

Improving service delivery of water, sanitation, and hygiene in primary schools: a cluster-randomized trial in western Kenya

Kelly T. Alexander, Robert Dreibelbis, Matthew C. Freeman, Betty Ojeny and Richard Rheingans

ABSTRACT

Water, sanitation, and hygiene (WASH) programs in schools have been shown to improve health and reduce absence. In resource-poor settings, barriers such as inadequate budgets, lack of oversight, and competing priorities limit effective and sustained WASH service delivery in schools. We employed a cluster-randomized trial to examine if schools could improve WASH conditions within existing administrative structures. Seventy schools were divided into a control group and three intervention groups. All intervention schools received a budget for purchasing WASH-related items. One group received no further intervention. A second group received additional funding for hiring a WASH attendant and making repairs to WASH infrastructure, and a third group was given guides for student and community monitoring of conditions. Intervention schools made significant improvements in provision of soap and handwashing water, treated drinking water, and clean latrines compared with controls. Teachers reported benefits of monitoring, repairs, and a WASH attendant, but quantitative data of WASH conditions did not determine whether expanded interventions out-performed our budget-only intervention. Providing schools with budgets for WASH operational costs improved access to necessary supplies, but did not ensure consistent service delivery to students. Further work is needed to clarify how schools can provide WASH services daily.

Key words | budget, handwashing, monitoring, school sanitation and hygiene, service delivery, water

ABBREVIATIONS

SMC School Management Committee
WASH Water, sanitation, and hygiene

INTRODUCTION

It is estimated that millions of school-days are lost each year due to diarrhea or other illnesses (UNDP 2006; Haller & Hutton 2007). There is evidence that improving access to water, sanitation, and hygiene (WASH) facilities at school can improve health and reduce absence. Intensive hand-washing promotion at schools has been shown to

significantly reduce absenteeism due to diarrhea (Freeman *et al.* in press), respiratory infections (Bowen *et al.* 2007), and conjunctivitis (Talaat *et al.* 2011). Primary schools in Kenya with treated water revealed a substantial difference in student absence compared with those without treated water (O'Reilly *et al.* 2008; Blanton *et al.* 2010). There is some evidence that the benefit of school WASH may be greater for girls than for boys (Freeman *et al.* 2012a).

Many schools in low-income countries lack WASH facilities (UNICEF 2012); those that do have these facilities cannot, or do not, sustainably provide WASH services to students and staff on a regular basis throughout the school

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year (Snel 2004; Bolt *et al.* 2006; Saboori *et al.* 2011). We define basic WASH services as the daily inputs required to enable handwashing with soap, treated drinking water, and private, comfortable latrine use. It is not uncommon to find dirty or poorly functioning school latrines (Njuguna *et al.* 2009; Dube & January 2012), reducing student use (Ekpo *et al.* 2008; Cameron 2009; Njuguna *et al.* 2009; Dube & January 2012). Soap for handwashing is rarely found in schools in these settings (Ekpo *et al.* 2008; Njuguna *et al.* 2009; Xuan *et al.* 2012), and materials for anal cleansing are effectively absent (McMahon *et al.* 2011a; Xuan *et al.* 2012). Use of sanitation facilities, without water and soap for handwashing, may put students at a higher risk of exposure to pathogens (Greene *et al.* 2012).

There are several possible reasons for poor WASH services in schools. An assessment of sustainable school WASH provision in western Kenya found 56% of schools with broken taps on handwashing containers, restricting the school's ability to provide water to students 2.5 years after being provided by an intervention program. (Saboori *et al.* 2011). School budgets were identified as a barrier to tap, soap, and chlorine repurchase. In Vietnam, limited school budgets were the primary cause of inconsistent latrine maintenance and lack of anal cleansing materials (Xuan *et al.* 2012). A World Bank Water and Sanitation report found that teachers from schools in Peru and Vietnam are over-burdened and report not having time to supervise the delivery of school WASH services (Dutton *et al.* 2011). Efforts to strengthen both the quality of education and the sustainability of community water supplies are more effective when community members and the intended beneficiaries are involved in monitoring and oversight (Harvey & Reed 2006; Kendall 2007; Banerjee *et al.* 2008; Björkman & Svensson 2009; Kremer & Holla 2009; Lassibille *et al.* 2010).

In this cluster-randomized trial, we assessed improvements in conditions and provision of WASH services as a result of interventions addressing school budgets, monitoring and accountability, and maintenance. Through a series of formative research activities and small pilots, we identified specific challenges that influenced service provision. These included: limited budgets for purchasing supplies for water treatment, soap and latrine cleaning; lack of technical capacity to repair and maintain infrastructure; and lack of oversight by and time for teachers and school staff

(Dreibelbis 2012). Through targeted, small-scale interventions addressing these challenges, we intended to identify replicable and scalable models for improving WASH service delivery in primary schools in Kenya.

METHODS

Study design

Schools participating in this trial were recruited from the pool of past participants in a series of action-research projects documenting the health and educational impact of school-based WASH interventions in western Kenya. Eligible schools were those that had not been involved in research or intervention activities since 2009 and comprised 185 schools that participated in an initial randomized trial (Dreibelbis *et al.* in press; Freeman *et al.* 2012a). As part of the initial trial, schools had received some combination of: (1) handwashing and water treatment interventions using WaterGuard™ – a sodium-hypochlorite solution manufactured and marketed by Population Services International, (2) additional school latrines, or (3) water supply improvements that benefited both the school and the associated community. In total, 96 of the 185 schools were eligible for participation in the current study (Figure 1), and 70 were randomly selected; this was the maximum sample feasible due to logistical constraints. The 70 primary schools were recruited and randomly assigned to one of three intervention groups ($n = 15$ schools per group) and one control group ($n = 25$) prior to the baseline survey. We over-allocated the control group to account for the challenge of multiple comparisons.

Interventions

Intervention models were piloted in nine schools between February and April 2011 (Dreibelbis 2012) and refined based on feedback from key stakeholders, including school officials, teachers, implementing partners and students. The **Budget** intervention included a financial disbursement of approximately 0.44 USD per student. This amount was based on an estimate of the daily operational costs associated with providing WASH services in primary schools and consistent with existing national enrollment-based

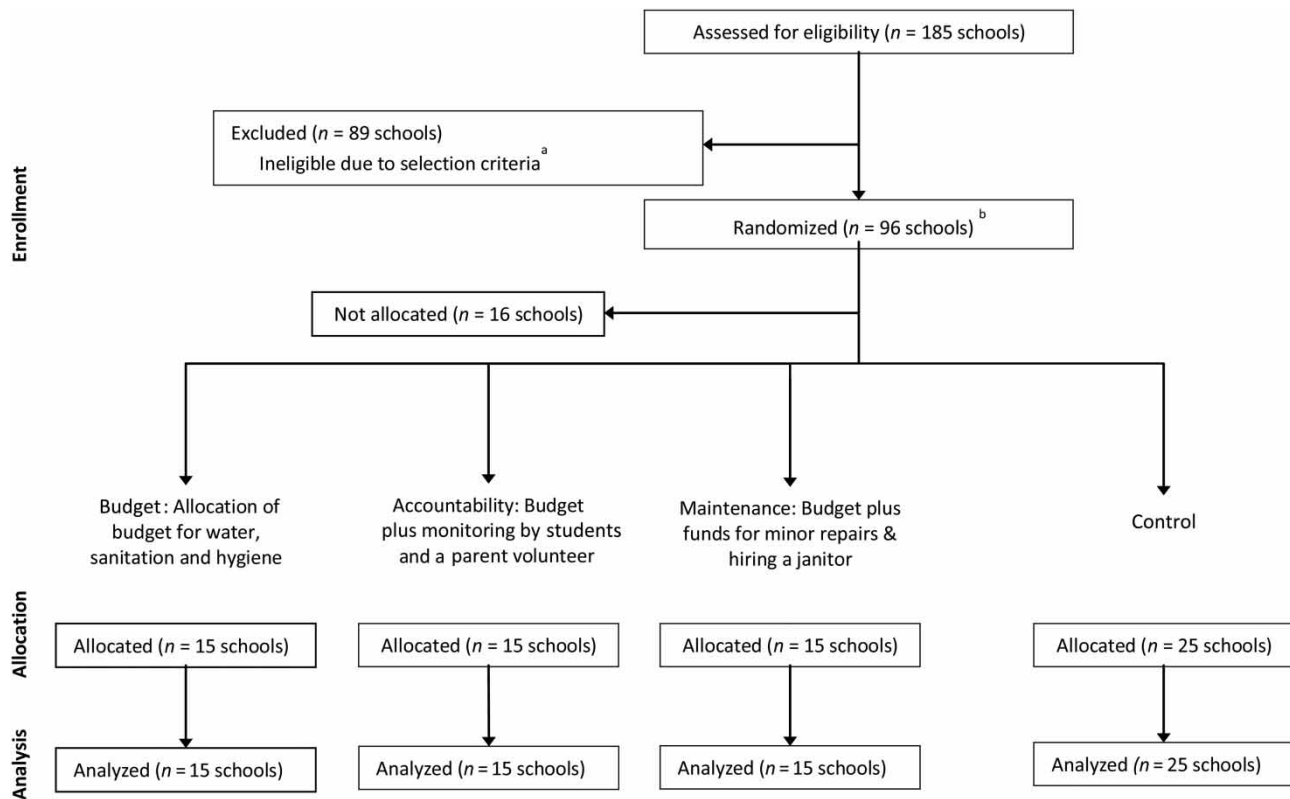


Figure 1 | School selection. ^a Selection criteria were schools that had not been involved in implementation or research activities for 2 years. ^b Selection was stratified across three geographic clusters covering contiguous administrative divisions in six districts (Nyando, Kisumu Districts; North and South Rachuonyo Districts; Suba and Mbita Districts).

budgeting practices (Gallo *et al.* 2012). All intervention schools ($n = 45$) received this component.

The **Accountability** intervention included the monetary package described above plus a set of monitoring tools for use by students, adapted from a previous trial (Caruso 2012). Accountability schools also received information on how to engage a parent to monitor WASH conditions using a pre-prepared monitoring tool and represent health issues to the school management committee (SMC), the parent-teacher body responsible for budgets and general management of the school. This parent's position, referred to as the SMC representative, was voluntary and received no remuneration from the school. Fifteen schools received the Accountability intervention in addition to the Budget intervention described above.

The **Maintenance** intervention included the monetary package plus an allocation of approximately 60 USD for minor repairs of existing infrastructure. Maintenance schools were also given the option to employ a part-time WASH attendant and receive an additional allocation of approximately 120 USD to cover the stipend. The WASH

attendant could be tasked with latrine cleaning, water collection, or other similar duties. Of the 45 intervention schools, 15 received the Maintenance intervention in addition to the Budget intervention.

Our study was designed to assess differences in WASH service provision between each intervention package and a control school. Specifically, we tested whether each of these above described intervention packages could result in measurable improvements in the quality of school latrines, rainwater-harvesting systems, and other school infrastructure, and consistently maintain clean latrines, proper handwashing facilities, and treated drinking water.

Implementation

Following baseline data collection and intervention allocation in May 2011 staff from CARE Kenya, an international non-governmental organization, scheduled appointments with school officials and parents to discuss the intervention assigned to their school. In all 45 intervention schools, trained

moderators from CARE distributed budget templates and told the group 37 KES (Kenyan shillings; approximately 0.44 USD) per student would be deposited in their school account in the coming weeks. The moderator told the group that the money was for 'WASH supplies,' covering any item the school officials deemed necessary to provide 'WASH services' to students, including – but not limited to – handwashing soap, brooms, replacement taps, or cleaning supplies. Schools were expected to make a budget according to their specific needs and priorities. For the Maintenance intervention schools, the moderator introduced the additional intervention components: funds for completing minor repairs of WASH infrastructure and the hiring of a WASH attendant. Schools also received implementation guidelines. For Accountability schools, a moderator led the school officials and parents on a one-time structured walk-through and discussion of school WASH facilities and then introduced the additional intervention components: student monitoring and SMC representative. Multiple paper copies of both student and SMC monitoring sheets were left with Accountability schools. Financial disbursements to schools were made as a single payment to school accounts in early June 2011; amounts were calculated according to student population figures collected at baseline. Because some intervention schools experienced delays due to clerical or banking errors, the completion of the intervention was considered to be the end of June 2011.

Data collection

Surveys

WASH conditions at the school were evaluated at baseline (May 2011) and monitored four times over a period of 16 weeks (July 11th–October 28th). There was a period of 8 weeks when there was no data collection due to school breaks and teacher strikes. The survey included spot checks of school latrine quality and cleanliness, water availability, soap availability, and current stock of WASH supplies. Water in containers was tested for total chlorine using orthotolidine (OTO) solution (Hatch, Loveland, CO, USA). Latrine-specific observations included the presence and functionality of a door, locks on doors, and observations related to the latrine conditions. Rainwater-harvesting system information was collected separately for each storage tank, and included

observations on the conditions of the tap, tank, and gutters. The head-teacher provided information on water sources and school enrollment. Post-implementation surveys included additional questions about supplies purchased, and questions specific to the Maintenance and Accountability interventions. Data collection was unannounced, and the day of the week and time of day were altered between rounds.

Interviews

After the final survey, field staff completed a series of in-depth and semi-structured interviews with stakeholders at each intervention school. This included 56 in-depth interviews at the 30 Maintenance and Accountability schools and one structured interview at each of the 15 Budget schools. Topics covered in the interviews included the budgeting process, challenges, benefits, and observed outcomes of the interventions.

Data processing and analysis

The survey data were entered and stored in Microsoft Excel and analyzed with SAS v9.2 (Cary, NC, USA). We identified a number of possible indicators of WASH service provision at schools that served as the outcome measures for quantitative analysis. At the school level, these included objective binary indicators of the presence of handwashing water, soap, and chlorinated water available for students at the time of data collection; presence of supplies for cleaning school latrines, and stored supplies of water treatment products and soap for handwashing. A second set of outcome measures was associated with school rainwater-harvesting systems, which was analyzed at the level of the collection tank and its associated gutter system. Our third set of outcome measures related to school latrine conditions, analyzed at the level of the specific stall. A functioning door on a latrine stall was defined as a door that closed completely and had a lock on the inside. For each latrine stall, observations ranking specific cleanliness characteristics (smell, feces, internal cleanliness, pooled water, and/or urine) on a scale from 0 (absent) to 2 (very smelly, lots of feces, etc.), were summed to create a cleanliness score ranging from 0 to 8. Scores demonstrated acceptable internal consistency at baseline ($\alpha = 0.74$) and were used for all subsequent analyses (Portney & Watkins 1999).

Frequency and means for all outcome measures were compared for each intervention group against controls at baseline and across all four follow-up data collection rounds. Statistical significance comparing outcome measures in the intervention and control groups was conducted using the PROC GENMOD function. The log-link, Poisson-distribution with robust standard error estimates was used for binary outcome indicators and converted to prevalence ratios (Zou 1994). Continuous outcome measures, such as latrines cleanliness score, were modeled as traditional linear outcomes, and regression betas interpreted as the mean difference in the outcome of interest compared with controls. For all models, the REPEATED statement was used to adjust standard errors for multiple observations of the unit of analysis (school, rainwater-harvesting system, latrines).

For structured interviews, detailed notes were handwritten and then typed into Microsoft Word. The 56 in-depth interviews from the 30 Accountability and Maintenance schools were recorded. Study staff transcribed and translated interviews from Dholuo to English. MAXQDA v10 (Berlin, Germany) was used for coding data and creating themes according to research objectives. Although in-depth interviews and structured interviews were analyzed independently, conclusions were drawn across both types of data when themes overlapped. Where possible, observation data from facility surveys were compared with qualitative data to check for consistency.

Ethical considerations

Free and informed oral consent was obtained from all participants prior to data collection. The names of participants were not recorded. This study was reviewed and approved by the Ethical Review Committee at the Great Lakes University of Kisumu, Kenya and the Institutional Review Board at Emory University, Atlanta, USA.

RESULTS

Baseline

Key school WASH characteristics were similar across study groups at baseline (Table 1). The average population of

students across all schools was 342. Student latrine ratios were slightly higher than the Kenyan government standards of 25:1 for girls and 30:1 for boys (Kenya 2009). Across all school groups, 60 (86%) head-teachers reported access to protected water sources, all within 1,000 m. We found a smaller proportion of schools with access to an improved water source in the Maintenance intervention group. Forty-eight (69%) schools provided some water for student handwashing. Two schools (3%) provided soap to students for handwashing and 12 (17%) schools had detectable chlorine residual in at least one water container. At 43 (61%) schools, head-teachers reported using rainwater as their main water source for drinking and/or handwashing, and the majority of rainwater-harvesting systems had tanks in good condition with gutters properly connected. A functioning tap on a rainwater-harvesting tank was seen on 66 (45%) tanks across all study groups. Latrine door and cleanliness conditions were similar across all groups, except the Budget group which had better conditions at baseline.

Intervention fidelity

Presence of basic WASH supplies (including: soap, chlorine for water treatment, and materials for cleaning latrines) was assessed as part of routine data collection and their presence used to estimate intervention fidelity. As expected, schools in each intervention group were more likely to have WASH supplies than control schools. Disinfectant, soap, chlorine, buckets, and brooms were the most common WASH supplies observed in intervention schools (Table 2). Chlorine for water treatment was the only item that was seen in every intervention school at some point during the follow-up period, and was observed the most often: 78% of visits in Accountability schools, 82% in Budget schools, and 93% in Maintenance schools. Forty-two (93%) intervention schools had soap at some point during the follow-up period and 41 (91%) schools had disinfectant at some point during the follow-up period. Fourteen (31%) intervention schools reported using funds to replace taps on water containers. Although relatively expensive, 10 schools elected to use some of their budget to purchase sanitary pads, and 12 schools bought toilet paper.

All 15 Accountability schools installed an SMC representative and had actively engaged students in monitoring

Table 1 | Baseline characteristics of intervention and control schools^a

	Control	Budget	Accountability	Maintenance
General characteristics	<i>n</i> = 25	<i>n</i> = 15	<i>n</i> = 15	<i>n</i> = 15
Total population	304 (111)	363 (113)	340 (134)	362 (142)
Percentage girls	49 (4)	51 (4)	48 (3)	50 (3)
Nursery population	67 (38)	81 (33)	74 (26)	58 (26)
Girls:latrine ratio	33 (15)	30 (13)	38 (20)	34 (12)
Boys:latrine ratio	36 (19)	37 (16)	32 (10)	36 (17)
Improved water source	23 (92%)	13 (87%)	13 (87%)	11 (73%)
Water containers	<i>n</i> = 25	<i>n</i> = 15	<i>n</i> = 15	<i>n</i> = 15
HW upon arrival	16 (64%)	13 (87%)	10 (67%)	9 (60%)
Soap upon arrival	1 (4%)	1 (7%)	1 (7%)	0
DW upon arrival	16 (64%)	14 (93%)	12 (80%)	9 (60%)
Chlorine residual in at least one water container	2 (8%)	5 (33%)	3 (20%)	2 (13%)
Rainwater-harvesting systems	<i>n</i> = 53	<i>n</i> = 32	<i>n</i> = 29	<i>n</i> = 33
Has gutters	45 (85%)	28 (88%)	25 (86%)	25 (76%)
Gutters connected to tank	45 (85%)	26 (81%)	18 (62%)	19 (58%)
Tap in good condition	29 (55%)	13 (41%)	11 (38%)	13 (39%)
Tank in good condition	46 (87%)	26 (81%)	23 (79%)	31 (94%)
Latrines	<i>n</i> = 228	<i>n</i> = 167	<i>n</i> = 162	<i>n</i> = 157
Latrine stall has a door	187 (82%)	145 (87%)	126 (78%)	118 (75%)
Door functions	73 (32%)	72 (43%)	41 (25%)	42 (27%)
Latrine cleanliness score	4.6 (2.1)	5.2 (1.9)	4.7 (2.0)	4.7 (2.2)

^aData are mean (SD) or number (%).

HW: handwashing water; DW: drinking water.

Table 2 | Percentage of visits where specific WASH supplies were observed at intervention and control schools during the follow-up period

	Control (<i>n</i> = 25) %	Budget (<i>n</i> = 15) %	Accountability (<i>n</i> = 15) %	Maintenance (<i>n</i> = 15) %
Chlorine	12	82	78	93
Soap	3	60	65	82
Disinfectant	0	57	65	80
Bucket	2	65	68	83
Brooms	1	35	62	58
Filter cloth	0	3	15	15
Handbrush	0	0	35	15
Toilet tissue	0	20	23	12
Sanitary pads	1	5	20	8

school WASH facilities as evidenced by completed monitoring forms. However, the number of trained students and the frequency of monitoring visits to the school by the SMC representative varied greatly. Officials in 12 (80%) of the Maintenance schools decided to hire a WASH attendant, and all schools spent money on making minor repairs.

Drinking water and handwashing

All schools in all groups increased provision of school drinking water and handwashing facilities (Table 3). Compared with control schools, intervention schools were more likely to have drinking water (Budget: risk ratio [RR] 1.4, 95% confidence interval [CI] 1.1–1.9; Accountability: RR

Table 3 | Comparison of water container outcomes between intervention and control schools during the follow-up period

Indicator	Control (<i>n</i> = 25)	Budget (<i>n</i> = 15)				Accountability (<i>n</i> = 15)				Maintenance (<i>n</i> = 15)			
	%	%	RR	95%CI	<i>P</i>	%	RR	95%CI	<i>P</i>	%	RR	95%CI	<i>P</i>
HW upon arrival	61	88	1.3	1.2–1.7	0.003	95	1.4	1.2–1.7	<0.001	90	1.4	1.1–1.6	0.01
DW upon arrival	68	93	1.4	1.1–1.9	0.006	98	1.6	1.2–2.0	<0.001	90	1.6	1.1–1.9	<0.003
Soap upon arrival	10	50	5.5	2.5–12.0	<0.001	42	4.5	2.0–10.3	<0.001	50	5.4	2.4–12.4	<0.001
Chlorine residual in at least one container	21	77	3.6	2.1–6.3	<0.001	67	3.2	1.9–5.3	<0.001	58	2.8	1.5–5.1	<0.001
Functioning tap on at least one container	72	92	1.3	1.1–1.5	0.015	100	1.4	1.2–1.6	<0.001	92	1.3	1.1–1.5	0.015

HW: handwashing water; DW: drinking water.

RR: risk ratio estimate; *P*-value of Poisson regression coefficient of difference between intervention group and control.

1.6, CI 1.2–2.0; Maintenance RR 1.6, CI 1.1–1.9) and handwashing water (Budget: RR 1.3, CI 1.2–1.7; Accountability: RR 1.4, CI 1.2–1.7; Maintenance: RR 1.4, CI 1.1–1.6) available for students at the time of data collection and much more likely to have soap available for students (Budget: RR 5.5, CI 2.5–12.0; Accountability: RR 4.5, CI 2.0–10.3; Maintenance RR: 5.4, CI 2.4–12.4). The magnitude of effect was similar for all intervention groups for our indicators of drinking water and handwashing service provision.

Drinking water treated with chlorine and soap at handwashing stations was not always consistent with having chlorine and soap in stock. Among schools where soap was in stock, soap was observed at handwashing containers and available to students only 56% of the time. Among schools with water treatment supplies, drinking water tested positive for chlorine 68% of the time.

Rainwater-harvesting systems

During the follow-up period, 56 (80%) schools reported using rainwater as their main source, an increase over baseline. We did not find evidence that the intervention improved rainwater-harvesting systems (Table 4). The number of tanks with gutters connected and number of functioning taps increased in Maintenance schools compared to baseline levels, but differences between intervention and controls during the follow-up period were not statistically significant. In follow-up interviews, respondents at 12 (27%) intervention schools reported making improvements

to their rainwater-harvesting system, including replacing taps and fixing gutters.

Latrine quality and conditions

Latrine cleanliness improved in all groups. In the follow-up period, mean latrine cleanliness score was 5.3 (standard deviation [SD]: 1.9) in control schools with measurable increases in Budget (β 1.2, 95% CI 1.1–1.2), Accountability (β 1.2, CI 1.1–1.2), and Maintenance schools (β 1.1, CI 1.1–1.2) (Table 4). During the follow-up period, a larger proportion of latrines in the Maintenance group had fully functioning doors compared to controls (RR 1.6, CI 1.3–2.0). There was a decline in the proportion of latrines with a fully functioning door in control schools and Budget schools compared with baseline assessments.

Interview data

Use of funds for minor repairs

Among the Maintenance group, the most common use of the funds for minor repairs was the replacement of taps on water containers and rainwater-harvesting tanks, and hinges or locks on latrine doors. A number of schools used funds for slightly larger projects such as cementing a latrine floor or paying a repairman to re-align the rainwater gutters. Teachers commented that the minor repairs were important improvements. At schools where repairs were

Table 4 | Comparison of rainwater-harvesting and latrine conditions for intervention and controls schools during the follow-up period

Indicator	Control (n = 25)			Budget (n = 15)			Accountability (n = 15)			Maintenance (n = 15)		
	Mean	RR	P	Mean	RR	P	Mean	RR	P	Mean	RR	P
Tank has gutters	91%	0.9	0.455	86%	0.9	0.8–1.1	84%	0.9	0.8–1.1	83%	0.9	0.8–1.1
Gutters connected to tank	84%	0.9	0.7–1.1	74%	0.9	0.7–1.1	72%	0.8	0.6–1.0	76%	0.9	0.7–1.1
Tap in good condition	65%	0.9	0.7–1.2	62%	0.9	0.7–1.2	50%	0.7	0.5–1.0	59%	0.9	0.7–1.2
Tank in good condition	85%	0.9	0.8–1.1	82%	0.9	0.8–1.1	88%	1	0.9–1.2	86%	1	0.9–1.2
Latrine stall has a door	86%	1	0.9–1.0	85%	1	0.9–1.0	81%	0.9	0.8–1.0	84%	1	0.9–1.0
Door functions	50%	1.4	1.1–1.7	39%	1.4	1.1–1.7	50%	1.1	0.8–1.4	49%	1.6	1.2–1.9
Latrine cleanliness score	5.3 (1.9)	1.2 ^a	<0.001	6.2 (1.9)	1.2 ^a	1.1–1.2	6.0 (1.8)	1.2 ^a	1.1–1.2	6.0 (1.9)	1.1 ^a	1.1–1.2

Data are mean % or latrine score (SD).

RR is risk ratio estimate;

^aBeta estimate.

P-value of Poisson regression coefficient of difference between intervention group and control.

made to latrine doors, respondents reported that everyone, especially the girls, now felt more comfortable when using the latrines. As explained by one head-teacher:

‘Especially after the repairs were done ... you see, some of the doors were ... not lockable from inside. And therefore, especially the girls were not safe to use those, the latrines with faulty doors. But after the repairs were made, they were very free. And therefore there’s nothing that is disturbing them.’

Two Maintenance schools used funds to empty some pit latrines. Few schools (across all intervention groups) had a plan for what they would do when current latrine pits are full.

Monitoring

Nearly all head-teachers said that students reported problems to the teacher on duty when they found latrines dirty or soap missing. Although respondents from all Accountability schools reported electing parents to be SMC representatives, some head-teachers said their SMC representative was often too busy to come to school to monitor. In schools with active representatives, teachers noted the following benefits: increased transparency, more parents will become aware of the challenges at school, the SMC representative will teach parents about clean water and latrines and ‘keep teachers on their toes’.

WASH attendant

Among the three schools that did not hire a WASH attendant, officials expressed concern for sustaining payments to the attendant at the end of the project. In all Maintenance schools, there was initial skepticism about finding someone to clean latrines for minimal pay due to local taboos related to latrine cleaning and handling fecal material. Nearly every school hired a parent who was ‘most needy’ to do the job, often a widow from the local community. WASH attendants mainly cleaned latrines, while some also collected water. Due to the limited stipend available, many WASH attendants were employed part-time, coming two to three times per week to thoroughly clean latrines, while students cleaned them on the other days.

Head-teachers and SMC chairpersons at the 12 implementing schools all reported the improved condition of the latrines. One head-teacher noted:

‘Actually the latrines are now clean, the students that used to go outside the fence [since the latrines were dirty] are now visiting the latrines. Also it gives time for the students to stay in classrooms in the morning hours instead of spending a bit of their time in washing the latrines.’

Many reported that WASH supplies were used more conservatively by the WASH attendant than students and that cleaning was more thorough. Teachers appreciated that they had more time since the WASH attendant required minimal supervision. Respondents reported a number of benefits to having a WASH attendant, including: children spend more time in class due to less time collecting water or cleaning and children have less exposure to feces and cleaning chemicals. Some drawbacks expressed about hiring a WASH attendant were that children will not use latrines properly if they do not have to clean them; children are already accustomed to water collection and latrine cleaning and uncertainty about what the school would do when the trial ends.

DISCUSSION

To our knowledge, this is the first study that assesses the impact of low-cost financing, in conjunction with other interventions, to improve provision of school WASH services. Compared to controls, all intervention schools succeeded in improving water treatment, latrine cleanliness and access to handwashing services for students over the 16-week study period. These findings suggest that addressing recurrent costs for school WASH programs is effective in expanding access to basic WASH services. A cost of 0.44 USD per student per year enabled schools to cover operational costs for providing functional water containers, chlorinated water, soap, and clean latrines to students. With an estimated primary school population of 9.7 million, this would equate to 4.2 million USD per year for national coverage, less than 0.3% of Kenya’s estimated education budget of

1.7 billion USD for 2009 (Migele *et al.* 2007; Albonico *et al.* 2008; Omwami & Omwami 2009).

Our mixed-methods study provided important information on budgeting and expenditure priorities at the local level. In addition to the basic WASH supplies, 20% of intervention schools bought sanitary pads and 25% bought toilet paper; emphasizing the high value of these products despite their relatively high unit cost. Recently menstrual management has received increased attention in Kenya through proposed allocations to schools for sanitary pads (Gathigah 2011; Kaberia 2012). Studies have underscored the importance of menstrual management and hygiene issues on attendance and comfort of girls in schools (Sommer 2010; McMahon *et al.* 2011b). Expanding access to appropriate anal cleansing materials in schools in western Kenya is needed and male and female students agree toilet paper is the best option (McMahon *et al.* 2011a). While our findings suggest that minimal funds for recurrent WASH costs can significantly enhance services and conditions for students, the amount of 0.44 USD per student is insufficient to provide essential items such as toilet paper and sanitary pads, items which may positively impact a healthy school environment and children’s overall school-going experience.

A fully functioning, lockable latrine door is an essential component of providing a clean, private environment for children’s urination and defecation. That improvements in functioning doors – a relatively inexpensive repair – were isolated to our maintenance intervention group alone suggests that even low-cost physical repairs are not adequately reflected in budgets that are based on recurrent costs alone. Larger capital investments that exceed budgets based on recurrent costs are necessary even for minor infrastructure improvements. Beyond fixing doors, our survey data did not demonstrate marginal improvements in other aspects of WASH infrastructure despite reports that money was spent on items such as labor, cement, taps, and gutters. Our data collection and analysis systems may not have been sensitive enough to minor changes to infrastructure, such as upgrading one latrine floor or straightening a gutter. Qualitative data from our interviews with school officials portrayed minor repairs as important improvements that enhanced reliability of a water supply, facilitated handwashing, or increased the number of operational latrines.

A recent study in Kenya found that students are more likely to use sanitation facilities at school when latrines or urinals are clean (Freeman *et al.* 2012b).

Despite having soap and water-treatment in stock, provision of chlorinated water and handwashing soap for students remained inconsistent. One reason could be that teachers are not motivated to spend extra time facilitating WASH or that the teacher responsible for WASH is absent. A study on teacher incentives found that Kenyan primary school teachers were in the class and teaching only 45% of the time, pointing to overall poor occupational motivation (Kremer & Holla 2009). Another challenge for schools in consistently providing handwashing soap is that students may be pocketing the bar soap; soapy water (powdered soap mixed with water in a plastic bottle) is a practical alternative (Saboori *et al.* 2010). It is also feasible that water was treated, but treated incorrectly. In an evaluation of school-based water treatment and hygiene promotion in Kenya, O'Reilly *et al.* (2008) found that 35% of trained students did not know proper water-treatment dosage. A study by McLaughlin *et al.* (2009) concluded that there need to be follow-up training in intervention communities where water chlorination techniques are introduced.

The hiring of a WASH attendant did not result in meaningful improvements in latrine cleanliness compared to the funding-only intervention. Two school-based WASH studies involving janitors found that provision of school janitors did not result in differences of latrine conditions (Mathew *et al.* 2009; Njuguna *et al.* 2009). The students may have cleaned the latrines as effectively as the attendant, or our tool for assessing latrine conditions may not have been sensitive enough to identify additional improvements in cleanliness. Follow-up interviews suggest that there are benefits associated with hiring an attendant beyond cleanliness. These include a reported reduction in student time outside the classroom, less time that teachers are required to monitor and supervise student chores, and more efficient use of cleaning supplies leading to long-term savings for the school.

We do not know the impact of student and parent monitoring on WASH service provision since Accountability schools did not out-perform other intervention groups for outcomes such as water chlorination, soap provision, and

cleanliness of latrines. A study on sustainability of sanitation and hygiene in Zimbabwe by Whaley & Webster (2011) suggests that visits from outsiders (such as our field staff) can have a positive impact on behavior change. Across all schools, including controls, we saw some level of improved conditions compared to baseline. Whether WASH-facility monitoring is done by an organization, a local government official, or by a combination of students and parents, there is likely to be improved delivery of WASH services in schools.

Limitations

Although visits were unannounced, school officials and students were generally aware of routine data collection. While schools may have maintained facilities more diligently than normal due to routine follow-up, this effect likely occurred across all study groups and was not confined to schools receiving interventions.

In the Accountability schools, results related to the SMC representative were limited by the short length of the trial and too few SMC meetings. One challenge at many Maintenance schools was that the WASH attendants did not work daily, and students were still involved in latrine cleaning or water collection. Although many head-teachers saw this sharing of duties as a benefit since students were learning to care for facilities, our intention was to absolve the students of latrine cleaning.

The design of our intervention was based on budgeting and resource-disbursement practices by the Government of Kenya. In the current system, schools are given money, calculated on a per-student basis, which is allocated in loosely defined budget categories such as 'Electricity, Water and Conservancy', 'Contingency' and 'Activities'. SMCs are expected to make a budget and spend funds according to school priorities. Because this was the model we followed, all 45 intervention schools spent their budget differently. As such, interventions resulted in minor variations in outputs both between and within study groups. However, our intervention did allow us to identify local priorities in funding and allowed schools to tailor new resources to their specific circumstances. Further, given the short time-frame for this study, it is not clear what the long-term

implications are for increased budgets on maintenance of WASH facilities.

Multiple follow-up rounds over a short period of time allowed us to maximize information from our sample, but presented unique challenges to data analysis. We have minimized the longitudinal aspect of our data collection by adjusting standard errors for repeated observations of the same units over time, but have not specifically accounted for temporal trends in our analysis. Many of our outcome measures, such as provision of water for drinking or latrine cleanliness, are highly mutable and variable over time. Other measures, such as presence of a door on a latrine or condition of a rainwater tank, are less variable across time. For those indicators with less variability, our analytic approach could result in larger effect measures compared to those with greater variability. However, only conditions of latrine doors proved to have a significant association with intervention activities.

CONCLUSIONS

Our study was designed to assess the extent to which equipping schools with additional financial, technical and personnel resources could improve WASH conditions in schools. Across all intervention groups, we found that overall service delivery of WASH in schools improved. With limited guidance and oversight, schools were able to make a WASH-budget, purchase supplies, and deliver clean water, soap, and improved latrine conditions to students. Additional funding for minor repairs, employing a janitor, and monitoring by students and parents, were all seen by schools as positive interventions and beneficial to the WASH program, although these investments only demonstrated marginal improvements in infrastructure quality over the study period. Provision of these funds and services could be considered with other cost-effective interventions, such as urinals, to offset high capital costs of expanding sanitation infrastructure (Cairncross *et al.* 2010; Freeman *et al.* 2012b). Future studies are needed to investigate why daily services such as chlorinated water and soap were not always delivered to students, even when resources such as water, soap, and water treatment products were available at the school.

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