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Quantifying user preferences for sanitation construction and use: Application of discrete choice experiments in Amhara, Ethiopia

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ABSTRACT

Objective: Discrete choice experiments (DCEs) are stated preference methods that allow for the quantification of preferences by presenting respondents with hypothetical choices. We conducted image-based DCEs to assess preferences for latrine use (stratified by gender) and construction (among men only) in Amhara, Ethiopia.

Methods: Preference was quantified using a conditional logistic model to estimate utilities and corresponding odds ratios associated with a set of latrine attributes.

Results: For latrine use, tin roofing, handwashing stations, and clean latrines had the highest relative utility coefficients. Tin roofing was preferred to no roof for use (Women: OR 3.68, 95% CI 3.18-4.25; Men: OR 3.75, 95% CI 3.21-4.39) and new latrine construction (5.92, 5.04-6.95). Concrete slabs, a critical aspect of improved sanitation, was not preferred to dirt floors for use (Women: 0.87, 0.75-1.00; Men: 1.03, 0.88-1.20), but was preferred for new construction (1.52, 1.30-1.78). We did not observe any trends in preference for direct (monetary) or indirect cost (labour days), so we were not able to elicit trade-offs between latrine attributes and these costs for the construction of new latrines.

Conclusion: Our findings suggest similar latrine use preferences between men and women. We found that tin roofs are the most strongly preferred latrine characteristic, but concrete slabs, commonly promoted in sanitation programmes, were not preferred for use. We demonstrate the utility of DCEs to elicit stated preferences for latrine use and construction among community members who have myriad

motivations for using and making improvements to their sanitation facilities, including the ease of cleaning and hygiene, durability, or privacy and comfort.

Keywords: preferences, discrete choice experiments, sanitation, latrine use, latrine construction, Ethiopia

Introduction

Poor sanitation and hygiene are responsible for considerable morbidity and mortality in low income settings (1,2); yet interventions to improve and sustain sanitation coverage and use have had limited success (3). One reason may be that interventions often target a set of aims that do not overlap with the preferences, needs, and demands of the local populations for which interventions are designed (4–6). While elucidating local preferences may be difficult, doing so is essential for the design and execution of effective water, sanitation, and hygiene (WASH) programming (7–9). WASH preferences and demand assessments, particularly those employing more rigorous econometric methods, have been lacking in rural areas in low-income settings (10). Household sanitation – the construction, repair and upgrading of latrine facilities, and the use of those facilities by all members of the household – has frequently been treated as a single behaviour mediated by a simple set of factors. Scenario-based techniques, such as discrete choice experiments (DCEs), can serve to elicit data reflecting users' perceived needs and desires. WASH practitioners can leverage resulting DCE data to inform intervention design and further enhance traditional preference and demand assessments by pinpointing mechanisms that either facilitate or impede adoption of improved behaviours and practices. Here, we distinguish between behaviours and practices, as behaviours represent outcomes that reflect a multifactorial process which draws on and are influenced by factors internal and external to the actors (11), while a practice is a discrete measurable activity.

Coverage of sanitation in rural Ethiopia is low, with 32% of households having no facility and 63% only having unimproved facilities (12). To address this issue, the Ethiopian Federal Ministry of Health has promoted scaled implementation of community-led total sanitation and hygiene within the context of its Health Extension Program. While some evidence suggests that gains in sanitation coverage and use are sustained, the proportion of households with access to unimproved latrines remains high (13). There is some indication of regression back to unimproved practices, known as behavioural 'slippage,' after communities have been declared open defecation-free (14,15). Reasons for this behavioural slippage may include a lack of desire to use sanitation facilities due to behavioural barriers, such as existing habits, daily routines and cultural beliefs (16), as well as a

disconnect between the types of latrines promoted and constructed via WASH programs and local preferences (4–6,17).

DCEs are a methodological tool used to examine stated preferences, which has seen use in health research in low income settings (18), including Ethiopia (19). As a stated preference tool, DCEs are limited to examining preference based on hypothetical choices made by individuals rather than actual choices investigated by revealed preference methods. However, the high prevalence of latrine characteristics and choices would have made it prohibitively difficult to test for actual choices (13). DCEs present respondents with a pool of substitutable goods that they can choose from across a number of choice sets that simulate realistic scenarios (20,21), and as such represent a participant-centred approach to identifying the attributes that most influence decision-making. We chose DCEs over other stated preference methods, such as the contingent valuation method (CVM), because information on trade-offs among attributes can be elicited from a DCE by asking respondents to make discrete choices, rather than asking respondents to make binary choices, rank or rate different attributes in a CVM experiment. In addition, since it is possible to make choices based on images presented to the respondents, DCEs do not discriminate between literate and illiterate respondents as long as the images depicted are clear and the task is well explained by the interviewer. Finally, if the price of the service is included as an attribute, willingness to pay can be estimated (22). Consequently, the DCE approach integrates aspects of participant preference, intention, and trade-off into a single measure (23).

We conducted two DCEs regarding latrine construction and use preferences. The Latrine Use Experiment (LUE) focused on understanding which features of a latrine were preferred when considering latrine use practices. This experiment was conducted among men and women to elicit differences in preferences between genders. The Latrine Construction Experiment (LCE) focused on understanding the types of components men would prefer to include when constructing a new household latrine, and the respondent's willingness to pay for those attributes. This experiment was only conducted among men, since men are predominantly involved with decision making for large household purchases (24).

METHODS

Study site

We conducted this study within the context of the *Andilaye* Trial, a cluster-randomized controlled trial designed to quantify the impact of a demand-driven sanitation and hygiene intervention on sustained behaviour change and mental well-being in Amhara, Ethiopia. Our study sites included three districts (*woredas*) - Farta, Fogera, and Bahir Dar Zuria - located within South Gondar and West

Gojjam Zones, with households residing in rural and peri-urban communities within those districts. The DCE method was appropriate for the study population given we were able to combat low rates of literacy with exclusively image-based experiments.

The study was approved by the Institutional Review Boards of Emory University and the Amhara State Regional Health Bureau Research Ethics Review Committee.

Attributes

A DCE is conducted by providing respondents with a number of choice sets, each choice set including two or more choices related to the concepts being tested (25–27). Each choice includes a set of attributes. For example, in a DCE testing stated preference for restaurant visits, you may have three attributes: 1. Type of food; 2. Wait time; 3. Cost. Each of those attributes will have multiple levels. For example, type of food may have the following levels: a. Gourmet food; b. Healthy food; c. Bar food; d. Fast food. Each attribute is included in each choice, but the levels vary by choice so a single choice set compares different levels of the same attributes to each other. Attributes and levels included in the DCEs were derived from our previously conducted formative research related to the *Andilaye* trial. For example, for the floor attribute we considered dirt, cement, wood and tile floors as attribute levels, but our experience from the formative research revealed that tile floors were not found or talked about in the area. Our prior work with the formative research for the *Andilaye* trial helped ensure that our DCE attributes and levels were locally appropriate.

Each experiment included seven attributes, with each attribute represented by two or three attribute levels. We considered additional attributes, such as pit lining and whether or not the latrine door had a lock, but decided to limit the experiments to seven attributes. DCEs typically administer 4-6 attributes (28), so we did not want to increase the complexity of the task by adding more attributes. A full list of attributes and corresponding attribute levels for both experiments is outlined in Table 1. Note that there was substantial overlap in attributes and attribute levels between the two experiments, but the question posed to respondents was different for each experiment (i.e., “Assuming you were to use a latrine now, which one would you prefer: Latrine 1, Latrine 2, or neither?” [LUE] versus “Assuming you were to build a new latrine, which one would you prefer: Latrine 1, Latrine 2, or neither? [LCE])”. For the LCE, the interviewer clarified to the respondent during the introduction of the task, that the latrine would be a new latrine and that the respondent would have to pay for and construct the latrine himself.

Table 1: Attributes, attribute levels and Figure 1 identifiers

Attribute	Level	Figure Code
Latrine use and construction experiments:		
Floor	Concrete slab	F.1
	Wood floor	F.2
	Dirt floor	F.3
Door	Tin door	D.1
	Curtain	D.2
	No door	D.3
Roof	Tin roof	R.1
	Thatched roof	R.2
	No roof	R.3
Walls	Wood-walls	W.1
	Plastered walls	W.2
	Thatched walls	W.3
Washing	Present	WS.1
Station	Not present	WS.2
Latrine use experiment only		
Cleanliness	Clean latrine	CL.1
	Dirty latrine	CL.2
Condition	Good condition	CO.1
	Damaged latrine	CO.2
Latrine construction experiment only:		
Direct Cost	100ETB ($4.29)	C.1
	300ETB ($12.87)	C.2
	500ETB ($21.46)	C.3
Labour	2 person-days	L.1
	4 person-days	L.2
	8 person-days	L.3

Testing and revising the attributes

We conducted cognitive interviews among 11 respondents to test the face validity of the images depicted on the choice set cards. We were specifically interested in testing the study protocol itself, the respondent's interpretation of each image as it related to the investigator's intended meaning, and contextual acceptability of the images. Cognitive interviewing is a qualitative method that elucidates how respondents understand and interpret a study instrument. This can help identify possible improvements that need to be made to the study instrument, in this case the choice sets, to help with comprehension and other cognitive processes (29). We developed cognitive interview guides to elicit specific feedback about the clarity of the task and the images presented to the respondents. Respondents were presented with six choice sets and asked to employ a 'think aloud' technique to describe their decision-making process (30). After deciding which latrine they preferred, the interviewers probed respondents about the clarity of the images and the reasoning for their choice.

We used the findings from our cognitive interviews to refine our experiments to the local context. First, respondents had difficulty making trade-offs between the different attributes in the initial choice sets presented, and did not seem to settle into the task until the third or fourth choice set. Second, for the LCE, respondents struggled to understand what the images of money and labourers represented in each choice set (i.e., hypothetical construction cost and person-days of labour required to construct the respective latrine options). Third, respondents made recommendations for changes to the illustrations representing the attribute levels to make them more contextually appropriate. Based on these findings, we added three practice choice sets to the beginning of each experiment. The practice choice sets were comprised of latrine attributes and attribute levels used for the experiment. This allowed enumerators to go through three practice choice sets with respondents to get them acquainted with the task at hand and describe the attributes presented, with a focus on further explanation regarding images related to monetary and labour inputs for the LCE. The practice sets had various levels of complexity, with each one of the attribute levels represented at least once to ensure respondents were familiar the attribute levels and their corresponding images. We also went through an iterative process with an Ethiopian artist, who created the illustrations, to incorporate feedback from respondents on how best to represent each attribute level.

Study design

We administered the experiments as paired comparison designs, such that respondents considered a choice set with two alternatives and stated their preference for each pair, with a third 'neither' option. A pairwise design is frequently applied in health services DCEs (27), but the added 'neither'

option provided respondents the possibility to opt out whenever none of the presented alternatives were preferred (31). This avoids forcing respondents to choose an alternative and allows for the estimation of unconditional rather than conditional preferences. Figure 1 presents two example choice sets for each experiment. Corresponding identification codes for all attribute levels can be found in Table 1. These identification codes were not present on the printed versions of the choice set cards presented to respondents for the experiment, and are only displayed here to for illustrative purposes.

The choice sets were organized in to four groups of nine choice sets, each respondent completing nine choice sets (details in supplementary materials S1). Attribute levels were randomly allocated to each choice set, while ensuring a balanced (each level occurs equally often for each attribute) and orthogonal (each pair of levels occurs equally often across all pairs of attributes) design using the MkTex macro (SAS software, Version 9.4, Cary NC, USA) (26). There are several methods to calculate a necessary minimum sample size of respondents to gather sufficient data to produce statistically significant estimates of the utility coefficients (28). We used a combination of these methods (described in supplementary materials S2), to determine a sample size of 240 respondents per experiment.

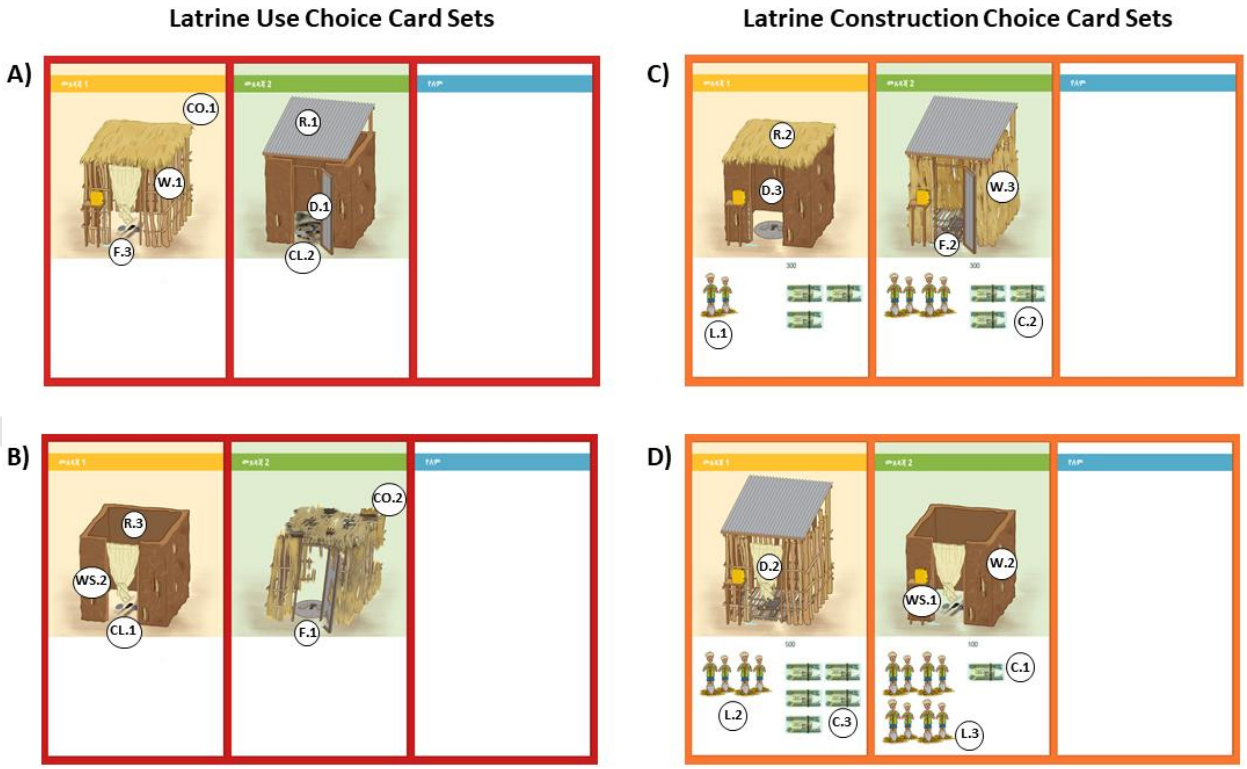

Figure 1: Two example latrine use choice sets (A & B) and two latrine construction choice sets (C & D), with attribute level identifier codes added (referenced in Table 1). Squares that are left blank indicate neither choices. Options are titled as Latrine 1, Latrine 2 and Neither in Amharic.

Data collection

A team of trained enumerators administered the DCEs in Amharic in June 2017. Households were randomly selected from respondents to the baseline surveys of the *Andilaye* trial; households were enrolled in the trial through systematically random sampling from within study villages. The DCE was administered after completion of the *Andilaye* baseline survey during the same household visit. Two different populations of men were sampled to complete LUE and LCE. At the start of each DCE, interviewers verbally described the task using a standard script to ensure consistent interpretation between respondents. The script described the motivation behind the DCE and the attributes presented in the choice sets. Then, enumerators interactively went through three practice choice sets with the respondents, before respondents completed nine choice tasks. For each choice set, respondents were asked to imagine what latrine they would prefer to use or what latrine they would prefer to construct and to select one of three possible options per task: Latrine 1, Latrine 2, or neither. Enumerators did not comment on the levels in each individual choice set or provide any description, to avoid introducing enumerator bias (27). Enumerators used mobile phones to mark the responses in a previously coded survey developed on password protected, Android-enabled mobile devices, using Open Data Kit.

Statistical analyses

We used conditional logistic models for our analyses, which we consider appropriate for choice models with several attributes where the primary focus of the analysis is how those attributes influence choice, rather than the characteristics of the individuals making the choice (32). Since we expected to see correlation among the nine choice sets from each respondent, our analysis accounted for this clustering. The output from the model consists of utility coefficients for attribute levels, which indicate the relative importance of each attribute (33). One level per attribute was designated as the reference level, and therefore has a utility coefficient of zero. We designated attribute levels that we hypothesized *a priori* to be the least desirable as reference levels. Below, we represent the models used for the LUE and LCE:

$$\boldsymbol{LUE}:\ U = u_i + \beta_0 + \beta_1 ConcreteSlab + \beta_2 WoodFloor + \beta_3 TinDoor + \beta_4 CurtainDoor + \beta_5 TinRoof + \beta_6 Thatched\ Roof + \beta_7 WoodWalls + \beta_8 Plastered\ Walls + \beta_9 WashingStation + \beta_{10} Clean + \beta_{11} GoodCondition$$

$$\boldsymbol{LCE}:\ U = u_i + \beta_0 + \beta_1 ConcreteSlab + \beta_2 WoodFloor + \beta_3 TinDoor + \beta_4 CurtainDoor + \beta_5 TinRoof + \beta_6 Thatched\ Roof + \beta_7 WoodWalls + \beta_8 Plastered\ Walls + \beta_9 WashingStation + \beta_{12} Cost + \beta_{13} Labor\ ,$$

Where u_i accounted for clustering at the respondent level, *U* represented the overall utility derived for any given latrine, β_0 is the intercept representing the utility for a latrine comprised of only

reference levels (so the *a priori* designated least desirable attribute levels), β_1 to β_9 are the utility coefficients for the structural components of the latrines consistent between the two experiments. Unique to the LUE, β_{10} and β_{11} represent the utility coefficients for the cleanliness and condition attributes. β_{12} and β_{13} were modeled as quantitative variables to represent cost and labour time for the LCE. Positive utility coefficients indicate that a level is preferred over the reference level, and negative utility coefficients indicate the opposite. The coefficient size indicates the strength of the preference. We obtained odds ratios for the utilities by exponentiating the utility coefficients.

RESULTS

Respondent Characteristics

We interviewed a total of 799 respondents (Table 2). High rates of illiteracy among female respondents (77%) and male respondents (41% for the LUE and 42% for the LCE, respectively) support the use of an image-based survey instrument. Approximately three quarters of our respondents had access to at least one household latrine.

Table 2: Respondent Characteristics

Characteristic	**LUE - Women**	**LUE - Men**	**LCE - Men**
Total Respondents (N)	297	254	248
District Breakdown (N)			
Bahir Dar Zuria	102	79	79
Farta	99	94	88
Fogera	96	81	81
Mean age (IQR)	34 (11)	40 (15)	39 (15)
Education Level			
None - Illiterate	77%	41%	42%
None - Literate	2%	24%	21%
Some primary (grades 1-4)	10%	15%	17%
Some secondary (grades 5-8)	8%	16.%	14%
High school or above (grades 9-12)	3%	5%	7%
HH has access to a latrine (%)	77%	78%	75%

Latrine Use Experiment (LUE)

The utility coefficients and corresponding odds ratios (OR) with 95% confidence intervals for the LUE are outlined in Table 3, where positive utility coefficient values (i.e., OR > 1) indicate preference for an attribute level over the reference level. We conducted tests for significance levels within each attribute and their corresponding reference level. However, higher utility coefficients between attribute levels indicate likelihood of a stronger preference based on point estimates compared to other attributes. Tin roofs represent the largest utility point estimates for men and women's latrine use preferences, followed by clean latrines and having a washing station. Men did not state a preference for type of floor, whereas women preferred dirt floors to wood floors but stated no preference between concrete and dirt floors. Men and women stated a preference for using latrines with a curtain door to not having a door. Women also stated a preference for latrines with tin doors to not having a door, whereas men stated no preference for tin doors to not having a door. Men and women preferred tin or thatched roofs to not having a roof, and plastered walls to thatched walls. However, both men and women stated no preference for wood walls to thatched walls. Men and women stated a preference for using latrines that had a handwashing station to not having a handwashing station, that were clean to being dirty, and that were in good condition to being in bad condition.

Table 3: Latrine use utility coefficient estimates.

	Men (N=256)		**Women (N=295)**	
Attributes and Levels	**Utility[1]**	**OR (95% CI)**	**Utility**	**OR (95% CI)**
Intercept				
All reference levels	-0.61	0.55 (0.42; 0.71)	-0.19	0.83 (0.65; 1.05)
Floor				
1. Concrete slab	0.03	1.03 (0.88; 1.20)	-0.14	0.87 (0.75; 1.00)
2. Wood floor	-0.03	0.98 (0.84; 1.14)	-0.21	0.81 (0.71; 0.94)
3. Dirt floor	Ref	Ref	Ref	Ref
Door				
1. Tin door	0.15	1.17 (1.00; 1.36)	0.29	1.34 (1.17; 1.55)
2. Curtain	0.22	1.25 (1.07; 1.46)	0.38	1.45 (1.26; 1.68)
3. No door	Ref	Ref	Ref	Ref
Roof				
1. Tin roof	1.32	3.75 (3.21; 4.39)	1.30	3.68 (3.18; 4.25)
2. Thatched roof	0.66	1.94 (1.66; 2.26)	0.61	1.84 (1.59; 2.12)

3. No roof	Ref	Ref	Ref	Ref
Walls				
1. Wood walls	-0.08	0.92 (0.79; 1.07)	-0.11	0.90 (0.78; 1.03)
2. Plastered walls	0.49	1.63 (1.40; 1.90)	0.50	1.65 (1.44; 1.90)
3. Thatched walls	Ref	Ref	Ref	Ref
Washing Station				
1. Present	0.72	2.05 (1.81; 2.33)	0.60	1.82 (1.62; 2.03)
2. Not present	Ref	Ref	Ref	Ref
Cleanliness				
1. Clean latrine	0.84	2.32 (2.04; 2.63)	0.69	1.99 (1.77; 2.24)
2. Dirty latrine	Ref	Ref	Ref	Ref
Condition				
1. Good condition	0.65	1.92 (1.69; 2.18)	0.45	1.57 (1.40; 1.76)
2. Damaged Latrine	Ref	Ref	Ref	Ref

[1] *Positive utility coefficients (i.e., OR > 1) indicate preference for an attribute level to the reference level, whereas negative utility coefficient indicate preference of the reference level to an attribute level.*

Latrine Construction Experiment

Tin roofs represent the largest utility point estimates for men's latrine construction preferences, followed by plastered walls and thatched roofs, relative to their respective reference characteristic based on point estimates (Table 4). Men stated a preference for constructing new latrines with a concrete slab to a dirt floor, tin door or curtain to no door, and tin roof or thatched roof to no roof. However, based on point estimates, tin roofs were the most important attribute level when choosing what latrine to construct and were more strongly preferred than thatched roofs. Men preferred plastered walls to thatched walls, but preferred thatched walls to wood walls. Men stated a preference for constructing new latrines with a handwashing station to not having a handwashing station. We did not observe any trends in preference for the direct cost or indirect cost, represented by person-days of labour needed to construct a latrine, so we are not able to provide willingness to pay for certain types of latrines or individual latrine attributes.

Table 4: Latrine construction utility coefficient estimates

Attributes and Levels	Utility	OR (95% CI)
Intercept		
All reference levels	-0.05	0.96 (0.71; 1.29)
Floor		
1. Concrete slab	0.42	1.52 (1.30; 1.78)
2. Wood floor	-0.04	0.96 (0.82; 1.13)
3. Dirt floor	Ref	Ref
Door		
1. Tin door	0.47	1.60 (1.37; 1.87)
2. Curtain	0.33	1.40 (1.19; 1.63)
3. No door	Ref	Ref
Roof		
1. Tin roof	1.78	5.92 (5.04; 6.95)
2. Thatched roof	0.61	1.84 (1.57; 2.16)
3. No roof	Ref	Ref
Walls		
1. Wood walls	-0.18	0.83 (0.71; 0.98)
2. Plastered walls	0.62	1.85 (1.58; 2.16)
3. Thatched walls	Ref	Ref
Washing Station		
1. Present	0.37	1.45 (1.27; 1.65)
2. Not present	Ref	Ref
Cost		
Direct Cost	<0.01	1.00 (1.00; 1.00)
Labour	0.01	1.01 (0.99; 1.04)

DISCUSSION

We conducted two discrete choice experiments in Amhara, Ethiopia to assess latrine characteristics preferred for construction among men and use among men and women. We tested stated preferences for latrine use among men and women, to understand what latrine characteristics may encourage improved latrine uptake, and reduce behavioural slippage and open defecation. Community members have myriad motivations for making improvements to their toilet facilities, including ease of cleaning and hygiene, durability, or privacy and comfort. Understanding which of these motivations drive both construction of specific toilet types and preference for use would enable the sanitation sector to better target both supply and demand side approaches. Our main findings revealed similar use preferences between men and women. Improved roofing was strongly preferred relative to other improvements. Slabs and improved flooring, a critical aspect of improved sanitation per the Joint Monitoring Programme, was not preferred. In contrast, it was preferred for men for the construction of new latrines. These findings point to challenges of the current

community-led total sanitation approach which prioritises basic sanitation to achieve open defecation free communities, potentially at the expense of more durable toilet facilities.

Several other studies have assessed household sanitation demand (8,34) and attitudinal factors related to latrine use (35). These studies have identified different factors that influence sanitation demand based on a sanitation adoption decision-making process grounded in rational thinking (5). However, no known studies have employed DCEs to generate scenario-based data to elicit stated preferences related to sanitation facilities. Our work points to several strengths and limitations of this approach for future development and use in developing community-based sanitation interventions. Latrines are a difficult good to ask respondents to make trade-offs on, given the large number of attributes that may influence each decision. DCEs typically administer 4-6 attributes (28), whereas we had seven attributes and still could have included more such as pit lining and whether or not the latrine door had a lock. A strength of this approach was the ease of implementation in the field. Training was minimal and execution did not put a huge burden on either enumerators or respondents.

The results on user preference were surprisingly similar between men and women. When compared to their referent condition, the point estimates suggest that tin roofing was the most preferred attribute for both men and women; thatched roofing was also strongly preferred to not having a roof. This preference may be driven by heavy rainfall in Ethiopia, an issue that was frequently raised during the cognitive interview phase. Presence of a washing station, cleanliness and latrines in good condition were strongly preferred for both men and women relative to other attributes, indicating the importance of hygiene for our target population when considering what latrines to use. Both tin doors and curtains were preferred to no door for women, indicating the importance of privacy and security for latrine use. Men exclusively preferred curtains and showed no preference for tin doors over curtain doors. There was no preference for concrete slabs over dirt floors, and dirt floors were preferred to wood floors by women. The preference for dirt floors came up during the cognitive interviews with women, who found dirt floors easier to clean than the alternatives. The lack of preference for concrete slabs was surprising given that this product is the most commonly promoted in sanitation marketing campaigns and is a critical factor in moving up the sanitation ladder from an unimproved latrine based on Sustainable Development Goal indicators (12).

The latrine construction experiment was designed to understand what latrine characteristics may mediate the construction of new latrines and encourage movement up the sanitation ladder. In contrast to latrine use, men preferred concrete floors to dirt floors, but showed no preference for wood floors. In contrast to the stated preference for concrete slabs, data on revealed preference

from a nationally representative survey of rural latrine characteristics, conducted in 2014, indicated that only 2% of household latrines had a concrete slab (36). The preference for plastered walls to thatched walls, while wood walls were less preferred than thatched walls, and the preference for tin and thatched roofs over no roofs is likely driven by a desire to build durable latrines. Collapsed latrines due to weak structural integrity was a common theme discussed by men during the cognitive interviews. Men also preferred to construct new latrines with tin or curtain doors and handwashing stations, reflecting the importance of privacy and hygiene for their households.

There were several strengths to this study. Our extensive formative research, which leveraged context-specific information regarding latrine characteristics and a cognitive interview phase, ensured the experiments were appropriate for the local context. We were also able to efficiently execute the experiments, with most DCE surveys taking under 10 minutes, after completion of baseline surveys conducted as part of the *Andilaye* trial. The respondents appeared to enjoy engaging with the latrine images we presented to them, and they seemed to benefit from interactively completing three practice choice sets with the enumerators. The efficient execution of the deployment of choice sets also ensured that we were able to exceed our sample size for both experiments. We believe the methods we used are transferable to other settings, making it possible to field similar experiments outside of Ethiopia, assuming the choice sets are adjusted to ensure they are contextually appropriate. Finally, because we used image-based experiments, this method did not discriminate between literate and illiterate respondents. Consequently, we did not come across any targeted respondents who were not able to complete the experiments.

Our findings should be interpreted with the limitations of our study in mind. First, we tested for stated preferences and did not collect data on revealed preferences to compare stated preferences to actual latrine use and construction decision-making. Second, the parameter estimates identified through this study estimate preference based on images presented to respondents. These images were likely not exhaustive in terms of covering all the different types of latrines our diverse set of respondents may be accustomed to. While the illustrations of each individual attribute level were also informed by results from a series of cognitive interviews, there were some inconsistencies in feedback across respondents. It is important to note, that we determined stated preference estimates for various latrine attributes, which were represented by images that may have been interpreted differently among respondents. Third, it was not possible to derive overall utilities for different combinations of latrines. Without statistically significant parameter estimates for all attribute levels, it is not possible to compare overall utilities of various latrines represented by different attribute levels, because stated preference for attribute levels cannot be distinguished from each other. Fourth, while we obtained qualitative data during our formative research phase,

we have not yet obtained qualitative data related to choice decisions to help fully interpret our quantitative results. Finally, we were not able to derive respondents' willingness to pay for individual latrine attribute levels because we did not see a trend for the direct (monetary) or indirect (labour) cost attributes in the LCE.

There are a few hypotheses as to why we did not observe any cost trends. One hypothesis is that the manner in which we represented both monetary and labour costs was too abstract for respondents to comprehend. Seven attributes in each choice may have represented too many characteristics, so cost may have been too much to consider when making trade-offs. Another hypothesis is that our levels for monetary cost and labour were too low, and respondents were not concerned with the difference between the highest and lowest levels. Finally, monetary and labour costs may not represent important trade-offs when it comes to decision-making around the inclusion of certain latrine components during construction.

Conclusion

We conducted two DCEs assessing stated preference for latrine attributes related to construction and use in Ethiopia. We were able to determine several components that were highly preferred, indicating that sanitation interventions in this context could focus on these improvements to best accommodate local preferences. Latrine use preferences were similar between men and women, by stating strong preferences towards improved roofing, but no preference for other characteristics such as concrete slabs. Improved roofing was also preferred among men for the construction of new latrines for their household, and in contrast to the latrine use experiment, concrete slabs were also preferred for latrine construction. Findings from our study suggest that as long as DCE tools are adapted to the local context, the methodology can be used to elicit information regarding stated preferences for latrine use and construction among rural populations with low literacy. However, we recommend validation of these findings by generating data on revealed preference, before applying them to improve the design of intervention content and delivery, program monitoring and evaluation frameworks.

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