was a factor; older villagers found latrine use difficult. Those with illness also struggled.

Discussions revealed that awareness of benefits of latrine use and the health and hygiene hazards associated with OD, was almost non-existent in the villages. Absence of this awareness meant it was easier to prioritise other water related activities including cooking, drinking and cleaning. There was also lack of awareness about sanitation procedures to do with regular pit emptying. Most villagers had not been educated, which may likely become an issue going forward. Because exposed excreta spreads disease and illness. In the villages we found unused government constructed toilets, which further reflected our concern for low latrine use and preference for OD. Informal attempts to raise awareness were found in wall writings across villages that talked of the need to use latrines. This highlighted that emotions like shame or fear of the Sarpanch may be associated with higher latrine use and less defecation in the open.

Feasibility and Acceptability of the Intervention

The commitment pledge/poster component of our intervention produced results about its feasibility and acceptability by villagers. Post-intervention we obtained feedback from 22 households, 79% of households chose to make the 30-day commitment to use their latrine. The discussion about barriers and selection of small improvement items were the most preferred intervention components.

Discussion

This paper draws on a pilot intervention located in the Udaipur District of Rajasthan, a largely tribal area of India where latrine use and OD is an ongoing issue. The purpose of this study is to develop and conduct a formative evaluation of a behavioural intervention to improve latrine use. Although the reasons for latrine adoption and OD have been debated for decades, most interventions designed to improve latrine use have had a modest effect [26]. For this reason there is need to focus on evaluating and implementing behaviour change interventions.

In the literature our findings support the view that there are ongoing infrastructure and resource issues, as well as sociocultural drives underlying latrine use and OD [22, 26-31]. Our formative study reaches beyond why some sanitation practices are adopted over others, and evaluates our intervention to understand how well it worked. Most interventions in sanitation have not used behavioural theory and instead the focus has been on educating [32]. The theory of change we adopt rests on the assumption that informed consent means willingness to change sanitation behaviour. In the field we found that older generations took longer than younger ones in adopting sanitation practices.

A strength of theory is that it guides the development of interventions, specifically, by incorporating feedback and testing across stages of implementation. Our approach is designed to identify influences, actual and potential, that make the intervention effective [33]. On the research agenda the practice of testing interventions for effectiveness is recommended [29]. Based on our feasibility study we refined our intervention in several ways. First, we amended the item list by removing unpopular items (e.g. mirror) adding new items (e.g. ventilation and basic repairs) and switching to more sustainable cleaning items. Second, we swapped the village-level commitment to a Household-level pledge. Third, we learnt to now conduct the intervention inside rather than away from the latrine. Fourth, we will target our intervention to female householders who are more receptive to using latrines.

In villages we visited, interventions to change behaviour should work with local government and informal leaders like the Sarpanch. Evidence suggests that the role that can be played by district authorities, local leaders and influencers such as PRI representatives, is extremely important[8, 34]. At an initial stage fear could possibly be an effective motivato and could be followed up with more positive messaging once the reluctance has been removed. Hand pumps near households encouraged latrine use of residents. Specifically, to influence the attitudes of villager's emotions can be evoked [35] But in cases emotional behaviour can be episodic and may not last[36].

As many studies, the findings may not be generalizable in larger population due to demographical, sociocultural and other relevant differences across the India. We note that challenges exist for similar future interventions that may adopt randomized controlled trials (RCTs) to improve latrine use. Blinding participants can be challenging as they may interact with each other. Another difficulty arises when scaled up programs in the field do not deliver the same benefits that were measured in smaller efficacy trials. In addition, there is the risk of imperfect compliance by villagers and poor fidelity of intervention implementation[37]. In measuring the primary outcome of latrine use and OD, behaviour indicating adherence should be captured. We recommend using average latrine use per person within a household. One method of measuring this is to use an electronic occupancy scanner. This draws on the Passive Latrine Use Monitor (PLUM) approach, which has worked in rural India[41].

A limitation of our study is that compared with RCT studies, behaviour at the village level offers less controls. This impacts fidelity of interventions. Another limitation is the lack of a follow up procedure to assess whether change in sanitation practices has endured.

Conclusion

A strength of our intervention development was the use of a theory-driven approach. The commitment/public pledge intervention adopted the principles of the MINDSPACE framework (Messenger, Incentive, Norms, Default, Salience, Prompt/Cues, Affect, Commitment, Ego). It involved habit reinforcement as a strategy that was both beneficial and rewarding for villagers (appendix 4). For behavioural interventions the MINDSPACE framework systematically provides non-coercive cues to influence actions and form habits[42, 43]. Thus, whilst subtle cues may encourage villagers to continue sanitary strategies, interventions can combine these cues with widely adopted techniques including subsidies, information, education and communication that engages conscious preferences as well[44].

Our formative research has highlighted several key barriers to latrine-use and opportunities to improve the intervention[45, 46]. Amongst steps taken, we improved our item list by removing unpopular items (.e.g. mirror) adding new items (e.g. ventilation and basic repairs) and switching to more sustainable hygiene

items. With improvements in our approach, further research is needed to reduce OD and its hazards and to encourage latrine use in rural India.

References

1. Barnard, S., et al., *Impact of Indian Total Sanitation Campaign on latrine coverage and use: a cross-sectional study in Orissa three years following programme implementation.* 2013. **8** (8): p. e71438.

2. Saleem, M., T. Burdett, and V. Heaslip, *Health and social impacts of open defecation on women: a systematic review.* BMC public health, 2019. **19** (1): p. 158-158.

3. Coffey, D., et al. *Revealed preference for open defecation: Evidence from a new survey in rural north India* . 2014.

4. Leong, C., *Narratives of sanitation: Motivating toilet use in India.* Geoforum, 2020. **111** : p. 24-38.

5. Routray, P., et al., *Socio-cultural and behavioural factors constraining latrine adoption in rural coastal Odisha: an exploratory qualitative study.* BMC Public Health, 2015. **15** (1): p. 880.

6. Sahoo, K.C., et al., *Sanitation-related psychosocial stress: a grounded theory study of women across the life-course in Odisha, India.*2015. **139** : p. 80-89.

7. Hulland, K.R., et al., *Sanitation, stress, and life stage: a systematic data collection study among women in Odisha, India.* 2015.**10** (11): p. e0141883.

8. O'Reilly, K., R. Dhanju, and A. Goel, *Exploring "The Remote" and "The Rural": Open Defecation and Latrine Use in Uttarakhand, India.* World Development, 2017. **93** : p. 193-205.

9. Garn, J.V., et al., *The impact of sanitation interventions on latrine coverage and latrine use: A systematic review and meta-analysis.* 2017. **220** (2): p. 329-340.

10. Clasen, T., et al., *Making sanitation count: developing and testing a device for assessing latrine use in low-income settings.*Environ Sci Technol, 2012. **46** (6): p. 3295-303.

11. Sinha, A., et al., *Assessing patterns and determinants of latrine use in rural settings: A longitudinal study in Odisha, India.*Int J Hyg Environ Health, 2017. **220** (5): p. 906-915.

12. Sinha, A., et al., *Assessing Latrine Use in Rural India: A Cross-Sectional Study Comparing Reported Use and Passive Latrine Use Monitors.* Am J Trop Med Hyg, 2016. **95** (3): p. 720-727.

13. Jain, A., et al., *Understanding Open Defecation in the Age of Swachh Bharat Abhiyan: Agency, Accountability, and Anger in Rural Bihar.* International journal of environmental research and public health, 2020. **17** (4): p. 1384.

14. Novotný, J., et al., *The role of perceived social norms in rural sanitation: an explorative study from infrastructure-restricted settings of South Ethiopia.* 2017. **14** (7): p. 794.

15. Roma, E., et al., *Assessing users' experience of shared sanitation facilities: A case study of community ablution blocks in Durban, South Africa.* 2010. **36** (5).

16. Banda, K., et al., *Water handling, sanitation and defecation practices in rural southern India: a knowledge, attitudes and practices study.* 2007. **101** (11): p. 1124-1130.

17. Rashid, M., D.J.E. Pandit, Development, and Sustainability,*Determination of appropriate service quality attributes for household toilets in rural settlements of India based on user perception.* 2017. **19** (4): p. 1381-1406.

18. Bathran, R., *Indian sanitation* . 2011, Economic and Political Weekly p. 34-37.

19. Lamba, S. and D. Spears, *Caste, 'Cleanliness' and Cash: Effects of Caste-Based Political Reservations in Rajasthan on a Sanitation Prize.* The Journal of Development Studies, 2013.**49** (11): p. 1592-1606.

20. Coffey, D., et al., *Understanding open defecation in rural India: Untouchability, pollution, and latrine pits.* 2017.**52** (1): p. 59-66.

21. Caruso, B.A., et al., *Understanding and defining sanitation insecurity: women's gendered experiences of urination, defecation and menstruation in rural Odisha, India.* 2017. **2** (4).

22. Khanna, T. and M.J.G.p.h. Das, *Why gender matters in the solution towards safe sanitation? Reflections from rural India.* 2016.**11** (10): p. 1185-1201.

23. O'Connell, K., *What Influences Open Defecation and Latrine Ownership in Rural Households?: Findings.* 2014.

24. Guterres, I.C.L., K. Yamarat, and P.J.J.o.H.R. Xenos, *Factors influencing households to use latrines after the open defecation free declaration in Ermera district, Timor-Leste.* 2014. **28** (3): p. 191-198.

25. Bhatt, N., et al., *What motivates open defecation? A qualitative study from a rural setting in Nepal.* PloS one, 2019.**14** (7): p. e0219246-e0219246.

26. Garn, J.V., et al., *The impact of sanitation interventions on latrine coverage and latrine use: A systematic review and meta-analysis.* Int J Hyg Environ Health, 2017. **220** (2 Pt B): p. 329-340.

27. Sinha, A., et al., *Assessing patterns and determinants of latrine use in rural settings: A longitudinal study in Odisha, India.*2017. **220** (5): p. 906-915.

28. O'Reilly, K., R. Dhanju, and A.J.W.D. Goel, *Exploring "the remote" and "the rural": Open defecation and latrine use in Uttarakhand, India.* 2017. **93** : p. 193-205.

29. Coffey, D., et al., *Switching to sanitation: understanding latrine adoption in a representative panel of rural Indian households.*2017. **188** : p. 41-50.

30. Boisson, S., et al., *Promoting latrine construction and use in rural villages practicing open defecation: process evaluation in connection with a randomised controlled trial in Orissa, India.* 2014.**7** (1): p. 486.

31. Alemu, F., et al., *The role of psychological factors in predicting latrine ownership and consistent latrine use in rural Ethiopia: a cross-sectional study.* 2018. **18** (1): p. 229.

32. Alemu, F., et al., *The role of psychological factors in predicting latrine ownership and consistent latrine use in rural Ethiopia: a cross-sectional study.* BMC Public Health, 2018.**18** (1): p. 229.

33. Stetler, C.B., et al., *The role of formative evaluation in implementation research and the QUERI experience.* Journal of general internal medicine, 2006. **21 Suppl 2** (Suppl 2): p. S1-S8.

34. Hirve, S., et al., *Psychosocial stress associated with sanitation practices: experiences of women in a rural community in India.* 2015. **5** (1): p. 115-126.

35. Pattanayak, S.K., et al., *Shame or subsidy revisited: social mobilization for sanitation in Orissa, India.* 2009. **87** : p. 580-587.

36. Guiteras, R.P., et al., *Disgust, shame, and soapy water: tests of novel interventions to promote safe water and hygiene.* 2016.**3** (2): p. 321-359.

37. Patil, S.R., et al., *The effect of India's total sanitation campaign on defecation behaviors and child health in rural Madhya Pradesh: a cluster randomized controlled trial.* 2014. **11** (8): p. e1001709.

38. Rutterford, C., A. Copas, and S. Eldridge, *Methods for sample size determination in cluster randomized trials.* International journal of epidemiology, 2015. **44** (3): p. 1051-1067.

39. Austin, P.C., *A comparison of the statistical power of different methods for the analysis of cluster randomization trials with binary outcomes.* Stat Med, 2007. **26** (19): p. 3550-65.

40. Donner, A., *Sample size requirements for stratified cluster randomization designs.* Stat Med, 1992. **11** (6): p. 743-50.

41. O'Reilly, K., et al., *Combining sensor monitoring and ethnography to evaluate household latrine usage in rural India.* 2015.**5** (3): p. 426-438.

42. Dolan, P., et al., *Influencing behaviour: The mindspace way.*2012. **33** (1): p. 264-277.

43. Vlaev, I., et al., *The theory and practice of "nudging": changing health behaviors.* 2016. **76** (4): p. 550-561.

44. Gautam, A.J.W.I. and S.I. ASIA, *Change for Ending Open Defecation in Rural India: A Review of India's Sanitation Policy Efforts.* 2019: p. 283.

45. Brown, J., et al., *The critical role of compliance in delivering health gains from environmental health interventions.* 2019.**100** (4): p. 777-779.

46. Routray, P., et al., *Socio-cultural and behavioural factors constraining latrine adoption in rural coastal Odisha: an exploratory qualitative study.* 2015. **15** (1): p. 880.

Appendix 1

Latrine use questionnaire to measure frequency of use.

Question	Options	Meaning
Type of latrine	Pit=1, Eco San=2, Septic=3, Others=4	
Can you see a water seal inside the latrine?	Yes=1, No=0	Expected answer is yes to assume latrine use
Is the platform of the latrine wet?	Yes=1, No=0	Expected answer is yes to assume latrine use, but no does not specify that latrine is not used
Can you see a water container inside the latrine?	Yes=1, No=0	Expected answer is yes to assume latrine use, but no does not specify that latrine is not used
Is there an arrangement to store larger quantities of water in the latrine?	Yes=1, No=0	Expected answer is yes to assume latrine use, but no does not specify that latrine is not used
Are any cleaning supplies (such as brush, harpic or acid) visible?	Yes=1, No=0	Expected answer is yes to assume latrine use, but no does not specify that latrine is not used
Is any foul odor emanating from the latrine?	Yes=1, No=0	
From seeing the latrine, can you say that the latrine is being used?	Yes=1, No=0	Judgement of surveyor

Appendix 2. (The theory of change of the proposed intervention is depicted as follows)

Hosted file

`image1.emf` available at https://authorea.com/users/365218/articles/485408-development-of-a-behaviour-change-intervention-to-promote-latrine-use-in-rural-rajasthan-a-pilot-study

APPENDIX 3- Quantitative Survey Tool and Qualitative survey questions

GENERAL INFORMATION

ualitative Survey Questions

1. Do you have a latrine in your household?
2. Is this latrine functional?
3. What type of latrine is it?
4. Who uses the latrine?
5. Who cleans the latrine?
6. How much water is required for each use?
7. Who brings the water for use?
8. Is there enough water for household consumption and latrine use?
9. Is the experience of using a latrine different from OD? Which do you prefer and why?
10. Why, in your opinion, is OD being discouraged?
11. Why is the government constructing toilets for every household?
12. How much money was spent by your family in constructing the latrine? What was the total cost of construction?
13. What is stopping you from using the latrine despite having one in your household?
14. Does every household in your village have latrines?
15. Which are the households which still do not have latrines and why?
16. Do people in your village prefer OD or use latrines?
17. What, in your opinion, could be done to change people's habits from OD to latrine use?

APPENDIX- 4 (Intervention Tool)

Commitment Intervention

On the bases of our research findings, we concluded that latrine use bares some similarities with another behavioural domain known as 'treatment adherence' (completing a program of treatment which could include taking medication, exercise program, diet, and using a device such as latrine). Our formative research has highlighted several key barriers to adherence. There is little positive feedback around benefits adherence; in fact, initial feedback might be negative (e.g. side effects in medication, or discomfort/smell/fear in latrine use). Also, there are not enough tangible rewards for adherence - the benefits are invisible. Individuals also cannot grasp the long-term impact of non-adherence (including OD) discounting the future (hypothetical illness) in favour of the power of now (e.g. the pit is a visible reminder of the hassle that is required to empty it one day, the necessity to bring water and clean the latrine is immediate, unpleasant effort). People also find it hard to resist temptation (hassle-free OD) and it is easy to cheat oneself (hence why self-reporting defecation behaviour is often inaccurate). Lack of routine (habit) to use the latrine is another key barrier. On the social side, people expressed a difficulty in committing to latrine use, and would often miss to act and not feel guilty.

Our solution is a commitment tool, which aimed to facilitate the creation of a new habit. The Commitment principle in the Mindspace framework postulates that "we seek to be consistent with our public promises, and reciprocate acts". The intervention utilizes several commitment techniques that tap into those psychological processes by also utilizing Messenger, Incentives, and Ego mechanisms of change.

(1) A poster located in the household. The intervention contains several components, some of which have been successfully piloted in the context of treatment adherence (see the images below). The poster intervention includes:

- Habit formation intervention to help individuals (or households) develop an adherence routine. Participants in the intervention group will receive a poster with a printed calendar upon it. They will be asked to track their latrine use by placing stickers (smiling face) on the days they defecate in the latrine. The feedback provided by the stickers is psychological tool recognised as integral to behaviour change, while the smiling face provides a positive reward reinforcing the action. The habit intervention also asks patients to sign a behavioural contract indicating the context (place, time, and action) surrounding when they expect to take their medication. For instance, a patient may write on the poster a promise to use the latrine every morning after waking up (action). Through repeated pairings, this context

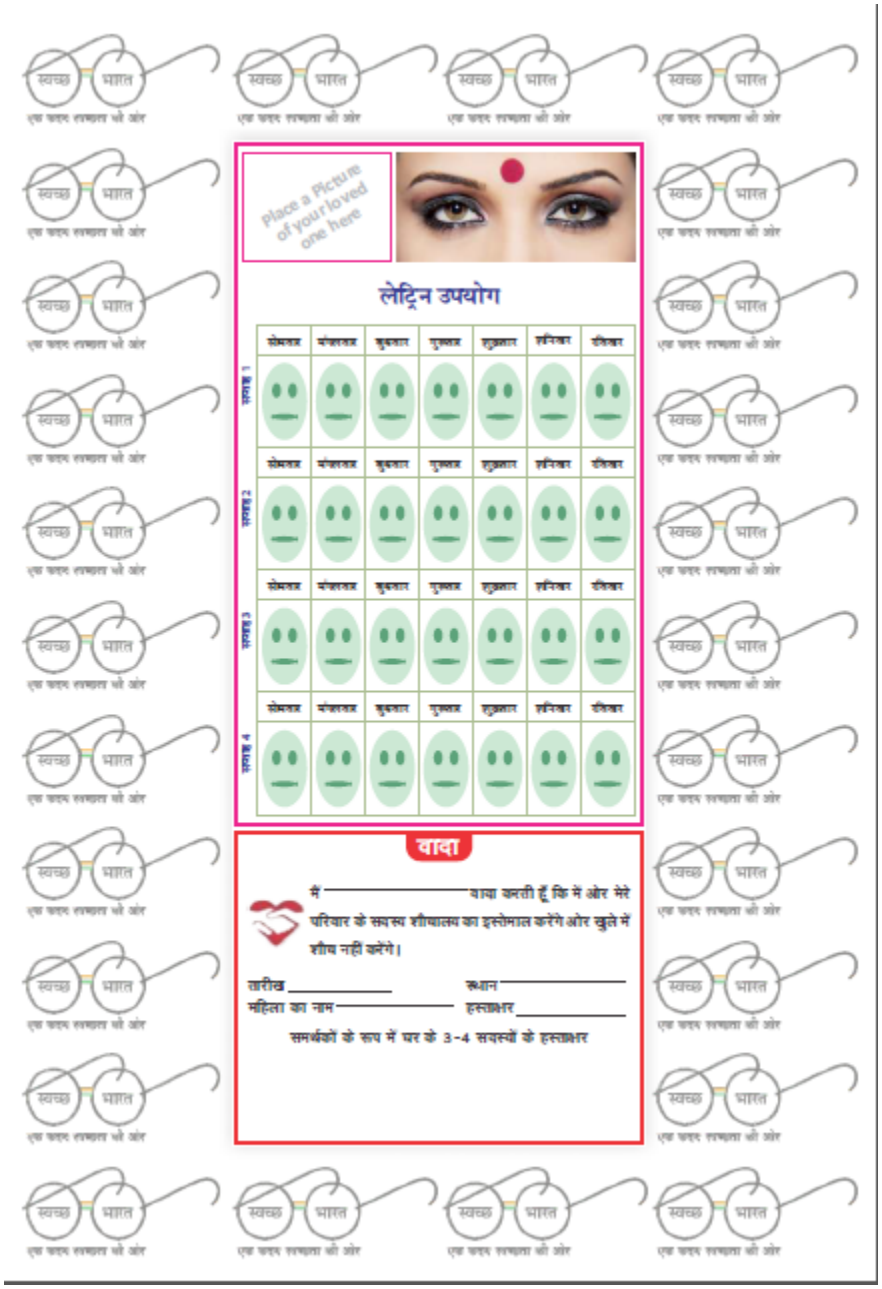
should become a trigger for patients to use the latrine, which persists after the poster ceases. Thus, the intervention contain all necessary ingredients involved in habit development: trigger (context), action (routine), and reward (reinforcement).

- The public "Promise Contract" signed by the household deploys a behavioural commitment device, a behaviour change technique which dials up saliency around the role of family/loved ones in supporting behaviour change.
- The poster shows a photo of the eyes and the face of a family member or loved one, which are a simple prime to encourage 'good' behaviour; for example, the photo of the children which reminds the parents that latrine use is also about the healthy future of their offspring.

(2) This poster is accompanied by a second commitment device: public pledge at village meetings and signing a pledge that is stuck at the wall in the village hall so everybody can see who committed to use their toilet. The poster/letter should also contain a photo of the family. This could be a version of the poster below, but without the self-report calendar and the eyes.

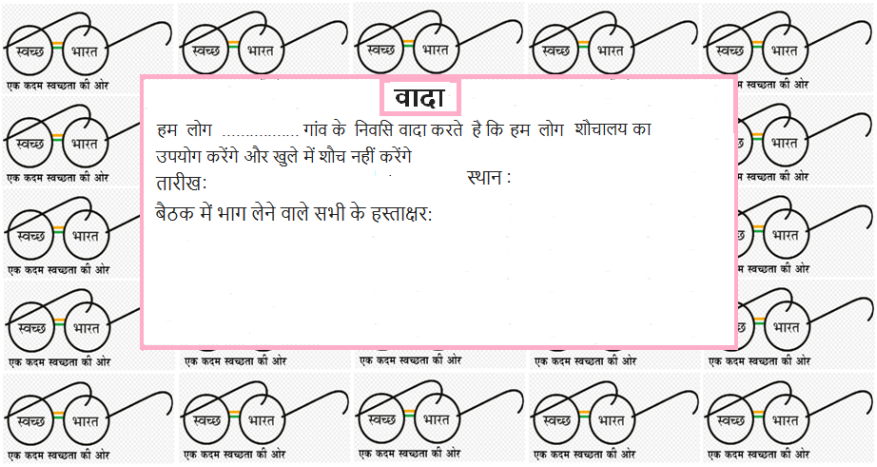
(3) A gift given to the household for small improvements of their experience using the latrine, which should trigger desire to reciprocate our kindness by using the latrine.

Illustrations of those three intervention components are presented below.



(1) Household level poster

(2) Village level poster



(3) Commitment booklet for the small improvements gift

Hosted file

`image4.emf` available at https://authorea.com/users/365218/articles/485408-development-of-a-behaviour-change-intervention-to-promote-latrine-use-in-rural-rajasthan-a-pilot-study

Hosted file

`image5.emf` available at https://authorea.com/users/365218/articles/485408-development-of-a-behaviour-change-intervention-to-promote-latrine-use-in-rural-rajasthan-a-pilot-study

.