

If I do not have enough water, then how could I bring additional water for toilet cleaning?! Addressing water scarcity to promote hygienic use of shared toilets in Dhaka, Bangladesh*

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Abstract

OBJECTIVES Provision of toilets is necessary but not sufficient to impact health as poor maintenance may impair toilet function and discourage their consistent use. Water in urban slums is both scarce and a prerequisite for toilet maintenance behaviours. We describe the development of behaviour change communications and selection of low-cost water storage hardware to facilitate adequate flushing among users of shared toilets.

METHODS We conducted nine focus group discussions and six ranking exercises with adult users of shared toilets (50 females, 35 males), then designed and implemented three pilot interventions to facilitate regular flushing and improve hygienic conditions of shared toilets. We conducted follow-up assessments 1 and 2 months post-pilot including nine in-depth interviews and three focus group discussions with adult residents (23 females, 15 males) and three landlords in the pilot communities.

RESULTS Periodic water scarcity was common in the study communities. Residents felt embarrassed to carry water for flushing. Reserving water adjacent to the shared toilet enabled slum residents to flush regularly. Signs depicting rules for toilet use empowered residents and landlords to communicate these expectations for flushing to transient tenants. Residents in the pilot reported improvements in cleanliness and reduced odour inside toilet cubicles.

CONCLUSIONS Our pilot demonstrates the potential efficacy of low-cost water storage and behaviour change communications to improve maintenance of and user satisfaction with shared toilets in urban slum settings.

keywords behaviour change, water scarcity, toilet cleanliness, shared toilet, urban slums, Bangladesh

Introduction

Problematising shared toilet cleanliness

Improved sanitation enhances quality of life [1, 2] and aims to protect human health by containing faecal contaminants responsible for enteric infection. However, these health benefits are often not evident following rigorously evaluated, sanitation interventions focused on

promotion and construction of toilets [3–6]. Clasen *et al.* [4] conducted a cluster-randomised controlled trial evaluating the effectiveness of India's Total Sanitation Campaign, the largest toilet promotion and construction initiative to date. Results showed no significant difference between intervention and control sites in reported 7-day prevalence of diarrhoea among children under 5 years of age, despite significant improvements in toilet coverage (+51% households with any latrine, +28% households with functional latrine). The authors speculate that low uptake and suboptimal use of constructed toilets may explain this lack of measurable health impact [4, 5]. If toilets are undesirable and used inconsistently, their health benefits go unrealised [6].

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R. E. Saxton *et al.* **Addressing water scarcity in shared toilets**

Poor toilet cleanliness discourages their consistent use [7–13]. Qualitative work in Mumbai, India revealed slum residents invested considerable time, energy and ingenuity each day to avoid toilets rather than suffer the indignity of using a dirty facility [8]. Furthermore, very dirty toilets may be hazardous to use [8–10]. Latrine ownership is associated with greater toilet cleanliness and user satisfaction [10, 11]. However, private toilets are not feasible in contexts of extreme urban poverty due to spatial and social factors. Demand for low-cost housing eclipses demand for sanitation or municipal services (sewerage, piped water) [14]. Where improved facilities are made available, landlords broker access and charge fees for use [15], but this opportunity for profit-making must be balanced to tenants' capacities to afford both housing and amenities. Public authorities who might otherwise extend formal access to municipal services are reluctant to regulate spaces considered to be illegal [14]. For these reasons, slum residents may depend on shared sanitation facilities with poor hygienic conditions.

Despite growing recognition of both the necessity of shared sanitation for poor urban populations and the importance of toilet cleanliness for consistent use, only a few recent publications have examined factors affecting poor cleanliness of shared toilets in slum settings [10, 13, 16]. In January 2014, we initiated a stakeholder workshop among local government and NGO actors implementing WASH projects in Dhaka, Bangladesh to identify specific contextual and behavioural factors affecting poor cleanliness of shared toilets in Dhaka slums. Each identified topic area became one of five research modules to develop behaviour change interventions to improve user experience with shared toilets (Table 1). Here, we describe the activities of Module 3, pertaining to how limited water availability affects cleaning of shared toilets.

Water is prerequisite for maintenance behaviours that ensure hygienic use of pour-flush toilets. Adequate water is required for flushing after each use to prevent exposure to faeces left on the pan. Furthermore, maintenance of a

Table 1 Modules of community-based, behaviour change intervention to improve shared toilet quality and cleanliness

Research Group	Topic	Problems identified	Potential interventions
Module 1	Waste Disposal and Faecal Sludge Management	<ul style="list-style-type: none"> • Communities lack designated option for waste disposal • Improper disposal of solid waste into the toilet pit causes toilet blockages • Large items disposed in the toilet inhibit safe emptying of faecal sludge from the pit using Vacutug machines • Women need private space to dispose of materials used for menstrual management, dispose these items in the toilet • Caregivers of young children use plastic or paper bags to collect and dispose of children's faeces, dispose these items in the toilet 	<ul style="list-style-type: none"> • Designated bin for private disposal of solid waste inside toilet chamber to prevent disposal in toilet pit • Train local residents to work as Vacutug operators, safely emptying pit of faecal sludge and transporting it away from compound using small machines able to navigate through slum areas
Module 2	Young Children	<ul style="list-style-type: none"> • Young children frequently open defecate in or around the household 	<ul style="list-style-type: none"> • Promote purchase and use of child potties
Module 3	Rules for Latrine Use and Regular Maintenance	<ul style="list-style-type: none"> • Toilets require <i>regular</i> cleaning after each use (adequate flushing) • Shared toilet should be a respected utility (no vandalism, spitting, or smoking in the latrine) 	<ul style="list-style-type: none"> • Develop behaviour change communications to convey expected toilet-use habits • Provide place to store water near toilet
Module 4	Fund Management for Periodic Maintenance and Repairs	<ul style="list-style-type: none"> • Toilets require <i>periodic</i> maintenance to remain functional (fix doors, safe emptying of faecal sludge) • No effective system to fund repairs necessary to assure functionality 	<ul style="list-style-type: none"> • Set up system for collection and proper use of funds
Module 5	Accommodating Special Needs Groups	<ul style="list-style-type: none"> • Special needs can make toilet use unsafe or impossible for elderly, disabled persons, pregnant women 	<ul style="list-style-type: none"> • Form User's Groups to enact non-behavioural interventions as needs emerge (high folding seat, ramps, handrails, lighting)

water seal blocks odour from the faecal sludge pit from venting into the toilet cubicle, and prevents insects from accessing the pit and spreading faecal contaminants [17, 18]. When water access is irregular in slums, either because water points are not proximal to toilets or are periodically non-functional, regular toilet cleaning varies from inconvenient to impossible. Little is known about effective strategies to immediately improve shared toilet cleanliness in slum communities with limited water resources. Here, we present qualitative findings regarding how residents acquire water for defecation purposes in slum communities in Dhaka and describe the results of a theory-based behaviour change pilot intervention to promote adequate flushing and regular cleaning of shared toilets in these communities.

Guiding theoretical framework

We structured our research questions using the Integrated Behavioral Model for Water, Sanitation, and Hygiene (IBM-WASH) [19] to capture factors affecting toilet maintenance behaviours across contextual, psychosocial and technology dimensions. Periodic unavailability of water in slums is a significant contextual feature inhibiting toilet cleaning. Psychosocial factors affecting flushing practices include social norms (descriptive and injunctive) [20, 21], and individual expectations regarding the cost *vs.* benefit of water use [19]. Norms influence behaviours most strongly when they are focal: when the socially acceptable choice is made both apparent and important at the point of action [20, 21]. Finally, in order to facilitate habit formation, promoted flushing technologies must be accessible, perceived to be beneficial, and convenient to use [19].

Methods

Study design, setting and sampling

We designed theory-based behaviour change interventions to improve shared toilet cleanliness in urban slums of Dhaka. Intervention development followed three, iterative phases (Table 2).

Phase 1: Formative research

Formative research involves the collection of data, often qualitative, to inform the development of public health interventions prior to programme implementation or baseline data collection in experimental trials [22, 23]. Formative data allow interventionists to recommend health strategies that are feasible and appropriate given specific social and material contexts.

As a method of source triangulation and to corroborate the maintenance priorities identified during the stakeholder workshop, field researchers conducted focus group discussions ($n = 6$) with slum residents ($n = 61$) regarding barriers to shared toilet use. Three toilet structures were selected by convenience from within the catchment area of our partner NGO, Water and Sanitation for the Urban Poor. Toilets were included if they met our definition of 'shared', meaning each toilet cubicle, or squatting area, was used by two or more households within a compound. Sharing of a single cubicle among 10–20 households is common, and most toilet structures are comprised of multiple cubicles that drain to a common pit or place. Excluded were toilets shared by fewer than two households, and public toilets that did not have an identifiable group of residential users. Adult users of the selected toilets were asked to rank typical toilet maintenance problems by sorting cards that depicted hypothetical barriers, then list potential latrine-use rules to improve user experience in each scenario, and suggest strategies for communicating and enforcing rules among residents.

Next, field researchers conducted three focus group discussions with adult users of toilets meeting the criteria above, plus purposive sampling by type of water access: eight users of toilets with rooftop water storage that made piped water available via a spigot *inside* each toilet cubicle, and 16 residents living in areas where water access was *not proximal* to the toilets. In the *not proximal* setting, some households collected and carried water from a communal pump located elsewhere within the housing compound, while other households walked to acquire water from among surrounding compounds and paid ~150 BDT (1–2 USD) per month for this access.

Phase 2: Pilot intervention procedures

Using *trial of improved practices* methodology [24], we implemented small-scale pilot interventions to facilitate adequate flushing and regular cleaning of shared toilets. We hired local artists to depict problem scenarios respondents had described regarding shared toilet use, as well as visual instructions for our proposed solutions. We selected facilitating hardware from among low-cost, locally available options.

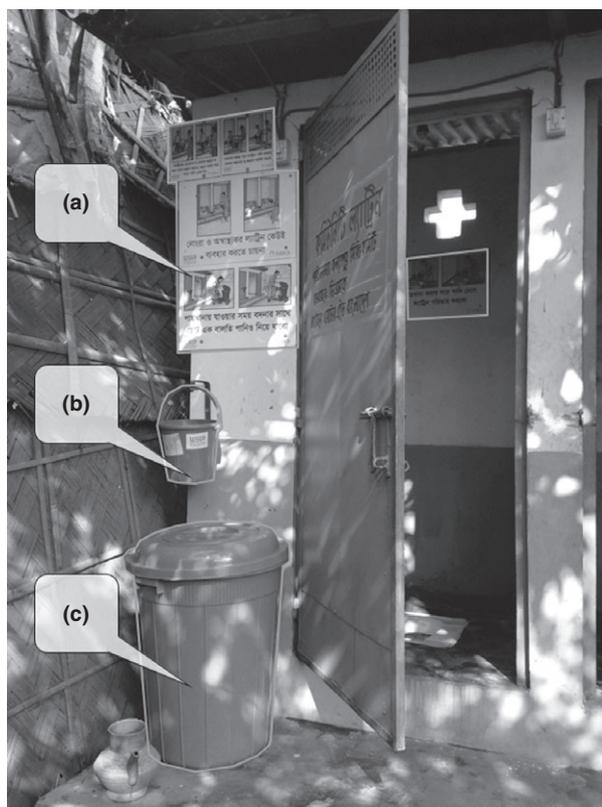
We selected three shared toilets in Bauniabad, Kolyanpur and Mohammadpur with different scenarios of water access (piped water *inside* toilet cubicle, piped water *beside* toilet structure, and water *storage only*). Residents in each site tested a different configuration of water storage and flushing hardware (Table 3, Figure 1), and corresponding behaviour change signage (Figure 2).

Table 2 Phases of formative research and data collection methods

Phase	Method (sample)	Main objectives	Data collected
Phase 1: Formative research to determine promoted behaviours	<p>Focus group discussions (6) and ranking exercises (6) with slum residents: Female groups (11, 9, & 13) Male groups (9, 11, & 8)</p> <p>Focus group discussions (3) with residents of slums purposively selected by water access type: Water <i>inside</i> toilet (8 female) Water <i>not proximal</i> to toilet (9 female, 7 male)</p>	To understand water access and toilet use in slum communities, determine barriers to maintaining shared toilet cleanliness, and select target behaviours for intervention based on residents' priorities	<ul style="list-style-type: none"> • Community prioritisation of shared toilet maintenance problems • Barriers to toilet use/cleanliness • Perceptions of toilet quality, suggestions to improve toilet use/maintenance • How water accessed for defecation purposes (personal washing and toilet cleaning) in different slum contexts • Contextual, psychosocial and technology factors affecting adequate flushing • Feasibility, advantages/disadvantages of proposed two-container approach • Feedback on content/placement of prototype behaviour change signage
Phase 2: Pilot trials to facilitate adequate flushing	<p>Trial of improved practices; CHPs present behaviour change communications and demonstrate hardware at courtyard sessions in three sites: Water <i>inside</i> toilet Water <i>beside</i> toilet Water <i>storage only</i></p>	To explore the feasibility of the proposed two-container approach in communities with different levels of water access	<ul style="list-style-type: none"> • Advantages/disadvantages of flushing hardware (adequate volume, convenient location, perceived quality) for toilet cleaning
Phase 3: Refining the intervention strategies	<p>1 month after: In-depth interviews (9) with male residents and landlords; focus group discussions (3) with female residents: Water <i>inside</i> toilet (7 female, 2 male, 1 landlord) Water <i>beside</i> toilet (8 female, 2 male, 1 landlord) Water <i>storage only</i> (8 female, 2 male, 1 landlord)</p> <p>2 months after: In-depth interviews (9) with male residents and landlords; focus group discussions (3) with female residents: Water <i>inside</i> toilet (6 female, 2 male, 1 landlord) Water <i>beside</i> toilet (7 female, 2 male, 1 landlord) Water <i>storage only</i> (9 female, 2 male, 1 landlord)</p>	<p>Residents: To understand persistent barriers to shared toilet cleanliness; to assess perceived advantages/disadvantages of pilot intervention</p> <p>Landlords: To understand delegation of toilet cleaning/maintenance responsibilities; to explore current/potential role of landlords in enforcing toilet maintenance</p>	<ul style="list-style-type: none"> • Toilet cleaning practices pre/post-pilot • Advantages/disadvantages of flushing hardware (adequate volume, convenient location, perceived quality) for toilet cleaning • How maintenance/cleaning responsibilities assigned • Factors that motivate landlords to ensure maintenance of shared toilets • Feedback on intervention messages and signage • Suggestions for improving the intervention

Table 3 Intervention sites and materials

Type of water access	Intervention received
Inside: Piped water available via spigot inside each toilet cubicle powered by electric pump	a (signs indicating expected behaviours)
Beside: Water supplied by hand pump located in common area near toilet structure	a & b (4-l bucket for flushing)
Storage only: No proximal water source, residents collect and carry water from other compounds	a, b & c (70-l water storage reservoir)

**Figure 1** Intervention hardware for one toilet cubicle in a water storage only setting.

Community health promoters (CHPs) presented hardware and signage during courtyard discussions attended by the residents and landlords of each compound. CHPs encouraged residents of the *water beside* and *storage only* settings to use a two-container approach: carry a *bodna* (1.5-l, plastic, teapot-shaped container used for anal cleansing) for personal washing, and a second (4-l) bucket of water provided for flushing faeces after



No one wants to use dirty and unhygienic latrine

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We will take a bucket of water from reservoir bucket for flushing

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We will clean latrine after defecation by pouring water into latrine

WSUP
Water & Sanitation
for the Urban Poor

icddr,b

Figure 2 Detail of messages for water storage only setting (English translation).

defecation. During the courtyard session in the *storage only* setting, residents established a rotation of responsibility for refilling the supplied (70-l) reservoirs during hours when water was available. In the setting with *piped water inside* the cubicle, residents were encouraged to flush adequately by refilling their *bodna* with additional water from the spigot.

In addition to promoting the flushing hardware, CHP presentations emphasised disgust themes (photographs of very dirty, poorly maintained toilets), and nurture themes (importance of hygienic toilet use for child health). The

topics presented were not intended as purely emotional appeals, but rather to stimulate discussion about the need to maintain toilet cleanliness. CHPs reinforced presentation content during weekly household visits for the subsequent 2 weeks.

Phase 3: Refining the intervention strategies

We assessed residents' experiences with the promoted flushing strategies at 1 and 2 months post-implementation. Field researchers conducted three focus group discussions with female residents ($n = 23$ at month one, $n = 22$ at month two) and six individual interviews with male residents. Field researchers also interviewed the landlord ($n = 3$) of each pilot community regarding their role in toilet maintenance. These data were used to prepare a final intervention package for subsequent use in a large-scale trial.

Data quality and analysis

Field researchers from the Environmental Intervention Unit, Enteric and Respiratory Disease Program of icddr,b with training in qualitative methodology conducted all data collection in Bengali using open-ended interview guides. Field researchers audio-recorded all data collection, then conducted preliminary analyses to summarise and organise data from these recordings. Written summaries were translated to English for thematic analysis by international investigators.

Ethical approval

We obtained written informed consent from all respondents. Landlords gave verbal permission for CHPs to work in their compounds. The study protocol was reviewed and approved by the ethical review committee of icddr,b and institutional review board of Stanford University.

Results

Residents ranked *a lack of arrangement for water inside the latrine* as the most critical problem and emphasised that rules regarding latrine cleanliness could not be enforced without water access. Other problems, in order of importance to respondents were *faeces left on the toilet pan after defecation due to inadequate flushing; dried faeces stuck permanently to the toilet pan due to irregular cleaning; sanitary napkins and condoms are disposed in the latrine* (addressed in Module 1); *no arrangement for handwashing, and theft of soap; odour from smoking*

inside the latrine; dirty queuing area outside the latrine; spit on latrine walls and doors. Because the top three priorities all pertained to water use, intervention development came to focus on water access for flushing. Flushing practices in Dhaka slums are influenced by contextual, psychosocial and technological factors (Table 4).

Contextual factors affecting flushing behaviours

Access to water in slums is highly variable, both between and within compounds. Inconsistencies in service disrupt life and residents make great effort to obtain water. In areas where water points are located within the compound, they may be functional for only a few hours each day, typically early morning during off peak hours when citywide water demand is lowest.

To ensure access to water throughout the day, residents collect water when and where it is available to store in various containers in their residence. For defecation, residents carry one *bodna* filled with stored water from their residence. Residents agreed that this amount of water was insufficient for both personal washing and flushing after defecation, but were reluctant to carry additional water for toilet cleaning:

We actually use one *bodna* of water and are not interested to use more water because of water scarcity. But this one *bodna* is not enough water for cleaning the pan after defecation. (Male resident, water not proximal)

Water was difficult to acquire, and stored water was barely sufficient to cover daily needs. When asked about the feasibility of carrying additional water for flushing, a female resident responded, 'If I do not have enough water, then how could I bring additional water for toilet cleaning?!'

Psychosocial factors affecting flushing behaviours

Residents felt embarrassed to carry additional water to the toilet, as it is viewed as irrational to waste water for flushing:

It looks odd if anyone sees us with two containers in front of the latrine. People think you are not acting sensibly. Thus we feel embarrassed. What a shame it is!! Nobody goes to the latrine with two containers. If anyone sees that I take two containers, I feel embarrassed! I feel uncomfortable!! (Male resident, water storage only)

Descriptive norms, queues of toilet-goers carrying only one container of water for personal washing, conveyed

Table 4 IBM-WASH framework applied to shared toilet flushing practices

Level	Contextual factors	Psychosocial factors	Technology factors
Societal/Structural	<p>Rapid urban population growth; informality of service provision</p> <p>'We 20–25 people went to the DWASA* office recently to complain to the technician responsible for operating the motor that pumps water to our compound that we do not get enough. He replied that some multistoried buildings have been built and they use an auto machine for taking water. As a result, there is water shortage in our area'. (Male IDI, Phase 3, water inside)</p> <p><i>*Dhaka Water Supply and Sewerage Authority</i></p>	<p>NGO/landlord commitment to shared toilet maintenance</p> <p>'There is no quarrel between renters regarding refilling the reservoir, but I have to remind them to refill. This is the only problem that I faced'. (Landlord IDI, Phase 3, storage only)</p> <p>'Sometimes some outsiders come to their compound to use the latrine. They don't clean/pour water in the latrine... Today, he [landlord] had rebuked a person who only took a bodna but didn't take the bucket in the latrine. He told him, 'Have you not seen <i>ubhat is written on the signboard?</i>' Afterwards, he poured the bucket with water and threw water in the latrine'. (Male IDI, Phase 3, water beside)</p>	<p>Manufacturing/distribution of toilets and flushing hardware</p> <p>No quote</p>
Community	<p>Type/timing of water access; distance between water point and toilet</p> <p>'We have four toilet chambers in our compound. There is no water source beside our latrine. We collect water far away from our residence, 5 min walking distance. Water is available there from 4 to 9 am'. (Male FGD, Phase 1.b, not proximal)</p> <p>'We are facing water shortage for 2 months, there is irregular supply. We collect water at 2 am. We generally keep the tap open so that we hear the sound of water falling. If anyone hears the sound, he/she calls his/her neighbor... His neighbor calls his neighbor... Thus, all the families wake up for collecting water'. (Male IDI, Phase 3, water inside)</p>	<p>Shared value for personal cleanliness; community responsibility to maintain clean toilet</p> <p>'As water is not available beside our latrine, we come back our residence after defecation and wash our hands. Thus, the place becomes muddy. Our living environment turns into a diaper! The mud attracts flies'. (Male FGD, Phase 1.b, not proximal)</p> <p>'We should pray for those who don't pour water on the latrine, or maybe spread Islamic rules regarding cleanliness'. (Male IDI, Phase 3, water inside)</p> <p>'We maintain cleanliness by rotation basis... One after another household members clean our latrine each week'. (Female FGD, Phase 1.a, rules/ranking)</p> <p>'One person is responsible to clean the latrine in our community. But this person doesn't come to do that regularly. When community people call to him, then he comes and cleans the latrine. He is paid for this duty. Every month we pay our service charge for cleaning toilets with other utility bills'. (Female FGD, Phase 1.a, rules/ranking)</p>	<p>Types of toilets (pour-flush); local availability of buckets/reservoirs</p> <p>'If any of this [pilot] hardware is broken, compound members will try to buy replacement hardware by collecting money from every household'. (Female FGD, Phase 3, storage only)</p>

Table 4 (Continued)

Level	Contextual factors	Psychosocial factors	Technology factors
Interpersonal/ Household	<p>Frequent resident turnover; number of users sharing toilet; gender dynamics</p> <p>‘Women feel embarrassed in the latrine if any male waits for his turn beside latrine. Sometimes a woman can’t complete her defecation in this situation as she tries to go outside as soon as possible’. (Female FGD, Phase 1.a, rules/ranking)</p> <p>‘In our camp, some toilets are allocated for some particular group of people in a specific area. For the last 2 months, our latrines have been under repair, therefore one group of people is currently sharing another’s toilet. This extended number of people creates extra pressure. Therefore we need to stand for a long time to use toilet during rush hour’. (Male FGD, Phase 1.a, rules/ranking)</p> <p>‘After getting these buckets, the latrine environment is almost clean. New renter household came a month ago and other residents told them that there are some rules for living in this compound. You have to maintain the [queue] order for going to the latrine. You must take the bodna and bucket when going to the latrine. He will use the bodna water for his own cleaning purpose and use the bucket to pour water for flushing’. (Male IDI, Phase 3, water beside)</p>	<p>Injunctive/descriptive norms for adequate flushing and water use; shame associated with wasting water</p> <p>‘When I see no one brings additional water to clean toilet except me, and find feces left in the latrine, then I’ll feel demoralized. Then I’ll think. <i>“This is a shared toilet. Why should I take on this burden?”</i>’ (Female FGD, Phase 1.b, not proximal)</p> <p>‘We have limited water access. We have to calculate water spending for things like drinking, and cooking. We don’t lead a life of luxury considering water shortage. We have to fulfill our essential households work with limited water. So, it is tough for us to bear two containers of water...we can’t allow this water to be consumed for the cleanliness of the latrine’. (Male IDI, Phase 1.b, not proximal)</p> <p>‘Sometimes it’s embarrassing to carry water for defecation in front of many people’. (Male FGD, Phase 1.a, rules/ranking)</p> <p>‘If anyone doesn’t want to take the bucket during defecation, then we tell him/her: why don’t they take the bucket with them? As we are not facing any problem, then why don’t they follow the same?’ (Female FGD, Phase 3, water beside)</p> <p>‘Nowadays, members of this compound take the bucket along with them so that other members could not say anything regarding their not pouring water’. (Male IDI, Phase 3, water beside)</p>	<p>Modelling use of flushing hardware to children; adequate volume of water stored</p> <p>‘Every day, two families refill the reservoir, and all families that live in this compound maintain this chore serially’. (Female FGD, Phase 3, storage only)</p> <p>‘Compound members should accompany their children to the latrine. If the guardian is not present, a neighbor will have to accompany the child and clean the latrine’. (Female FGD, Phase 3, storage only)</p>

Table 4 (Continued)

Level	Contextual factors	Psychosocial factors	Technology factors
Individual	<p>Resident's income and work schedule</p> <p>'Garment workers have to hurry to go office. We also give them priority to go latrine'. (Male FGD, Phase 1.a, rules/ranking)</p> <p>'In comparison to household members, the quantity of toilets is not sufficient. Therefore, people must wait in a long queue during rush hour... usually from 7 to 9 am, most people go to the toilet before leaving home'. (Male FGD, Phase 1.a, rules/ranking)</p>	<p>Perceived cost/effort to acquire water; disgust and perceived health threat of using dirty toilet</p> <p>'Usually women collect water by <i>kolshi</i> [large, pear-shaped jug, usually metal] from water source far away from their compound (5 min walking distance). Sometimes quarrel is occurred among dwellers in water source where queue is broken up. It hard task to take water 2.5–30 <i>kolshi</i> daily, especially female as they do this task early in morning'. (Male FGD, Phase 1.b, not proximal)</p> <p>'There is gas (bad odor) after one defecates in latrine and this makes it difficult for the next user to breathe. This gas could infect our body and we could become sick. If we become sick, more money is lost to pay for medical treatment costs'. (Female FGD, Phase 1.a, rules/ranking)</p>	<p>Perceived quality, durability and convenient location of hardware</p> <p>'Our residence room is located so far away from latrine, therefore it's inconvenient for us to carry water for cleaning as well as defecation purpose'. (Female FGD, Phase 1.b, not proximal)</p> <p>'All the hardware provided to compound are useful. If the big bucket [reservoir] is filled with water, water is preserved for use. The mug [scoop inside reservoir] is useful since it helps to draw water from the big bucket to the small bucket. The small bucket contains enough water which cleans the dirt properly'. (Female FGD, Phase 3, storage only)</p> <p>'If it were a bigger size [flushing bucket], then children would not be able to use it'. (Female FGD, Phase 3, water beside)</p>
Habitual	<p>Inconsistent water access</p> <p>unfavourable for habitual flushing</p> <p>'This bad habit might improve if water is available beside latrine, or even in residences. Then people would be more likely to take water in a small bucket with the <i>bodna</i>'. (Male FGD, Phase 1.b, not proximal)</p> <p>'No one likes to go to a dirty latrine, and now water is available so all community members use the flushing bucket after defecation'. (Landlord IDJ, Phase 3, storage only)</p>	<p>Current flushing practices; expected benefit of consistent flushing with adequate water</p> <p>'Some people are very stubborn and do not want to understand anything that they are told for his/her betterment. They only do what they like to do'. (Female FGD, Phase 1.b, not proximal)</p> <p>'Despite of water availability, people sometimes forget to pour water, sometimes feel lazy to clean. Sometime they don't consider other people's inconvenience and leave the latrine unclean. Unavailability of water is not the only reason for the latrine being unclean. People's existing habit is another reason of unwillingness to clean the latrine'. (Female FGD, Phase 1.b, water inside)</p>	<p>Visibility of hardware in/near toilet cue to action for consistent use</p> <p>'Yes, that place is appropriate [hanging the bucket by the latrine door], so it is easy for us to take it each time for defecation, even for a child'. (Female FGD, Phase 3, water beside)</p>

this practice was appropriate. Injunctive norms, a perception that disapproval would accompany carrying additional water, also influenced behaviour. Some residents evaded criticism while queuing outside the latrine with extra water and made a second trip home to refill their *bodna* for flushing. However, this delay inconvenienced users who entered the dirty cubicle between use and cleaning.

Technology factors affecting flushing behaviours

Residents agreed that regular, adequate flushing using a second, larger container of water would prevent inconvenience for subsequent toilet-goers. They noted that this practice would only be feasible if additional water were made available specifically for this purpose. Residents have limited space to store additional water inside their residence rooms. Some residents' homes were located far from the latrine, making carrying water for flushing inconvenient. Residents with water storage only expressed preference for the installation of piped water into the latrine structure. Such improvements are beyond slum residents' financial means. To facilitate adequate flushing, we installed low-cost reservoirs beside each toilet cubicle in the storage only setting.

Reactions to pilot intervention

During pilot assessments, all respondents accurately described at least one programme activity, indicating the programme was implemented with high reach and fidelity. After piloting, residents reported reduced odours and increased satisfaction using the latrine:

Before, the latrine remained extremely dirty. We would hold a cloth over our nose. Sometimes we fainted in the latrine. After the construction of the latrine, it was in this bad condition. Now, you have given us materials and the latrine remains much better than before. (Male resident, water storage only)

Maintenance of flushing practices

Communities enforced the promoted flushing practices, and new residents were expected to uphold latrine-use rules and participate in replenishing the reservoir. The pilot inspired new norms regarding appropriate flushing:

If anyone doesn't want to take the bucket during defecation, then we tell him/her: why don't they take the bucket with them? As we are not facing

any problem, then why don't they follow the same? (Female resident, water beside)

Residents voiced disapproval to non-flushers to enforce an injunctive norm for adequate flushing, and offered personal success flushing as evidence of a descriptive norm for use of the flushing bucket. Landlords also took responsibility for enforcing toilet maintenance:

Those who are not taking the bucket to the latrine are often asked by the caretaker: why they do not take bucket in the latrine? I also asked them, but the caretaker warned me not to do that. He explained that they might turn rough to me, as I am not the caretaker of this compound. He further advised me to perform my responsibility of cleaning and I am doing that. (Male resident, water storage only)

The involvement of landlords as authorities in this context may have made the expectation to flush adequately more focal for fear of penalty, thus engaging normative pressure.

Persistent barriers and refining the intervention

Male residents urinate standing. Frequently, they dirtied the walls and floor of the latrine cubicle with their urine, and neglected to bring water for flushing after urination. Other residents complained that this habit created foul smells. We developed additional signs that encouraged men to clean the cubicle and toilet pan following urination, and that characterised failure to flush as an embarrassing action. Signs depicted a landlord chastising a man who had dirtied a latrine, and a second image of the landlord looking approvingly at the man carrying the flushing bucket to clean urine from the cubicle.

Small children were physically unable to carry and pour the flushing bucket. We developed additional signs targeting caregivers of young children, encouraging them to assist children in flushing until they were able to do so alone, modelling cleaning habits. Signs depicted a child exiting a latrine after defecation while a caregiver waited outside with a flushing bucket, and a second image of the caregiver and child pouring water on the toilet pan together to flush (Supporting Information).

Discussion

Elements of an effective toilet cleanliness intervention

Ours is one of few efforts that moves beyond recognising that shared toilets are often unclean and poorly

maintained to develop and pilot intervention strategies to promote shared toilet cleanliness [13, 16]. Access to sanitation depends on both toilet availability, and on habitual maintenance behaviours necessary for toilet functionality and consistent, hygienic use. As local governments and NGOs make considerable investments to increase toilet coverage in low-income, urban environments, attention should simultaneously be paid to behaviour-based, operational rules to ensure toilets remain functional and acceptable to the user, of which a locally determined method for adequate flushing is one integral part.

In contexts of water scarcity, social and material pressures discourage adequate flushing, resulting in dirty toilets that are undesirable to use. Our pilot demonstrates that low-cost water storage and flushing hardware and promotion of toilet maintenance behaviours can immediately improve both hygienic conditions and user satisfaction with shared toilets, even in areas experiencing water scarcity, and that residents and landlords were pleased with these efforts.

Few recent studies examine factors that motivate toilet maintenance behaviours in other slum contexts. Tumwebaze *et al.* [13] examine factors affecting *cleaning intentions* among shared toilet users in slums in Kampala, Uganda. Factors significantly associated with greater cleaning intention included: (i) *perceived importance* of using a clean toilet, (ii) *effort* required to maintain toilet cleanliness, and (iii) *communication* among toilet users [13]. Our interventions acted on these constructs by: (i) elevating the importance of toilet cleanliness in terms of user convenience and child safety through CHP presentations, (ii) reducing the effort required to clean through proximal water storage, and (iii) facilitating communication regarding toilet cleaning through signs depicting specific rules for latrine use and empowering residents and landlords to communicate these expectations to new residents.

A related study by Tumwebaze and Mosler [16] applies theories of *social dilemma* to explore strategies to promote cooperative cleaning among shared toilet users. Social dilemma, called ‘Tragedy of the Commons’ in human ecology, refers to conflict/cooperation scenarios in which an individual’s interests are best realised (in terms of reduced effort) when that individual behaves uncooperatively regarding administration of a shared resource, but if all individuals who collectively depend on that resource behaved uncooperatively and in their own interests, the result is unfavourable to all dependents [16]. Regarding shared toilets, an uncooperative toilet-goer might benefit from the cleaning effort of others, maximising his or her reward (use of a clean toilet without having

expended effort), but if all users refused to clean, the result would be unclean and unusable toilets for all.

One strategy to maximise cooperation in social dilemma scenarios involves the concept of *attribution*: the explanation given to be the cause of an undesirable situation [16]. Toilet-goers encountering a dirty toilet might imagine that it was made dirty either by *neglect* of another able user, or because of *unintended non-cooperation* by a child or disabled person requiring assistance to flush [16]. Toilet-goers may be *more* motivated to participate in cooperative cleaning when they regard the dirty state of a toilet as *unintended* [16]. Our pilot responded to both attribution scenarios – *neglect* by men urinating on the cubicle walls, and *unintended non-cooperation* by children unable to flush. Behavioural interventions to maximise cooperative cleaning of shared toilets could emphasise scenarios in which cleaning is necessitated by *unintended non-cooperation*. In response to *neglect*, behavioural interventions could engage injunctive norms; our pilot depicted the promoted flushing behaviours as expected actions enforced by landlords.

Our study adds to the growing literature on factors that motivate shared toilet maintenance by translating these concepts into actionable strategies. Regarding the potential of behaviour change communications and low-cost water storage hardware interventions to motivate toilet cleaning behaviours in urban slum areas experiencing water scarcity, our piloting suggests the following strategies:

- The two-container approach and water storage reservoir can facilitate regular flushing, even in areas where water is only intermittently available. In our pilot, a 4-litre bucket carried adequate water for toilet cleaning, while an additional container carried water for anal cleansing. Specific volumes required per use may vary by programmatic setting.
- Signs depicting social pressure for shared responsibility to clean enable communication and motivate regular maintenance.
- Landlords should be engaged to enforce maintenance through injunctive norms, prevent disputes among residents and sustain cooperative cleaning.

Study limitations

Baseline data on toilet cleanliness and user satisfaction were not collected. The improvements reported post-pilot are based on residents’ self-reports.

Our piloting results are based on a small sample of three latrine structures, one for each type of water access. Although purposively selected to account for the variability in water access observed in our formative work, results

presented from such a small sample need further testing to be transferrable to other slum communities. The recommendations detailed here were subsequently applied in a large-scale, cluster-randomised controlled trial to assess improved cleanliness and functionality of 1200 shared toilets in low-income neighbourhoods in Dhaka, Bangladesh (ClinicalTrials.gov: NCT02324075) [25].

Conclusions

Interventions to improve sanitation access in urban slum settings should consider the maintenance behaviours needed to ensure consistent, hygienic toilet use. Theory-based behavioural interventions that are attentive to contextual, psychosocial and technological factors affecting toilet maintenance can immediately improve shared toilet cleanliness and user satisfaction.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Figure S1. Detail of messages for water beside setting (English translation).

Figure S2. Detail of messages for water inside setting (English translation).

Figure S3. Detail of messages for male urination practices (English translation).

Figure S4. Detail of messages for caregivers of young children (English translation).

Table S1. Demographic Characteristics of Participants.

Table S2. Discussion Guides by Phase.

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