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## Evaluation of SaTo Pans as a New Latrine Technology in Kisumu County Healthcare Facilities, Kenya

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### Abstract

**Objectives:** Innovations to improve public sanitation facilities, especially in healthcare facilities (HCFs) in low-income countries, are limited. SaTo pans represent novel, largely untested, modifications to reduce odor and flies and improve acceptability of HCF sanitation facilities. We conducted a pilot project to evaluate acceptability, cleanliness, flies, and odor within latrines in 37 HCFs in Kisumu, Kenya, randomized into intervention (SaTo pan modifications) and control arms by sub-county and HCF level.

**Methods:** At baseline (pre-intervention) and endline (>3 months after completion of SaTo pan installations in latrines in intervention HCFs), we surveyed users, cleaners, and in-charges, observed odor and cleanliness, and assessed flies using fly tape. Unadjusted difference-in-difference analysis compared changes from baseline to endline in patient-reported acceptability and observed latrine conditions between intervention and control HCFs. A secondary assessment compared patient-reported acceptability following use of SaTo pan versus non-SaTo pan latrines within intervention HCFs.

**Results:** Patient-reported acceptability of latrines was higher following the intervention (baseline: 87%, endline: 96%,  $p = 0.05$ ). However, patient-reported acceptability was also high in the control arm (79%, 86%,  $p = 0.34$ ), and the between-arm difference-in-difference was not significant. Enumerator-observed odor declined in intervention latrines (32% to 14%) compared with controls (36% to 51%, difference-in-difference ratio: 0.32, 95% confidence interval: 0.12, 0.84), but changes in flies, puddling of urine, and visible feces did not differ between arms. In the secondary assessment, fewer intervention than control latrines had patient-reported flies (0% v 26%) and odor (18% v 50%), and reported satisfaction was greater. Most cleaners reported dropholes and floors were easier to clean in intervention vs. controls; limited challenges with water for flushing were reported.

**Conclusions:** Our results suggest SaTo pans may be acceptable by cleaners and users and reduce odor in HCF sanitation facilities, though challenges exist and further evaluation with larger sample sizes is needed.

### Keywords

latrine; sato pan; sanitation; public health; healthcare facilities; water, sanitation, hygiene (WASH)

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### Introduction

Poor water, sanitation, and hygiene (WASH) conditions in healthcare facilities (HCFs) increase the risk of healthcare-associated infections (HAI) through contaminated water, food, hands, medical equipment, and other objects (1). Poor sanitation services not only affect conditions for disease transmission, but also patient satisfaction and dignity. Studies among patients in HCFs in several sub-Saharan African countries have found high rates of patient dissatisfaction with sanitation facilities, often involving substandard cleanliness, with evidence of suppressed care-seeking behavior (2). However, barriers to basic sanitation—especially flush toilets—include high construction costs, inadequate availability of or capacity for sewage treatment, water scarcity, and inadequate resources for maintenance and repair (3,4). Additionally, aesthetic challenges (cleanliness, presence of flies, poorly maintained facilities) are also obstacles to adequate services and optimal use of latrines (5). Low-cost sanitation innovations might improve sanitation in HCFs where facilities are present yet sub-standard or poorly maintained. To date, household settings have largely been the focus of such innovations, and evidence regarding sanitation innovations for HCFs, which have different needs than private homes, is lacking.

SaTo pans (LIXIL Corporation, Tokyo, Japan) are “Safe Toilet” fiberglass inserts for latrine slabs that are relatively inexpensive, can be manufactured in low-income countries, and can be mounted on existing latrine slab openings, with some models requiring less than 1L of water to “flush” urine and excreta via a counterweighted trapdoor (Figure S1). SaTo pans are designed to reduce odor, reduce flies, and improve the overall experience of using latrines; however, there have been few formal assessments of SaTo pans, most of which were in household settings where they have been marketed. For example, surveys in Uganda found high customer satisfaction in households (6), while assessment of flies, odor, and smell in Ethiopia was limited due to issues with installation and latrine slab surfaces (7). Though there is interest in expanding use to include sanitation facilities in HCFs (8), SaTo pans have not been evaluated for their potential to improve user experiences in public or shared facilities generally, or their appropriateness in HCFs specifically. Public toilets may have a larger volume of users, who are not familiar with the SaTo technology, and other considerations that make it different than a private home.

The objectives of this pilot project conducted in public HCFs in two sub-counties in Kisumu, Kenya were to: 1) assess whether SaTo pans in public latrines in HCFs reduced latrine flies and odor and improved cleanliness compared to latrines without SaTo pans; 2) describe whether SaTo pans are acceptable to use by patients and feasible to manage by HCF staff.

Results from this evaluation can inform the applicability of SaTo pans in public sanitation facilities and provide insight into considerations for improving sanitation in HCFs.

## Methods

### Study sites and sampling

Implementation of the intervention and evaluation assessment visits were conducted by the Safe Water and AIDS Project (SWAP), a local public health non-governmental organization, with technical support from the U.S. Centers for Disease Control and Prevention (CDC). The intervention and evaluation took place in all 37 public HCFs (as of March 2019) within the rural sub-counties of Nyando (N=18) and Nyakach (N=19) in Kisumu County, Kenya. These sub-counties were selected based on their proximity to SWAP, HCF management request for sanitation improvements to existing pit latrines, and the agreement to participate from county and sub-county Health Management Teams. HCFs were classified by public health officials into four service levels: dispensaries, health centers, sub-county hospitals, or county hospitals. Stratified by level and sub-county, half of HCFs were randomly assigned the intervention arm (N=18) and half to the control arm (N=19) using random number generation in Microsoft Excel (Microsoft, Redmond, WA, USA). Midway through the study, two HCFs from the control arm were lost to follow-up and excluded due to latrine collapse (one HCF) and closure from flooding (one HCF).

### Study design

For the intervention, existing pit latrines in HCFs were modified with a low-flow SaTo pan insert (9), installed by a local artisan following manufacturer's instructions (example in Figure S1). This SaTo pan model required 200mL for flushing, less water than other models (9). For the "primary" assessment (main outcomes), visits occurred in March 2019 ("baseline", prior to SaTo pan installation) and in April 2020 ("endline", >3 months after completion of SaTo pan installations, Figure 1) and included HCF assessments (close-ended questionnaires and HCF observations), surveys with users and cleaners and fly trapping and counting. Two pairs of enumerators each conducted surveys and HCF and latrine observations and a separate pair of enumerators conducted fly counting. All enumerators were trained and supervised during assessment visits by researchers from SWAP.

To conduct a "secondary" assessment of patient latrine preferences, delivery of the intervention was staggered within intervention HCFs to allow for surveys with latrine users who had the opportunity to use either an intervention-modified latrine or an unmodified latrine within a single HCF. The secondary assessment visit occurred October-November 2019, >3 months after installation of SaTo pans in half the dropholes of each latrine block in intervention HCFs.

Interventions took place in June 2019, when SaTo pans were installed in 34/57 latrines in intervention HCFs, and in January 2020, when SaTo pans were installed in the majority of remaining latrines in intervention HCFs, totaling 61/71 latrines. The 10 latrines in the intervention arm without SaTo pans installed were in 7 HCFs where the administration

requested one or more latrines remain without a SaTo pan to avoid the need for flushing in the event of water shortages.

### HCF assessments

As part of primary assessment visits, enumerators surveyed management (i.e., doctor or nurse in-charge or clinical health officer) about WASH conditions at HCFs using a close-ended questionnaire, followed by visual observation of HCF grounds and latrines. The questionnaire was adapted from the Water, Sanitation, and Hygiene Facility Improvement Tool (WASH FIT) developed by the World Health Organization as well as from previous assessments conducted by the US Centers for Disease Control and Prevention and IRC WASH (10,11) and included questions about staffing, patient volume, water supply, sanitation facilities, and handwashing stations near latrines. Enumerators also observed conditions of each eligible latrine: presence of a strong odor inside or outside the latrine compartment, puddling of urine or stagnant water inside the compartment; and intact feces on the floors or drophole (Supplementary Questionnaire 2). A latrine was eligible for observation if it had not been decommissioned and if it was able to be unlocked at the time of the assessment visit.

### Surveys with users and cleaners

In primary assessments of latrine acceptability, patients (users) and cleaners participated in close-ended questionnaires. Patient questionnaires included questions about acceptability and rating of HCF latrines. Questionnaires for cleaners included questions about cleaning frequency, materials, and preferences. All patients over the age of 18 who were present the day of the survey and reported ever having used HCF sanitation facilities were eligible for inclusion in the survey. To obtain a convenience sample of patients seeking a variety of healthcare services offered by HCFs, at least five patients per HCF from outpatient and inpatient (if any) waiting areas were invited to participate. For the cleaning staff survey, enumerators invited all cleaning staff members present on the day of the survey to participate. In the secondary assessment of side-by-side latrine preference, patients were asked about conditions and rating of HCF latrines following use of either a latrine modified with a SaTo pan or an unmodified latrine. Questionnaires were developed in English, translated into Dholuo, and administered using SurveyCTO (Dobility, Cambridge, Massachusetts, USA) to allow surveys to be administered using tablets and for participants to choose their preferred survey language.

### Fly Assessments

A roll of brightly colored sticky fly tape (RESCUE! Non-toxic Fly Tape, Sterling International Inc., Spokane, WA, USA) was hung vertically in each eligible pit latrine in the HCFs on the day of the fly assessment visit. The placement of the tape was as near to the drophole as possible without obstructing latrine use or the door. Staff returned after approximately 24 hours and counted the total flies, the number of *Chrysomya* (latrine flies), and the number of *Musca domestica* (house flies). Backup photographs were taken of fly tapes, and verification of fly counts was conducted on a subset of 10% of fly tapes.

## Analysis

For primary assessments, we compared HCF demographic and WASH characteristics, latrine conditions, fly counts, and patient and cleaner responses from baseline to endline, separately within each arm, using Chi-square tests for frequencies (or Fisher's exact test if low expected cell counts), Mann-Whitney-Wilcoxon test for scales and counts, and t-tests for continuous measures. In the secondary side-by-side assessment, patient response frequencies were similarly compared by recent latrine use (SaTo pan vs. unmodified).

Additionally, in the primary assessment, difference-in-difference analysis was used to model changes from baseline to endline in the odds of patient acceptability and the proportion of latrines with the following characteristics: enumerator-reported odor, visible urine, visible feces, and any vs. no latrine flies caught. To account for clustering and repeat observations within the same HCF, logistic regression with generalized estimating equations (GEE) was used for patient acceptability and modified Poisson regression with GEE was used for latrine observation and fly counting outcomes. Proportions of latrines were estimated at the HCF-level using the count of latrines with a chosen characteristic and the log total number of eligible HCF latrines as the model offset. An interaction term of arm (intervention vs. control) and assessment round (endline vs. baseline) was used to estimate difference-in-difference ratios. To avoid overfitting the limited data, multivariable models were not developed. Regression analyses were run using SAS (version 9.4; SAS Institute), and descriptive analyses were run using R (version 3.6.1; R Core Team).

## Ethics

The protocol was approved by the Maseno University Scientific Ethics Review Committee (MUESRC) and the National Commission for Science, Technology, and Innovation (NACOSTI) prior to the start of evaluation (MUESRC proposal reference number: MSU/DRPI/MUERC/00658/19; NACOSTI reference number: NACOSTI/P/19/80422/27315). The CDC Institutional Review Board reviewed and determined that this activity was non-research because it was a programmatic evaluation (protocol reference number: 011819DB). Verbal consent was obtained prior to participation in surveys and no compensation was provided to participants.

## Results

### HCF characteristics (primary assessment)

We assessed 112 functional latrines at baseline (intervention, n=57; control, n=55) and 132 at endline (intervention, n=71; control, n=61) for odor and cleanliness, and 123 functional latrines at baseline (intervention, n=60; control, n=63) and 128 at endline (intervention, n=70; control, n=58) for number of flies trapped. Construction of new latrines and decommissioning of latrines in HCFs account for differences in the number of latrines between baseline and endline, and availability to be unlocked on the day of assessments account for differences within rounds in the number of latrines assessed for odor and cleanliness and the number assessed for flies trapped.

The median numbers of daily inpatients and outpatients, total staff, and the cleaning staff did not differ from baseline to endline in either the intervention or control arm (Table 1a). Almost all main water sources for HCFs (>94%) were onsite: mostly rainwater harvest (>65%), followed by borehole water. Feces (animal or human) was observed on the grounds of most intervention (89% at baseline, 75% at endline) and control (77% at baseline, 71% at endline) HCFs (Table 1b). In both arms, weather temperatures at HCFs were hotter, and HCFs had more days since the last rainfall at baseline compared to the endline.

### **Acceptability surveys: patient, cleaner, and in-charge (primary assessment)**

Patient ratings of latrines in the HCF (on a scale from very poor (1) to very good (5)) did not vary between baseline and endline in either arm (Table 1c). Overall, the percentages of patients who found latrines acceptable for use was high for both control HCFs (endline: 86% vs baseline: 79%,  $P=0.34$ ) and intervention HCFs (96% vs. 79%,  $P=0.05$ ), where acceptability was significantly higher at endline. Among cleaners surveyed (Table 1d), the reported proportion of toilets cleaned at least once a day did not vary from baseline to endline in either arm.

At endline, 78% (14/18) of intervention in-charges wanted to keep all the SaTo pans installed (Supplemental Table 2). When comparing SaTo pans to traditional latrines, most cleaners thought SaTo pan dropholes (85%, 17/20) and floors (90%, 18/20) were easier to clean, and most (70%) reported no challenges with the SaTo pans. Among those who reported challenges, issues most frequently involved maintaining and stocking buckets of water for flushing.

### **Side-by-side patient latrine preference (secondary assessment)**

In surveys with patients with the option to use either SaTo pan or traditional latrines within the same HCF, those who recently used traditional latrines reported flies more often (26% vs. 0%;  $P<0.01$ ), more frequent odor (50% vs. 18%;  $P=0.02$ ), and lower satisfaction scores (median 3 vs. 4,  $P=0.02$ ) than those who recently used latrines with SaTo pans (Supplemental Table 1). A greater proportion of SaTo pan users chose to use that latrine out of preference (less smell, cleaner, or interest) than did traditional latrine users (46% vs. 16%;  $P<0.01$ ), who mostly chose traditional latrines out of convenience.

### **Latrine characteristics, cleanliness, odor, flies (primary assessment)**

Overall, across arms, feces and puddling were observed in 11%-47% of latrines (at baseline) and 6%-38% (at endline); frequencies did not differ between baseline and endline by arm (Table 2). Enumerators reported strong odor in fewer intervention latrines at endline than baseline (14% vs. 32%,  $P=0.03$ ), while no difference was reported in the control arm (51% vs. 36%,  $p=0.17$ ). The percentage of latrines with any *Chrysomya* flies trapped ranged from 13-35%, while the percentage of latrines with any *Musca domestica* ranged from 2-5%. Median numbers of flies trapped did not vary between baseline and endline in either arm.



### **Difference-in-difference of patient acceptability, latrine conditions, and fly counts (primary assessment)**

In unadjusted regression analysis, there was no difference-in-difference between arms in patient-reported acceptability (Figure 2). For latrine conditions, the decline in observed odor from baseline to endline in the intervention arm was significant in comparison to the control arm (difference-in-difference ratio=0.32, 95% confidence interval: 0.12, 0.84). There were no difference-in-difference associations for the proportions of latrines with puddling, feces, or latrine flies.

### **Discussion**

Compared to those without SaTo pans, public HCF latrines with SaTo pans had reduced odor, higher patient preference in side-by-side assessments and were perceived by cleaners as feasible to clean. However, there was no measured between-arm effect on cleanliness, the proportion of latrines with flies, or overall patient-reported acceptability. The results from this pilot study suggest that SaTo pans may improve a key toilet condition that affects user experience with limited burden on cleaners in HCFs and other institutional settings. However, further evaluation of cleanliness and flies may be warranted, especially in busier or larger multi-user toilets in public institutions such as schools, markets, or other locations that may not have regular cleaning staff.

This analysis follows on others focusing on willingness to pay, preferences, and acceptability of SaTo pans in Zambia, Bangladesh, Ethiopia, and rural Kenya (12–15); however, it is the first to randomize and test SaTo pans for institutions, rather than households, and objectively assess flies. Shared or public sanitation, as in HCFs, encompasses more first-time or single-use users than households where repeated behaviors and habits can be developed, and therefore may require different, more intensive behavior change and management structures (16,17). This assessment also evaluated acceptability not only by users but also by cleaning staff, an invaluable and often under-resourced member of safe healthcare delivery (18).

There was a decrease in odor after the installation of SaTo pans, which may be due to the SaTo pan installation itself or changes in sanitation facilities cleaned at least once per day (85% at endline vs. 68% at baseline for intervention; 68% v 84% for control; non-significant differences). Odor is an important factor that may affect the use of and disgust with sanitation facilities; reducing odor may improve feelings of privacy and dignity for users (19–22). Notably, odor was measured by study enumerators, who could not be blinded to the presence of the intervention, and most latrines in both arms were ventilated improved pit (VIP) latrines, and therefore may have had a low baseline odor. There were no differences in observed cleanliness of latrines with and without SaTo pans, as measured by visible feces or puddles of urine or water, which suggests the odor reported was likely from the pit itself.

In HCFs where SaTo pans were installed, patient-reported acceptability was higher after installations, but this change was not significantly different from the trend in patient-reported acceptability in control HCFs. This may have been due to relatively high levels

of patient-reported acceptability at baseline in both arms (87% and 79%). However, in a side-by-side comparison, latrines with SaTo pans were more preferable than those without SaTo pans. Even while acceptability was high, users of household SaTo pans have reported issues related to noise produced by the trapdoor shutting after use (23), and so this design may lead to potential privacy issues for users in HCFs or other public settings. Although WASH conditions at healthcare facilities have not been consistently associated with patient care-seeking behavior specifically, WASH provisions—and in particular, satisfaction and cleanliness of sanitation facilities—are consistently associated with patient satisfaction with care (2). Low-cost modifications designed to improve the quality of pit latrine user interfaces, such as SaTo pans, but also more regular cleaning as well as other maintenance like emptying and safe disposal, should be considered in order to maintain patient satisfaction with overall healthcare services (24).

Cleaner-reported challenges with cleaning the SaTo pan, compared with control facilities, were rare and, in most cases were related to the bucket used to hold water for flushing and not the SaTo pan itself. These results underscore the ease of cleaning the SaTo pan itself if toilet users adhere to instructions for use. However, challenges or inability to provide water for flushing for users of public toilets, may in turn contribute to the deterioration of toilet conditions and user acceptability. Access to onsite water from improved sources is 74% in HCFs globally (25) and may be important for the success of maintaining clean toilets with SaTo pans (>94% of HCFs in our assessment had onsite water). The need for manual refilling of flushing water containers in latrine compartments may also increase burdens for cleaners and require security measures, additional funding, and instruction to ensure storage containers are maintained and not stolen or accidentally broken (26,27). These considerations apply not only to HCFs but to other institutional public toilets.

We did not observe a reduction in the presence of flies in SaTo pan; however, fly counts were low in both arms, and user-reported flies in the toilet were significantly lower in intervention toilets in the secondary side-by-side assessment. The low level of flies could have been attributable to the high coverage of VIPs, other latrine factors, or season (28,29). Although there are no clear data linking increased fly burden to illness in HCFs, flies can transmit feces and fecal pathogens and have been tied to diarrheal illness in household settings (30,31). Although our regression analysis was aggregated to HCF-level proportions of latrines with any flies present—and not individual toilet-level analyses due to logistical challenges with matching latrines at baseline and endline—latrine flies have an average radius of 500m-1km and thus are not limited to individual latrines themselves (32). Full coverage of SaTo pans in HCFs should reduce access to sources of fecal matter for fly breeding in the pit itself, as in other studies with high improved sanitation coverage (33); however, visible feces on the grounds of HCFs were common (>70% of HCFs) in both arms. The effect of SaTo pans should be further assessed in settings with a greater number of latrine flies.

One of the main limitations of this study was the small sample size, which precluded adjustment of potential confounders, such as HCF type and size, by which sanitation conditions and patient experiences may vary, in models assessing key study outcomes. Additionally, we were unable to match latrine-level conditions at baseline and endline,



precluding a latrine-level analysis. Because users and enumerators were not blinded to latrine type, reported conditions may have been biased towards SaTo pans due to social desirability or courtesy bias (34,35).

These results suggest SaTo pans may be an acceptable alternative to an open pit-latrine according to users, cleaners, and in-charges in HCFs, especially in areas where sewerage or septic tank infrastructure is not available. However, the benefits of a positive user experience, ease of cleaning, and reduction in odor, must be weighed against the costs and burden of additional water for flushing and the need to ensure appropriate use via instructional sessions or other behavior change strategies for users unfamiliar with novel designs. Further evaluation at a longer term and larger scale, with the ability to assess by different HCF or location types, of SaTo pans in public sanitation facilities should be undertaken to document these challenges and benefits more completely.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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## Disclaimer

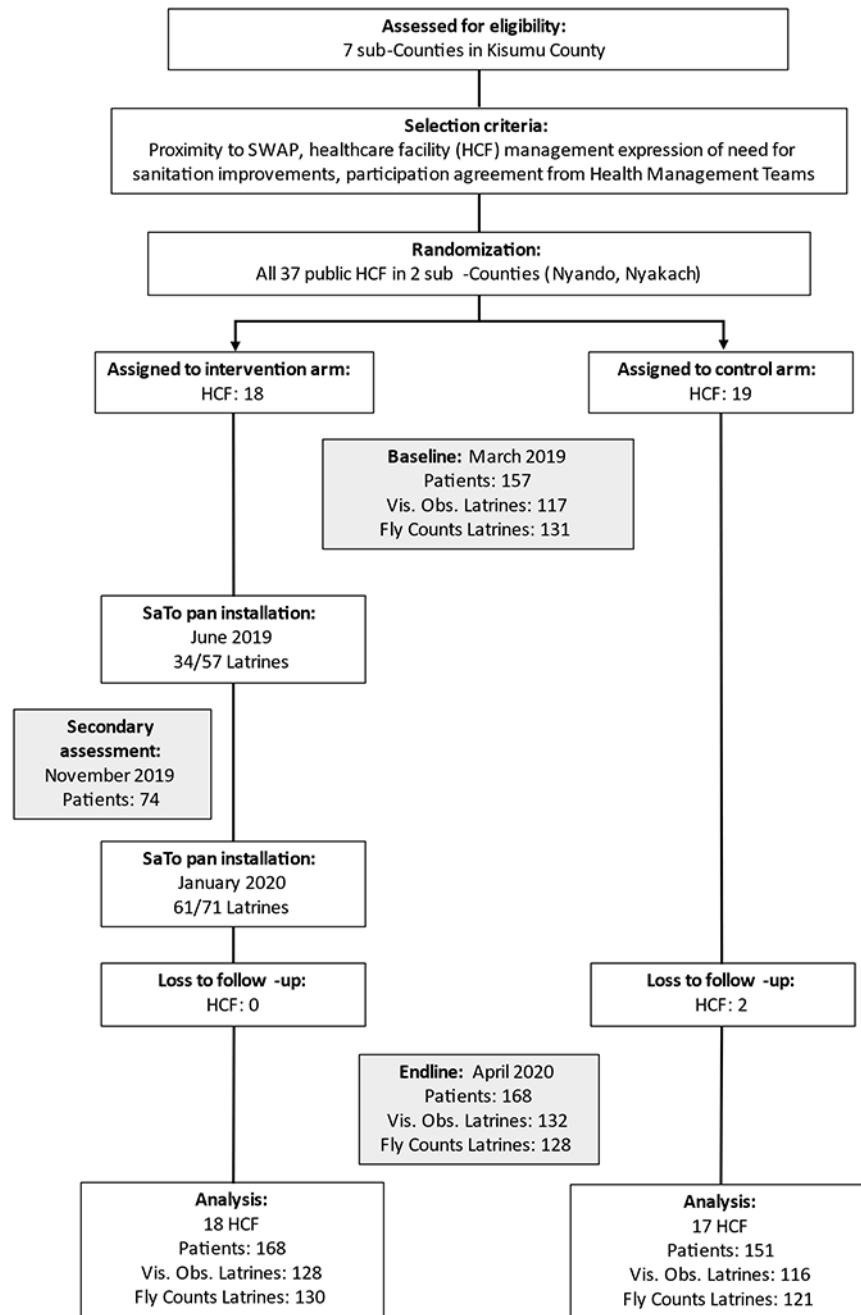
The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of U.S. Centers of Disease Control and Prevention

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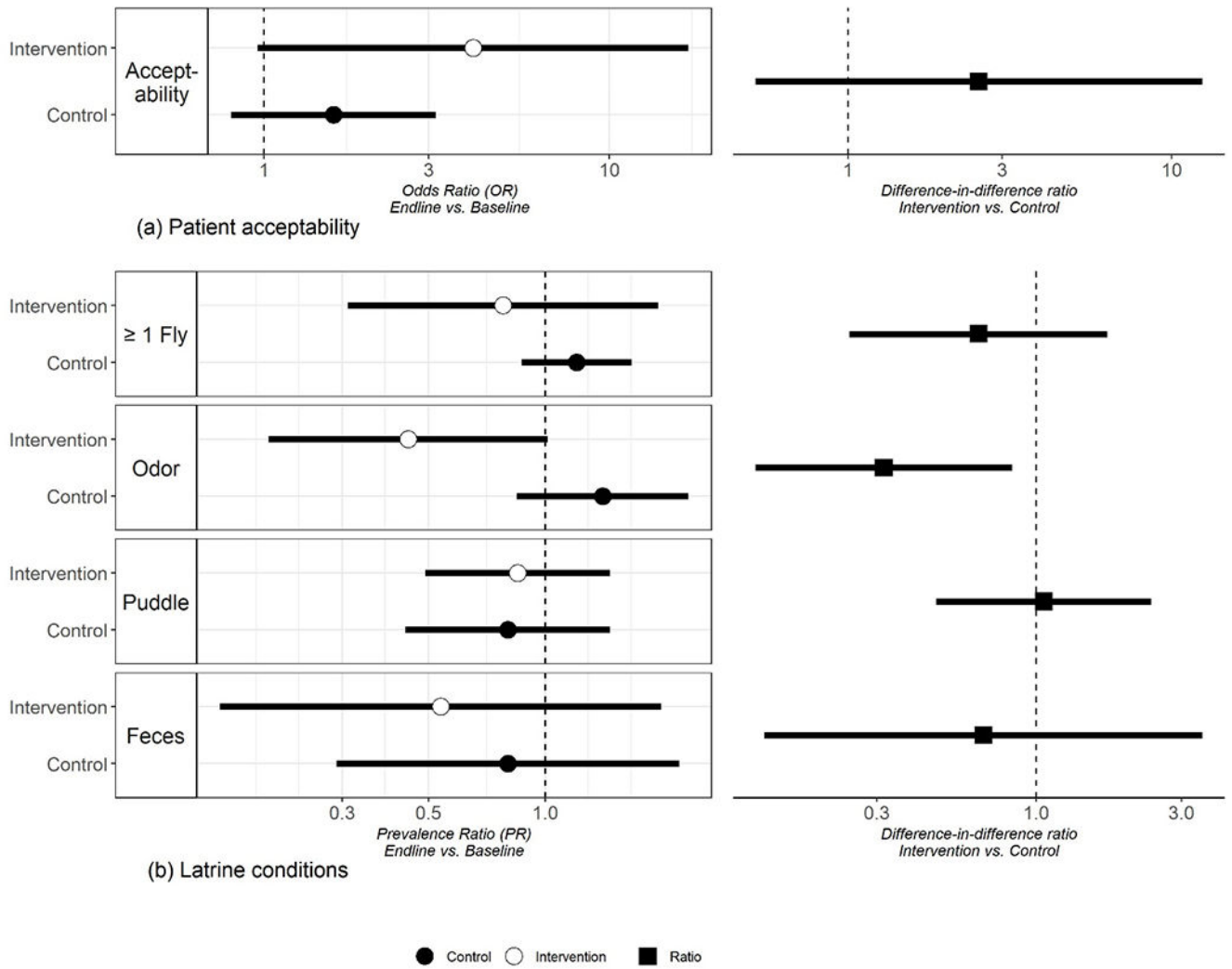
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**Figure 1.** Study flow diagram of installation of SaTo pans in healthcare facility pit latrines and assessment visits



**Figure 2.** Odds ratio of patient acceptability (a) and prevalence ratio of latrine conditions (b) (fly, odor, puddle, or feces) at endline to baseline, by intervention and control groups

**Table 1.**

Comparison of healthcare facility characteristics, patient acceptability, and cleaning frequency from baseline to endline within intervention and control arms

	Intervention HCFs N=18			Control HCFs =17		
	Baseline	Endline	P value	Baseline	Endline	P value
<b>a) Characteristics of facilities</b>						
Type of facility (%)						
<i>Hospital/sub-county</i>	5 (28)	5 (28)	--	6 (35)	6 (35)	--
<i>Health center</i>	9 (50)	9 (50)		8 (47)	8 (47)	
<i>Dispensary</i>	4 (22)	4 (22)		3 (18)	3 (18)	
Median number functional toilets [IQR] <sup>1</sup>	2 [2-3.8]	3.5 [2-4.8]	0.19	2 [2-3]	3 [2-5]	0.44
Median number outpatients/day [IQR]	28 [18-34]	30 [11-46]	0.89	30 [25-40]	22 [2-40]	0.21
Median number inpatients/day (hospitals) [IQR] <sup>2</sup>	5 [2-10]	2 [0.75-3.8]	0.31	6 [3.5-16]	9 [5.5-20]	0.70
Median number all staff [IQR]	19 [14-24]	26 [19-39]	0.12	21 [14-33]	16 [15-31]	0.86
Median number cleaners [IQR]	1 [1-2.2]	1 [1-2]	0.69	1 [1-2]	2 [1-2]	0.34
Typical main water source type (%)						
<i>Piped water (tap or standpipe)</i>	0 (0)	1 (5.9)	1.00	0 (0)	2 (12)	0.36
<i>Borehole</i>	4 (22)	3 (18)		4 (24)	3 (18)	
<i>Rain water harvest</i>	13 (72)	13 (77)		11 (65)	12 (71)	
<i>Surface water</i>	1 (5.6)	0 (0)		2 (12)	0 (0)	
Does main source ever have interruptions (%)	13 (72)	8 (47)	0.24	10 (59)	8 (47)	0.73
Access point for main source (%)						
<i>Onsite</i>	18 (100)	16 (94)	0.49	16 (94)	17 (100)	1.00
<i>Within 500m of facility grounds</i>	0 (0.0)	0 (0.0)		1 (5.9)	0 (0.0)	
<i>Outside facility grounds</i>	0 (0.0)	1 (5.9)		0 (0.0)	0 (0.0)	
<b>b) Environmental conditions of facilities</b>						
Visible feces (human or animal) on grounds of HCF (%)	16 (89)	12 (75)	0.39	13 (77)	12 (71)	1.00
Median number of days since last rainfall at time of assessment [IQR]	1 [1-2]	0 [0-1]	<0.01	1 [1-3]	1 [0-1]	<0.01
Median temperature at time of assessment <sup>3</sup> [IQR]	29 [28-31]	22 [22-27]	<0.01	28 [27-30]	23 [21-24]	<0.01
<b>c) Patient report</b>						
Number surveyed	<i>n=84</i>	<i>n=84</i>		<i>n=67</i>	<i>n=84</i>	
Median response on a scale of 1 (very poor) to 5 (very good, what do you think about the toilets at this HCF? [IQR]	4 [3-4]	4 [3-4]	0.76	4 [3-4]	4 [3-4]	0.24
Are latrines at this HCF acceptable for use (yes/no)? (%)	73 (87)	81 (96)	0.05	53 (79)	72 (86)	0.39
<b>d) Cleaner report</b>						
Number surveyed	<i>n=30</i>	<i>n=20</i>		<i>n=32</i>	<i>n=19</i>	
Toilets cleaned at least once a day (%)	20 (67)	17 (85)	0.26	27 (84)	13 (68)	0.29

<sup>1</sup> Interquartile range

<sup>2</sup> Median and interquartile range (IQR) given for County and sub-county hospitals only

<sup>3</sup> Median temperature at time of assessment significantly differed between arms at baseline (p-value: <0.01). No other characteristic different significantly between arms at baseline.



**Table 2.**

Comparison of latrine conditions and fly numbers from baseline to endline within intervention and control arms<sup>1</sup>

	Intervention			Control		
	Baseline	Endline	P value	Baseline	Endline	P value
<b>Visual Assessments</b>	<i>n</i> =57	<i>n</i> =71		<i>n</i> =55	<i>n</i> =61	
Type of user (%)						
Staff-only	7 (12)	18 (25)	<0.01	9 (16)	13 (21)	<0.01
Patient-only	15 (26)	21 (30)		13 (24)	17 (28)	
Not separated	24 (42)	32 (45)		22 (40)	31 (51)	
Unknown	11 (19)	0 (0.0)		11 (20)	0 (0.0)	
Strong odor (%)	18 (32)	10 (14)	0.03	20 (36)	31 (51)	0.17
Feces on floors or drophole (%)	6 (11)	4 (5.6)	0.34	9 (16)	8 (13)	0.82
Puddle of urine or stagnant water (%)	20 (35)	21 (30)	0.64	26 (47)	23 (38)	0.39
<b>Fly Trap Assessments</b>	<i>n</i> =60	<i>n</i> =70		<i>n</i> =63	<i>n</i> =58	
Ventilated improved pit (VIP) latrines <sup>2</sup> (%)	50 (83)	52 (74)	0.30	40 (64)	29 (50)	0.19
<i>Chrysomya</i> (%)						
Number of latrines with <i>any</i>	10 (17)	9 (13)	0.72	18 (29)	20 (35)	0.66
Median number of trapped, [IQR] <sup>3</sup>	1.0 [1.0-2.0]	2.5 [1.0-9.2]	0.29	1.0 [1.0-4.5]	1.5 [1.0-2.8]	0.85
<i>Musca domestica</i> (%)						
Number of latrines with <i>any</i>	3 (5.0)	3 (4.3)	1	1 (1.6)	2 (3.4)	0.61
Median number of trapped, [IQR] <sup>3</sup>	2.0 [1.5-2.5]	1.0 [1.0-1.0]	0.20	1.5 [1.2-1.8]	2.0 [2.0-2.0]	1

<sup>1</sup>Visual assessments of toilet conditions (presence of odor, feces, urine) and fly trap assessments were conducted on separate days and the number of latrines assessed differed due to accessibility of latrines for assessment

<sup>2</sup>Defined as having a fly vent or guard/screen and vent that reaches through the roof

<sup>3</sup>Reported as zero-truncated median and inter-quartile range (IQR)