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Acceptability of urine diversion dry toilets in Dollo Ado refugee camp, Ethiopia

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ABSTRACT

Given the increasing frequency and duration of humanitarian emergencies worldwide, there is a need to identify a greater range of effective and contextually appropriate water, sanitation and hygiene (WASH) interventions. Typical sanitation systems may be poorly suited for some of the conditions in which humanitarian emergencies can occur, such as in drought-prone regions. Urine-diversion dry toilets (UDDTs) are one potential alternative sanitation option which can be used in these conditions. Between 2014 and 2016, the U.S. Centers for Disease Control and Prevention (CDC) partnered with local agencies to evaluate the acceptability of UDDTs in a refugee camp in Ethiopia. The overall goals were to provide evidence regarding the level of adoption and satisfaction with UDDTs in this emergency context and the factors associated with satisfaction. Two cross-sectional surveys were conducted 18-months apart, using a stratified design to sample UDDT and latrine users for comparison. The proportion who reported to use their UDDT consistently was 88.8% (95% CI 85.1–92.5) in the first survey and 93.4% (95% CI 90.6–96.2) in the second survey. Reported satisfaction levels were significantly higher among respondents in the second survey ($p < 0.0001$), where 97.0% (95% CI 95.1–98.9) of respondents stated either that they were mostly or very satisfied with their UDDT. There was no significant difference detected in satisfaction between UDDT and latrine users ($p = 0.28$). Using a multivariable logistic regression model, we identified several factors associated with a higher level of satisfaction with UDDTs. Those who had previously (before coming to the camp) used a pit latrine (AOR = 4.2; 95% CI 1.4–12.7) or had no sanitation system (AOR = 2.4; 95% CI 1.3–4.4) relative to a pour-flush toilet, had a clean UDDT (AOR = 2.8; 95% CI 1.7–4.6), had been in the camp for a longer time period (AOR = 2.3; 95% CI 1.7–3.0), did not share their UDDT (AOR = 1.8; 95% CI 1.0–3.0) and had used their UDDT for a longer time period (AOR = 1.7; 95% CI 1.2–2.4) had higher odds of satisfaction. The findings demonstrate that UDDTs have been effectively introduced and utilized in this context and this may have implications for other humanitarian settings where they can be similarly managed.

1. Introduction

Humanitarian emergencies, resulting from conflict, natural disasters and disease outbreaks, are increasing worldwide. The number of displaced persons is at an all-time high, with over 79 million people forcibly displaced by the end of 2019 (UNHCR, 2019). Water, sanitation and hygiene (WASH) interventions are critical to sustain life and prevent disease transmission among emergency-affected populations; however, to-date there is a lack of evidence on effective and contextually appropriate WASH technologies and systems for emergencies (Yates et al., 2018). In recent years, there has been an increase in humanitarian emergencies in contexts that pose challenges for traditional emergency sanitation systems (i.e., pit latrines); for example, areas with difficult soil/ground conditions, flooding or a lack of space (e.g., in an urban setting) (Bastable and Lamb, 2012). These challenges are likely to become increasingly common due to effects of climate change (IPCC,

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2012). Therefore, there is a need to identify effective, alternative sanitation options in emergencies, which protect human and environmental health, as well as preserve dignity, privacy and safety of all users (Brown et al., 2012; De Mello et al., 2018).

Urine-diversion dry toilets (UDDTs) offer an alternative to pit latrines in emergency settings (Gensch et al., 2018). Unlike pit latrines, this sanitation technology offers a significantly longer lifespan and smaller footprint as they can be emptied and reused. Therefore, they may offer a promising potential alternative in protracted emergency settings. In these above-ground, dry excreta management systems, urine is diverted at the squat plate and feces is collected in one or two (alternating) vaults under the squat plate (Rieck et al., 2012). Generally, users are instructed to add materials, such as ash, to the UDDT after each use to assist with the desiccation process and minimize odors. When one vault is full, it is closed to allow microbial inactivation, and the other vault is put into use. After desiccation occurs in the stored waste, the contents can be emptied, and the vault is ready to be used again. These toilets are often described as an ecological sanitation or 'ecosan' system, however excreta reuse is not necessarily a design goal for UDDTs.

UDDTs have been in use in a variety of contexts for decades; in 2012, it was estimated that UDDTs were in 84 countries with approximately 2 million users (Rieck et al., 2012). However, with few exceptions, they have only been implemented in any given location on a small scale (i.e., <1000 units) (Rieck et al., 2012; WSP, 2005). One of the cited reasons for this is the increased complexity of correct use and maintenance of these systems, which may be a barrier for users accustomed to conventional sanitation systems (Rieck et al., 2012). There is little information regarding the use of UDDTs in emergency settings. Implementation of these systems on a small scale has been documented after emergencies in El Salvador (1998) and Afghanistan (1995) (Mwase, 2006). More recently, these technologies have been piloted in flood-affected areas of Bolivia, cyclone-affected regions of Bangladesh and the Philippines, in a refugee camp in Chad and at internally displaced person camps in Port au Prince, Haiti (Bastable and Lamb, 2012; Kinstedt, 2012; Delepiere, 2011; Patinet, 2010). While these pilots have primarily documented implementation during the early emergency period, they have not provided evidence regarding UDDT acceptability over time and related contextual factors to inform their appropriate use in emergency settings.

Starting in 2014, the U.S. Centers for Disease Control and Prevention (CDC) partnered with the United Nations High Commissioner for Refugees (UNHCR), Oxfam GB, and the Norwegian Refugee Council (NRC) to evaluate UDDT acceptability in Hiloweyn refugee camp, in the Dollo Ado region of Ethiopia. The overall goals of the evaluation were to provide evidence regarding the acceptability of UDDTs over a two-year period in this protracted emergency context and the potential for use in other refugee camps in Ethiopia or other humanitarian emergencies.

We defined acceptability broadly as adoption and level of satisfaction and developed four primary indicators to evaluate acceptability of UDDTs (Table 1). Our study objectives were to: 1) determine the level of adoption of UDDTs, 2) determine the level of satisfaction of UDDT users and compare to that of pit latrine users, and 3) determine factors contributing to satisfaction among UDDT users, over a two-year period.

CDC designed the evaluation, provided oversight and remote management of data collection and conducted data analysis. UNHCR managed data collection in the field and NRC provided supervision and logistical support to evaluation teams.

2. Methods

The acceptability evaluation included two, repeated cross-sectional surveys of a representative sample of UDDT users and pit-latrine users in Hiloweyn refugee camp. We conducted an initial cross-sectional survey to assess acceptability across the different types of UDDTs in the camp. The second survey was intended to determine whether acceptability changed over time. We included households with latrines in both surveys to draw comparisons with UDDT users.

Table 1
Acceptability evaluation indicators and definitions.

Variables	Indicator	Definition/Measure(s)
Acceptability	*Adoption*	
	Current use (reported)	UDDT use by the respondent in the past 24 h
	Consistent use	UDDT use by the respondent every day
		UDDT use by all household members
	Correct use	Addition of ash after every use
	Level of satisfaction	Likert-type scale (5-point)
Observations	Correct use	Presence of ash bucket
		Ash in the bucket
		Covers down on squat plate
		No foreign objects in vaults
		No foreign objects in urine pipe
		No wet waste in active vault
	Usability (lack of)	Cracks in masonry (slab or walls)
		Doors (entrance or vaults) broken/ damaged
		Urine pipe clogged or broken
		Flies inside UDDT
		Visible waste on floor of UDDT
		Strong odor inside UDDT

2.1. Study setting

The Dollo Ado region in south-eastern Ethiopia is one of the largest refugee operations in the world, accommodating approximately 150,000 persons as of November of 2019. This area has hosted refugees primarily of Somali origin and saw a major influx after the famine in 2011. Hiloweyn refugee camp, one of the five refugee camps in the region, is currently home to approximately 34,000 persons (UNHCR, 2019). Due to the soil conditions in some areas of Hiloweyn camp, which makes pit latrine construction difficult and expensive, Oxfam GB and UNHCR decided to install 140 single-family UDDTs as a pilot program in 2012 (Ngala et al., 2014). As a result of demand generated by social mobilization activities, along with increased need as pit latrines filled, the pilot project was scaled up considerably, with approximately 970 shared-family (two families) UDDTs constructed in three phases (annually) between 2013 and 2015. Oxfam GB managed the first two phases of construction (2013–2014) and NRC managed the third phase of shared UDDT construction, after taking over management of WASH in Hiloweyn camp during 2014. The other distinct sanitation systems in Hiloweyn include communal block pit latrines (4 stalls, each stall intended to be shared by four families (16 families total use each block)), single-family (private) pit latrines and disability-accessible pit latrines. Both Oxfam GB and NRC provided education on correct use to UDDT users (e.g., addition of ash after use) during monthly hygiene promotion activities conducted throughout the camp. NRC also provided buckets for ash (additive material), cleaning kits, as well as tools to help spread the waste within the vault to assist with the desiccation process.

2.2. Survey and sampling design

The sample frame for each survey included all households registered with UDDTs and those registered with a single-family latrine in Hiloweyn camp as of the end of 2014. The lists of registered households were updated one month in advance of each survey. In order to evaluate acceptability among the different types of UDDTs, we used a stratified sampling design to select households from each of four groups: 1) single-family UDDT households from original pilot (2012) (n = 140), 2) shared-family UDDT households from first phase (2013) (n = 1270), 3) shared-family UDDT households from second phase (2014) (n = 260), and 4) single-family latrine user households (as of 2014) (n = 950). This sampling design allowed us to meet our study objectives in a single survey, including the potential effect of time (duration of use) on

acceptability, in the event that a second data collection activity wasn't possible (due to security restrictions). A required sample size of 94 from each group was determined based on the following parameters: limit of statistical significance (alpha) of 0.05 (95% confidence interval), power (1-beta) of 0.8, ability to detect a 20% difference between the hypothesized proportions for satisfaction with sanitation type among the four groups using 50% as the reference proportion. We sampled 420 households (105 from each list), with an expected response rate of 90%.

For both surveys, simple random sampling using Microsoft Excel was used to select a representative sample of households from each group. This strategy was employed over following the same households over time, due to reports of population relocation from Hiloweyn to other camps in Dollo Ado. Additionally, for the same reason, each list was oversampled (i.e., more than 105 households) and supervisors were instructed to continue until reaching the desired sample size (time permitting). Supervisors were instructed to have enumerators return to a household the next day if the targeted respondent was temporarily outside of the home and replace with the subsequent household on the list if the household was abandoned or could not be located.

2.3. Survey questionnaire

In the field, informed verbal consent was obtained, and a standardized questionnaire was administered to the female head of household ((≥18-years old) at each selected household. If the female head was unavailable, the adult male was interviewed if he was familiar with sanitation practices within the home. Verbal consent included full explanation of the purpose of the evaluation, how the information would be used, and potential risks or benefits to the respondent. Importantly, the respondent was informed that their responses would be anonymous and no personally identifiable information (PII) was collected; this was conducted to attempt to minimize social desirability bias.

The questionnaire (see Supplementary Material) included questions on respondent and household demographics, respondent sanitation type (previous and current), as well as sanitation knowledge, attitudes, practices, and satisfaction with current sanitation system. Based on the current primary sanitation type self-reported (i.e., latrine or UDDT), respondents were asked a series of sanitation type-specific questions.

For UDDT users, the questionnaire also included structured observations by the enumerator to assess correct use (6 indicators) and usability (e.g., toilet cleanliness) (6 indicators) of the respondent sanitation system (Table 1). The indicators were developed collaboratively with CDC, UNHCR and NRC; correct use indicators were determined based on educational messages previously disseminated to the users by Oxfam and NRC, and usability indicators focused on structural faults and lack of cleanliness.

2.4. Supervision and field procedures

Before each survey, CDC conducted a 3-day training on survey and field methods, as well as electronic data collection, for enumerators (10), supervisors (3) and survey managers (2). Enumerators were Somali refugees either living in one of the other camps (not Hiloweyn) or within the host community; they were not affiliated with the WASH NGOs who had installed the UDDTs. During each training, the questionnaire was refined and translation/back-translation was completed from English-Somali (local dialect: May May). To test the survey tool and ensure clarity and accuracy, a one-day pilot was conducted in the field following the training. During the survey periods, CDC remotely supervised and did quality control and initial statistics on a daily basis. Data was collected electronically using the open data kit (ODK) application on password-protected Android devices (Samsung Galaxy Tab S). Data were stored locally at UNHCR on secure devices with FIPS 140–2 encryption and transferred daily via secure connection from UNHCR to CDC network.

2.5. Analytical methods

Survey data were analyzed using SAS Version 9.3 (SAS Corporation, Cary, NC) by CDC staff in Atlanta, GA. Wald chi-square was used for univariate analysis and a multivariable logistic regression model was also constructed to determine factors that were associated with satisfaction with UDDTs. For the multivariable logistic regression model, data from both surveys were combined, with a variable created to differentiate from which survey the respondent corresponded (i.e., first or second survey) which was included in the model. With the full dataset, the level of satisfaction was redefined as unsatisfied (combining very, mostly dissatisfied and neutral) and satisfied (combining mostly and very satisfied) for the model. For inclusion in the multivariable regression model, we screened selected variables associated with satisfaction, with $p \leq 0.05$ as the cut-off by Wald chi-square. The selected variables for the model included respondent and household characteristics (demographic variables) as well as previous and current sanitation type, sharing with another family and UDDT cleanliness (i.e., no cleanliness issues observed). Manual forward and backward elimination was performed on the included variables, with the final regression model generated when all variables had $p \leq 0.05$. Finally, two-way interactions were tested on the variables within the final model.

2.6. Ethical considerations

The protocol for the evaluation was subject to ethical review and oversight by the Institutional Review Board (IRB) of the US Centers for Disease Control and Prevention. The IRB board determined that the evaluation was a non-research public health program evaluation activity. Following this internal review at the CDC, the protocol was shared with the Administration for Refugee and Returnee Affairs (ARRA) and approved in Ethiopia prior to implementation.

3. Results

The two surveys were completed in April of 2015 and October of 2016 (18-months apart). In total, 631 and 522 households were attempted, with 397 and 414 household interviews completed during the first and second survey, respectively (Supplemental Material S1). The additional homes were either not located (i.e., unknown) or the families had relocated out of the camp; there were no refusals at either time period when the selected household was located. Over 85% of completed interviews were conducted with the female head of household (86.9% and 87.7% for the first and second survey, respectively).

Although we sampled based on four lists of registered users of various sanitation types, there were differences between the current primary sanitation type reported by respondents and the lists. The overall proportion of UDDT and latrine users was consistent with the

Table 2
Primary sanitation system reported by respondents at the time of the surveys in Hiloweyn.

	April 2015 (n = 397)		October 2016 (n = 414)	
Variable	Frequency	Percent (95% CI)	Frequency	Percent (95% CI)
Block latrine	41	10.3 (7.3–13.3)	19	4.6 (2.6–6.6)
Private family latrine	64	16.1 (12.5–19.8)	88	21.3 (17.3–25.2)
UDDT	**285**	**71.8 (67.3–76.2)**	**303**	**73.2 (68.9–77.5)**
Disability-accessible latrine	2	0.5 (0.0–1.2)	4	0.9 (0.0–1.9)
Other (unspecified)	5	1.2 (0.0–2.0)	0	0.0

sampling strategy, however, there were small differences in reported latrine type (Table 2). For UDDT users, the proportion who reported to share their UDDT and the duration of use was lower than expected in the second survey (Table 3); just over half (51.8%; 95% CI 46.2–57.5) of respondents reported sharing their UDDT (vs expected 67%) and only 34.7% (95% CI 29.3–40.0) of respondents reported using their UDDT for three or more years (vs expected 67%).

Due to the inconsistencies on type of UDDT (single-family vs shared) and reported duration of use, we decided to not analyze on the original strata. Rather, we present main results for all UDDT users for each survey and for single-family UDDT households and shared-family UDDT households (not stratified according to year of construction) of the full dataset to highlight where differences were found.

3.1. Demographics of respondents and households

The major demographical characteristics of the respondents and households are summarized in Table 4. Less than 20% of respondents reported that they were able to read or had completed any level of formal education, over 75% had a child(s) under 5 in the households, and over 65% reported having had no sanitation system (i.e., defecated in the open) in Somalia. However, there were key significant differences in individual and household demographics between the two samples.

The reported ability to read and formal education variables were significantly higher in the first survey. In terms of family composition, there were significantly more families who reported having a child under 5, elderly or disabled family member in the second survey. There were also significant differences among the reported previous sanitation types between two surveys ($p < 0.0001$). In the first survey, one-third of respondents reported previously using an improved sanitation type in Somalia, with pour-flush toilets being the most commonly reported (21.4%; 95% CI 17.4–25.5). In contrast, fewer than ten percent of respondents from the second survey reported previously using an improved sanitation type, with a majority (86.2%; 95% CI 82.9–89.6) reporting to have had no sanitation system (i.e., defecated in the open) in Somalia.

3.2. UDDT adoption and observed condition

Among all UDDT users, more than ninety-five percent of respondents said they currently use their UDDT. The proportion who reported to use their UDDT consistently was 88.8% (95% CI 85.1–92.5) in the first survey and 93.4% (95% CI 90.6–96.2) in the second survey (Table 5).

Less than 35% of respondents reported that all family members use the UDDT (Table 5). Of respondents who reported that some family members did not use the UDDT, over ninety percent reported that a child (s) under five did not use it, followed by a small number of elderly and disabled family members (Supplemental Material S2). There were multiple response options for the reasons why they didn't use them; for the child(s) under five, the most common responses were that they were 'unable to use them', 'afraid to use them' and 'not allowed to use the UDDTs' (Supplemental Material S3). The most common responses for

Table 3
Reported type and duration of UDDT use among UDDT users.

Variable	Percent (95% CI)	
	April 2015 (n = 285)	October 2016 (n = 303)
Share UDDT with another family	68.1 (62.6–73.5)	51.8 (46.2–57.5)
Reported duration of use		
3–5 years	13.0 (9.1–16.9)	34.7 (29.3–40.0)
1–2 years	49.1 (43.3–55.0)	59.4 (53.9–65.0)
6–11 months	21.1 (16.3–25.8)	2.0 (0.4–3.6)
3–5 months	14.0 (10.0–18.1)	1.3 (0.0–2.6)
<3 months	2.8 (0.9–4.7)	2.0 (0.4–3.6)
Average duration of use (years)	1.44[a]	2.32

[a] Denotes a number, not a percent

Table 4
Key demographics of survey respondents and households.

Variable	Percent (95% CI)		p
	April 2015 (n = 397)	October 2016 (n = 414)	
Respondent Characteristics			
Average age of respondent in years[a] (range)	35.4[b] (18–91)	34.9[b] (18–90)	0.53
Ability to read	19.4 (15.5–23.3)	13.5 (10.2–16.8)	0.024
Completed some level of formal education	15.4 (11.8–18.9)	4.6 (2.6–6.6)	<0.0001
Household (HH) Characteristics			
Average family size[a] (range)	6.42[b] (1–15)	6.64[b] (1–13)	0.1984
Average number of years in the camp[a] (range)	3.75[b] (1–5)	5.11[b] (1–6)	<0.0001
Has one or more child < 5 years in HH	75.1 (70.8–79.3)	85.8 (82.4–89.1)	0.0001
Has one or more elderly person in HH	14.9 (11.3–18.4)	23.7 (19.6–27.8)	0.0015
Has one or more disabled person in HH	9.3 (6.4–12.2)	14.0 (10.7–17.4)	0.038
Previous primary sanitation (Somalia)			
Open Defecation	66.8 (62.1–71.4)	86.2 (82.9–89.6)	<0.0001
Pour-flush toilet	21.4 (17.4–25.5)	6.04 (3.7–8.3)	<0.0001
Pit latrine	5.5 (3.3–7.8)	3.4 (1.6–5.1)	0.95

[a] Indicates variables that were consistent between the two surveys or changed with respect to time as expected.
[b] Denotes a number, not a percent.

Table 5
Reported UDDT adoption and observed condition.

	Variable	Percent (95% CI)	
		April 2015 (n = 285)	October 2016 (n = 303)
Reported	Respondent current use	98.3 (96.7–99.8)	96.7 (94.7–98.7)
	Respondent consistent use	88.8 (85.1–92.5)	93.4 (90.6–96.2)
	All family members use the UDDT	34.7 (29.2–40.3)	25.4 (20.48–30.3)
	Correct use of additive (add ash after each use)	85.3 (81.1–89.4)	97.0 (95.1–98.9)
Observed	*Correct use indicators*		
	Presence of ash bucket	97.9 (96.2–99.6)	91.1 (87.9–94.3)
	Ash in the bucket[a]	81.4 (76.9–86.0)	67.0 (61.7–72.3)
	Covers down on squat plate	60.4 (54.6–66.1)	65.0 (59.6–70.4)
	No foreign objects in vaults[a]	91.2 (87.9–94.5	80.5 (76.0–85.0)
	No foreign objects in urine pipe	77.2 (72.3–82.1)	88.4 (84.8–92.1)
	No wet waste in active vault	58.6 (52.8–64.3)	73.3 (68.2–78.3)
	Usability (lack of) indicators		
	Cracks in masonry (slab or walls)	19.6 (15.0–24.3)	9.2 (6.0–12.5)
	Doors (entrance or vaults) broken/damaged	22.1 (17.2–27.0)	12.5 (8.8–16.3)
	Urine pipe clogged or broken	15.8 (11.5–20.0)	10.2 (6.8–13.7)
	Flies inside UDDT	28.1 (22.8–33.3)	17.8 (13.5–22.2)
	Visible waste on floor of UDDT	30.5 (25.2–35.9)	38.6 (33.1–44.1)
	Strong odor inside UDDT	26.3 (21.2–31.5)	16.8 (12.6–21.1)

non-use among elderly and disabled family members was that they were 'unable to use them' (data not shown).

Reported correct use was high (Table 5). The proportion who said they added ash after each use was 85.3% (95% CI 81.1–89.4) in the first survey and 97.0% (95% CI 95.1–98.9) in the second survey. The related observations of these variables, presence of an ash bucket and ash in the bucket, were consistent with the reported results in each survey. However, observed ash in the bucket was only observed at 67.0% (95% CI 61.7–72.3) of UDDTs in the second survey (Table 5).

The six usability indicators showed that the majority of UDDTs did not have structural faults or lack of cleanliness. The most observed structural fault was damaged doors; this was observed in 22.1% (95% CI 17.2–27.0) of UDDTs in the first survey and 12.5% (95% CI 8.8–16.3) of UDDTs in the second survey. The most observed lack of cleanliness indicator was waste on the floor of the UDDT, observed in 30.5% (95% CI 25.2–35.9) of UDDTs in the first survey and 38.6% (95% CI 33.1–44.1) of UDDTs in the second survey (Table 5). The least observed lack of cleanliness indicator was a strong odor inside the UDDT; this was observed in 26.3% (95% CI 21.2–31.5) of UDDTs in the first survey and 16.8% (95% CI12.6–21.1) in the second survey.

There were no significant differences between single-family and shared-family UDDT respondents in the reported current use, consistent use and correct use within the full dataset. However, the proportion who reported that all family members use the UDDT was slightly higher among shared UDDT households (Supplemental Material S4).

Among the six observed correct use indicators, the only significant difference between single-family and shared-family UDDTs was that there was a slightly higher proportion of shared-family UDDTs with an ash bucket present in the UDDT ($p = 0.005$) (data not shown). Among the six observed usability indicators, there were significant differences between shared-family and single-family UDDTs for two of the variables (data not shown). Broken or damaged doors were observed on a higher proportion of shared UDDTs ($p = 0.013$) and a strong odor inside the UDDT was observed on a higher proportion of shared UDDTs ($p = 0.013$). There was also a difference (though not statistically significant) between single-family and shared-family UDDTs for having a clogged or broken urine pipe and presence of flies ($p = 0.07$ and $p = 0.08$, respectively); these proportions were also higher in shared UDDTs.

3.3. Sanitation satisfaction among UDDT users and latrine users

For UDDT users, satisfaction levels were significantly higher among respondents in the second survey ($p < 0.0001$), where 97.0% (95% CI 95.1–98.9) of respondents stated either that they were mostly or very satisfied with their UDDT, compared to 62.8% (95% CI 57.2–68.4) in the first survey (Table 6). In the first survey, approximately one-quarter of UDDT users reported that they were very or mostly dissatisfied with the UDDT, versus only 2.3% in the second survey.

Overall, the single-family UDDT users had a significantly higher proportion than the shared-family UDDT users that were mostly or very satisfied ($p < 0.0001$), with 88.9% (95% CI 84.9–93.0) of single-family UDDT users reporting satisfaction, compared with 75.2% (95% CI 70.7–79.7) of shared-family UDDT users (Supplemental Material S3).

The satisfaction of pit latrine users was collected for comparison. Among pit latrine users, approximately two-thirds of respondents (66.4%; 95% CI 57.3–75.5) stated either that they were mostly or very satisfied in the first survey; in the second survey, this proportion was 88.9% (95% CI 82.9–94.9) (Table 6). Like the reported UDDT satisfaction level, satisfaction of pit latrine users was higher in the second survey ($p < 0.0001$). At either survey, this proportion was not significantly different than the UDDT respondents ($p = 0.28$).

3.4. Factors associated with satisfaction of UDDT

Of the variables tested within the full dataset ($n = 588$), formal education, previous sanitation type, length of time residing in the camp, length of time using UDDT, sharing their UDDT with other families, and cleanliness of the UDDT were significant in univariate analyses (Supplemental Material S5); these were therefore included in the multivariable logistic regression model.

Five factors remained significantly associated with satisfaction in the multivariable model (Table 7). Not having any formal education was the only variable that did not remain significantly associated with satisfaction in the final model. Those who had previously (before coming to the camp) used a pit latrine (AOR = 4.2; 95% CI 1.4–12.7) or had no sanitation system (AOR = 2.4; 95% CI 1.3–4.4) relative to a pour-flush toilet, had a clean UDDT (AOR = 2.8; 95% CI 1.7–4.6), had been in the camp for a longer time period (AOR = 2.3; 95% CI 1.7–3.0), did not share their UDDT (AOR = 1.8; 95% CI 1.0–3.0) and had used their UDDT for a longer time period (AOR = 1.7; 95% CI 1.2–2.4) had higher odds of satisfaction. The most significant associations with a higher level of satisfaction were related to the cleanliness of the UDDT and length of time (years) residing in the camp (both $p < 0.0001$).

Table 7
Multivariable logistic regression model of factors significantly associated with higher satisfaction of current sanitation among UDDT respondents (n = 588).

Variable[a]	Adjusted Odds Ratio	95% Wald Confidence Limits	Wald X^2	p
Previous sanitation type in Somalia				
Pour-flush	ref			
Pit latrine	4.16	1.37–12.66	6.29	0.0121
Field (open defecation)	2.41	1.33–4.36	8.48	0.0036
Cleanliness of UDDT				
One or more of the observed uncleanliness indicators	ref			
None of the observed uncleanliness indicators	2.82	1.72–4.61	17.07	<0.0001
Years in the camp (Increase in satisfaction per year)	2.26	1.69–3.01	30.88	<0.0001
Share UDDT				
Yes	ref			
No	1.76	1.03–3.01	4.28	0.0385
Duration of use of UDDT (Increase in satisfaction per year)	1.71	1.207–2.433	9.06	0.0026

[a] Logistic regression model (n = 588) included the variable for time of survey (April 2015 or October 2016).

Table 6
Current satisfaction level (Percent (95% CI).

	UDDT User		Latrine users	
Response Option	April 2015 (n = 285)	October 2016 (n = 303)	April 2015 (n = 107)	October 2016 (n = 108)
Very dissatisfied	7.7 (4.6–10.8)	1.0 (0.0–2.1)	7.5 (2.4–12.5)	3.7 (0.1–7.3)
Mostly dissatisfied	17.2 (12.8–21.6)	1.3 (0.0–2.6)	15.9 (8.8–22.9)	3.7 (0.1–7.3)
Neutral/No opinion	12.3 (8.5–16.1)	0.7 (0.0–1.6)	10.3 (4.4–16.1)	3.7 (0.1–7.3)
Mostly satisfied	**42.8 (37.0–48.6)**	**13.5 (9.7–17.4)**	**50.5 (40.8–60.1)**	**34.3 (25.2–43.4)**
Very satisfied	**20.0 (15.3–24.7)**	**83.5 (79.3–87.7)**	**15.9 (8.8–22.9)**	**54.6 (45.1–64.2)**

Importantly, there were two, significant two-way interactions between the previous sanitation type variable and both cleanliness and duration of use of UDDT variables in the final model; therefore, the model was run for each previous sanitation type (data not shown). For those who had no access to a sanitation system (i.e., defecated in the open) in Somalia, cleanliness of the UDDT remained significantly associated with satisfaction level ($p = 0.0071$); however, duration of use of UDDT did not. Neither cleanliness nor length of time using UDDT were significantly associated with satisfaction for those who previously accessed a pit latrine. Finally, for those who had used pour-flush toilets in Somalia, both cleanliness ($p = 0.0005$) and duration of use of the UDDT ($p = 0.0044$) were significantly associated with satisfaction level.

4. Discussion

The two, repeated cross-sectional surveys collected information related to UDDT adoption and satisfaction level among UDDT users and latrine users in Hiloweyn refugee camp. Despite some similarities, there were marked differences in the demographics of respondents between the two surveys. Significant differences in terms of ability to read, education level and previous sanitation type indicate that we may have sampled more respondents of urban origin or higher socioeconomic status (in Somalia) during the first survey. While there were no new arrivals to the camp during the study, one possible explanation for this was that the different sampling periods reflected seasonal and/or temporal movement out of the camp for work or otherwise among those of different demographics or origin (personal correspondence). While the average reported duration of use of the UDDT was higher in the second survey, the demographic differences in the samples precluded longitudinal comparison of acceptability as intended based on the study design.

4.1. UDDT adoption and observed condition

The reported adoption of UDDTs was high among all respondents in both surveys, and we did not detect differences in adoption based on whether the UDDT was shared or not. However, a majority of respondents said that the UDDTs were not used by some family members. The non-use of UDDTs among family members was most commonly reported for the child(s) under five. Notably, having a child under five in the home was not associated with respondent satisfaction level (Supplemental Material S5). The non-use of sanitation technologies by certain demographic groups, namely children under 5 years, has been reported elsewhere due to cultural factors (e.g., a belief that children's feces are harmless) (Alemu et al., 2017). However, in our study, the non-use of UDDTs by certain groups was believed to be primarily due to specific instructions by the WASH NGOs that these populations should not use the UDDTs, due to a lack of adaptation of the UDDTs for young children as well as the potential for incorrect use (e.g., adding urine to the dry vault) (personal correspondence). In emergency contexts with a high proportion of these family members, the lack of adaptation for these user groups may important implications on appropriateness of UDDTs for these settings. The issue of lack of adaptation of sanitation systems for young children may not be limited to UDDTs, however, as a study in Kakuma refugee camp among Somali refugees in 2016 noted the same finding for latrines (Nyoka et al., 2017).

In our study, the majority of UDDTs were observed in useable condition based on defined structural and cleanliness indicators at both the April 2015 and October 2016 survey. At the time of the second survey, when most UDDTs had been operational for several years, under 18% had strong odors. This contrasts from an evaluation of a pilot UDDT program in Bangladesh after cyclone response in 2007 and 2009; in this case approximately 40% of UDDTs had odor issues after two years of use (Delepiere, 2011). One contributing factor could be that these UDDTs were in a flood prone area, unlike Hiloweyn camp which is hot and arid. Notably, we did detect some significant differences in the condition of single-family and shared-family UDDTs; broken or damaged doors were observed on a higher proportion of shared UDDTs and a strong odor inside the UDDT was observed on a higher proportion of shared UDDTs. Similar issues with lack of maintenance and upkeep of shared sanitation facilities have been reported from studies in Kenya and South Africa, where a lack of defined and consistent management have been associated with poor condition of communal latrines (Simiyu et al., 2017; Roma et al., 2010). Other researchers examining these factors in India have also observed that these issues may increase with the number of users of shared sanitation facilities (Heijnen et al., 2015).While UDDTs in our study are registered to only two-households, our results indicate that this may still pose maintenance challenges relative to single-family systems.

4.2. Satisfaction level and associated factors

Our findings indicate a high level of acceptability of the UDDTs in this setting. High satisfaction level was also reported among latrine users, and there was no significant difference detected in satisfaction level between UDDT and latrine users. Evidence on acceptability of UDDTs in other settings is primarily from the development context, where both high and low levels of acceptability have been reported. Small development programs introducing UDDTs in Kenya (118 UDDTs), Nepal (~500 UDDTs), and Mozambique (~300 UDDTs) have reported high levels of acceptability after initial barriers (e.g., aversion to excreta handling), reportedly due primarily to strong management and support from local implementing organizations (Uddin et al., 2012; Pradhan, 2008; Van der Meulen et al., 2003). This is consistent with our results, where the overseeing WASH NGOs also provide management and support (e.g., provision of cleaning kits) to the UDDT program in Hiloweyn Camp. On the other hand, low and decreasing acceptability level over time have been reported in large and long-running development programs in eThekwini Municipality, South Africa, where over 74, 000 UDDTs have been implemented since 2001 (Mkhise et al., 2017; Roma et al., 2013). Odor, maintenance issues and excreta handling were most often cited as hurdles to acceptance and effective use of the toilets among users in South Africa, where the beneficiaries were responsible for maintaining their own UDDTs.

There were several factors found to be associated with a higher level of satisfaction with UDDTs in Hiloweyn camp. In particular, those who had some indication of uncleanliness in their UDDT, had been in Hiloweyn (and also used their UDDT) for fewer years and had previously accessed a pour-flush toilet were less satisfied than others. The association with cleanliness as a key factor for acceptability of sanitation is consistent with other sanitation research (Hulland et al., 2015), including within two studies based in rural Ethiopia (Alemu 2017; Ross et al., 2011). The association of time on satisfaction, both in terms of number of years in the camp and duration of use of the UDDT, may indicate that, other factors aside, it took time for certain users in Hiloweyn camp to become accustomed to the UDDT. Increasing levels of adoption over time have been recorded elsewhere in the literature; in a detailed study from Bolivia looking at factors leading to adoption of improved sanitation over time, researchers mapped a myriad of triggers, many of which occur longitudinally (Helegren et al., 2018).

In addition to lower satisfaction among those who had previously used a pour-flush toilet, the two-way interactions in the model indicate different factors associated with satisfaction based on the previous sanitation type used in Somalia. For those that didn't have access to any sanitation system in Somalia, the duration of use of the UDDT was not associated with satisfaction level; whereas for those who had used pour-flush toilets, the duration of use of the UDDT significantly impacted their satisfaction level. In other words, the UDDT was more acceptable after a lesser duration of use for those who had not had any sanitation system previously, compared to those who had used a pour-flush toilet. The influence of context-specific factors on adoption, including the type of sanitation system that a targeted user is familiar with, has been observed in other settings. In a study among urban households in Malawi,

respondents had a strong preference to continue to use or adapt their existing improved sanitation system rather than adopt a new ecosan system (Chunga et al., 2016). For respondents in our study who had previously used and were familiar with a pour-flush toilet, there may also have been initial barriers to satisfaction with the new and unfamiliar UDDT design which would have represented a significant change in sanitation practice (e.g., water-based to water-less). On the other hand, for those respondents who did not have any sanitation system prior to coming to the camp, the UDDTs instead may have offered a preferable option to their previous practice. Further, the UDDT may potentially have been perceived as an elevation of status or a prestige symbol for those who previously had no sanitation system. This has been observed in other studies in Tanzania, Ghana and Benin looking at determinants of sanitation adoption (Sara and Graham, 2014; Jenkins and Scott, 2007; Jenkins and Curtis, 2005).

4.3. Study limitations

This evaluation is subject to important limitations. First, staff from CDC were not allowed to travel to Hiloweyn during either survey because of security restrictions, therefore all training was conducted offsite and CDC supervision was remote. However, UNHCR and ARRA staff helped supervise activities on the ground, and we hired extra supervisors (4 total) for the ten data collectors to address this limitation. Next, despite the camp being closed to new arrivals, population movements and potentially inaccurate lists of UDDT and pit latrine users meant that many selected respondents could not be located and were therefore replaced. It's not known if these respondents were different than those who were found. Relatedly, there were marked differences in demographics between the two surveys; potentially because of population movements to/from Somalia. However, we tried to account for these differences by including demographics variables and the survey (e.g., first or second) within the final multivariable analysis for the full dataset. Next, longer recall periods may be inaccurate in terms of reported length of time in the camp and reported duration of use of the UDDT. Next, we interviewed one person *per* household, usually the female head of that household. We did not attempt to determine the satisfaction levels among other family members such as adult men, or school aged children. We assumed that the respondents reporting satisfaction likely represented that of the household as a whole, however we do not know if this was indeed the case. Finally, our results may be impacted by social desirability bias. However, we tried to mitigate this by keeping responses anonymous and by hiring interviewers who were Somali refugees from the nearby host community and not affiliated with the WASH NGOs who had installed the UDDTs in the camp.

5. Conclusion

This evaluation provided evidence on the acceptability of the UDDTs in Hiloweyn refugee camp in Dollo Ado region, Ethiopia, several years into the UDDT program and after considerable scale-up. Reported adoption and satisfaction towards UDDTs were high among this Somali population. Several factors, including UDDT cleanliness, duration of UDDT use and previous sanitation practices, were found to be associated with higher satisfaction with the UDDTs in this setting.

Given the increasing scale and complexity of humanitarian emergencies, identifying effective alternative sanitation interventions is a priority. This evaluation provides evidence of a successful UDDT program in a protracted emergency setting, as well as insight into the factors contributing to acceptability of these UDDTs, which may have implications for use of UDDTs in other humanitarian settings where they can be similarly managed. To better understand the potential role of UDDTs in humanitarian emergencies, it is recommended to continue to pilot and study UDDTs in earlier phases of the emergency, as well as in different locations and among different cultural groups.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijheh.2021.113745.

Disclaimer

The conclusions and opinions expressed by authors contributing to this journal do not necessarily reflect the official position of the U.S. Department of Health and Human Services, the Centers for Disease Control and Prevention or other organizations.

References

Alemu, F., Kumie, A., Medhin, G., Gebre, T., Godfrey, P., 2017. A socio-ecological analysis of barriers to the adoption, sustainability and consistent use of sanitation facilities in rural Ethiopia. BMC Publ. Health 17, 706. https://doi.org/10.1186/s12889-017-4717-6.

Bastable, A., Lamb, J., 2012. Innovative designs and approaches in sanitation when responding to challenging and complex humanitarian contexts in urban areas. Waterlines 31 (1–2), 67–81. https://doi.org/10.3362/1756-3488.2012.007.

Brown, J., Cavill, S., Cumming, O., Jeandron, A., 2012. Water, sanitation, and hygiene in emergencies: summary review and recommendations for further research. Waterlines 31 (1), 11–29. https://doi.org/10.3362/1756-3488.2012.004.

Chunga, R.M., Ensink, J.H.J., Jenkins, M.W., Brown, J., 2016. Adopt or adapt: sanitation technology choices in urbanizing Malawi. PloS One 11 (8). https://doi.org/10.1371/journal.pone.0161262 e0161262.

Delepiere, A., 2011. Household UDDTs after cyclone disaster, padma and rohitra villages, barishal division, Bangladesh – case study of sustainable sanitation projects. Sustainable sanitation alliance (SuSanA). Accessed August 11, 2020 from: https://www.susana.org/en/knowledge-hub/resources-and-publications/case-studies/details/1183.

DMello-Guyett, L., Yates, T., Bastable, A., Dahab, M., Deola, C., Dorea, C., Dreibelbis, R., Grieve, T., Handzel, T., Harmer, A., Lantagne, D., Maes, P., Opryszko, M., Palmer-Felgate, S., Reed, B., Van Den Bergh, R., Porteaud, D., Cumming, O., 2018. Setting priorities for humanitarian water, sanitation and hygiene research: a meeting report. Conflict Health 22. https://doi.org/10.1186/s13031-018-0159-8.

Gensch, R., Jennings, A., Renggli, S., Reymond, P., 2018. Compendium of sanitation technologies in emergencies. August 11, 2020. https://www.susana.org/en/knowledge-hub/resources-and-publications/library/details/3145. first ed.

Heijnen, M., Routraya, P., Torondela, B., Clasen, T., 2015. Neighbour-shared versus Communal Latrines in Urban Slums: a Cross-Sectional Study in Orissa, India Exploring Household Demographics, Accessibility, Privacy, Use and Cleanliness, vol. 109. Transaction of the Royal Society of Tropical Medicine and Hygiene, pp. 690–699. https://doi.org/10.1093/trstmh/trv082.

Helgegren, I., Rauch, S., Cossio, C., Landaeta, G., McConville, J., 2018. Importance of triggers and veto-barriers for the implementation of sanitation in informal peri-urban settlements ± the case of Cochabamba, Bolivia. PloS One 13 (4). https://doi.org/10.1371/journal.pone.0193613 e0193613.

Hulland, K., Martin, N., Dreibelbis, R., DeBruicker Valliant, J., Winch, P., 2015. What Factors Affect Sustained Adoption of Safe Water, Hygiene and Sanitation Technologies? A Systematic Review of Literature. EPPI-Centre, Social Science Research Unit, UCL Institute of Education, University College London, London, ISBN 978-1-907345-77-7.

Intergovernmental Panel on Climate Change (Ipcc), 2012. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: Special Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, p. 582. Accessed August 11, 2020 from: https://www.ipcc.ch/site/assets/uploads/2018/03/SREX_Full_Report-1.pdf.

Jenkins, M.W., Curtis, V., 2005. Achieving the 'good life': why some people want latrines in rural Benin. Soc. Sci. Med. 61, 2446–2459. https://doi.org/10.1016/j.socscimed.2005.04.036.

Jenkins, M.W., Scott, B., 2007. Behavioral indicators of household decision-making and demand for sanitation and potential gains from social marketing in Ghana. Soc. Sci. Med. 64, 2427–2442. https://doi.org/10.1016/j.socscimed.2007.03.010.

Kinstedt, K., 2012. The Application of Ecological Sanitation for Excreta Disposal in Disaster Relief; Experience, Selection and Design, Hamberg, Germany. Institute of Wastewater Management and Water Protection. https://www.susana.org/en/knowledge-hub/resources-and-publications/library/details/1506. (Accessed 11 August 2020).

Mkhise, N., Taylor, M., Udert, K.M., Gounden, T.G., Buckley, C.A., 2017. Urine diversion dry toilets in eThekwini Municipality, South Africa: acceptance, use and maintenance through users' eyes. J. Water, Sanit. Hyg. Dev. 7 (1) https://doi.org/10.2166/washdev.2017.079.

Mwase, H., 2006. The potential of ecosan to provide sustainable sanitation in emergency situations and to achieve 'quick wins' for MDGs. https://www.susana.org/en/knowledge-hub/resources-and-publications/library/details/1241. (Accessed 11 August 2020).

M. Ngala, P., Burt, M., Gonzaga, S., Bastable, A., 2014. Ecological sanitation in refugee camps: implementing urine diversion dry toilets in Dollo Ado, Ethiopia. 37th WEDC International Conference, Hanoi, Vietnam. Accessed February 1, 2021 from: https://wedc-knowledge.lboro.ac.uk/resources/conference/37/Ngala-1919.pdf.

Nyoka, R., Foote, A.D., Woods, E., Lokey, H., O'Reilly, C.E., Magumba, F., Okello, P., Mintz, E.D., Marano, N., Morris, J.F., 2017. Sanitation practices and perceptions in Kakuma refugee camp, Kenya: comparing the status quo with a novel service-based approach. PloS One 12 (7). https://doi.org/10.1371/journal e0180864.

Patinet, J., 2010. Household pit latrines with urine diversion in the Farchana refugee camp in eastern Chad – draft – Case study of sustainable sanitation projects. France: sustainable Sanitation Alliance (SuSanA) and Groupe URD. Accessed August 11, 2020 from: https://www.susana.org/en/knowledge-hub/resources-and-publications/case-studies/details/1018.

Pradhan, A., 2008. Assessment of urine-diverting EcoSan toilets in Nepal. WaterAid, Nepal. https://www.susana.org/en/knowledge-hub/resources-and-publications/library/details/1600. (Accessed 11 August 2020).

Rieck, C., von Münch, E., Hoffmann, H., 2012. Technology Review of Urine-diverting dry toilets (UDDTs): overview of design, operation, management and costs. Deutsche Gesellschaft Fur Internationale Zusammenarbeit (GIZ) GmbH. https://www.susana.org/en/knowledge-hub/resources-and-publications/library/details/874. (Accessed 11 August 2020).

Roma, E., Philp, K., Buckley, C., Xulu, S., Scott, D., 2013. User perceptions of urine diversion dehydration toilets: experiences from a cross-sectional study in eThekwini Municipality. WaterSA 39 (2), 305–312.

Roma, E., Chris Buckley, C., Jefferson, B., Jeffrey, P., 2010. Assessing users' experience of shared sanitation facilities: a case study of community ablution blocks in Durban, South Africa. WaterSA 36 (5).

Ross, R.K., King, J.D., Damte, M., Ayalew, F., Gebre, T., Cromwell, E.A., Teferi, T., Emerson, P.M., 2011. Evaluation of household latrine coverage in Kewot woreda, Ethiopia, 3 years after implementing interventions to control blinding trachoma. International Health 3 (4), 251–258. https://doi.org/10.1016/j.inhe.2011.06.007.

Sara, S., Graham, J., 2014. Ending open defecation in rural Tanzania: which factors facilitate latrine adoption? Int. J. Environ. Res. Publ. Health 11, 9854–9870. https://doi.org/10.3390/ijerph110909854.

Simiyu, S., Swilling, M., Cairncross, S., Rheingans, R., 2017. Determinants of quality of shared sanitation facilities in informal settlements: case study of Kisumu, Kenya. BMC Publ. Health 17, 68. https://doi.org/10.1186/s12889-016-4009-6.

Uddin, S.M.N., Muhandiki, V., Fukuda, J., Nakamura, M., Sakai, A., 2012. Assessment of social acceptance and scope of scaling up urine diversion dehydration toilets in Kenya. J. Water, Sanit. Hyg. Dev. 2 (3), 182–189.

United Nations High Commissioner for Refugees (Unhcr), 2019. Global Trends: Forced Displacement in 2019. UNHCR, Geneva, Switzerland. https://www.unhcr.org/globaltrends2019/. (Accessed 27 January 2021).

United Nations High Commissioner for Refugees (Unhcr), 2019. Operational portal refugee situations. UNHCR, Geneva, Switzerland. https://data2.unhcr.org/en/situations/horn/location/161. (Accessed 11 August 2020).

Van der Meulen, R.J., Moe, C., Breslin, E.D., 2003. Ecological sanitation in Mozambique: baseline data on acceptability, use and performance. Lübeck, Germany. https://www.susana.org/en/knowledge-hub/resources-and-publications/library/details/644.

Water and Sanitation Program (Wsp), 2005. A Review of EcoSan Experience in Eastern and Southern Africa. Field Note. Sanitation and Hygiene Series. World Bank Group, Washington, DC, USA.

Yates, T., Vujcic, J.A., Joseph, M.L., Gallandat, K., Lantagne, D., 2018. Efficacy and effectiveness of water, sanitation, and hygiene interventions in emergencies in low- and middle-income countries: a systematic review. Waterlines 37 (1). https://doi.org/10.3362/1756-3488.17-00016.