

Research Paper

Determinants of toilet ownership among rural households in six eastern districts of Indonesia

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ABSTRACT

In 2012, the Government of Indonesia and UNICEF launched a project within eastern provinces of Indonesia to scale up and strengthen a national hygiene and sanitation program called '*Sanitasi Total Berbasis Masyarakat*'. A formative study prior to the project was conducted to characterize sanitation and hygiene knowledge, attitudes, and practices (KAP) among 1,700 households in six rural Indonesian districts in 2014. Separate multivariate analyses for toilet ownership (outcome 1) and improved sanitation (outcome 2) were conducted with generalized linear models to assess the association between potential determinants and sanitation outcomes. Respondents who agreed that most people do not have a toilet in their community were associated with lower levels of toilet ownership compared to respondents who disagreed with the statement ($p < 0.001$). The perception that building a toilet is expensive was also associated with reduced toilet ownership in contrast to respondents without this perception ($p < 0.001$). Embarrassment and convenience were associated with ownership of improved sanitation versus those with shared or unimproved toilets. The study suggests that social norms play an important role in changing sanitation behaviors. Future research should aim to clarify the extent to which norms and other psychosocial factors can be used to influence sanitation practices.

Key words | Indonesia, open defecation, sanitation, social norms

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BACKGROUND

Access to improved sanitation – a toilet facility that hygienically limits human contact with excreta – has implications for many health-related outcomes in children of low- and middle-income countries (LMICs), including diarrheal diseases, soil-transmitted helminths, undernutrition, stunting and cognitive development (Clasen *et al.* 2010; Spears *et al.* 2013; Pruss-Ustun *et al.* 2014; Cronin *et al.* 2016; Torlesse *et al.* 2016). There are also several important non-health-related outcomes that sanitation can affect, including saving time, increasing dignity, convenience and security,

associated with not having to find a place to safely defecate in the open (Tilley *et al.* 2013; Sommer *et al.* 2015). Given the importance of access to sanitation, especially to women and children, it is critical to improve this basic human necessity for health and development (Benova *et al.* 2014; Smith *et al.* 2015).

Indonesia currently has the second highest burden of open defecation worldwide, estimated at 51 million people (World Health Organization (WHO)/United Nations Children's Fund (UNICEF) 2015). The Ministry of Health

estimated that 30.5% of households have access to improved sanitation in Nusa Tenggara Timur and Papua, while in South Sulawesi it is estimated at 54.9%. National coverage with improved sanitation is estimated to be 59.8% (RISKEDAS 2013). The nation also has a low percentage of households with access to improved sanitation, 61% (WHO/UNICEF 2015). The Government of Indonesia (GoI) has long acknowledged the importance of sanitation to health on a national level. Even as early as 1973, there was an Indonesian Presidential Decree on Drinking Water Supply and Household Toilets (Mukherjee & Shatifan 2010). The program focused primarily on subsidizing household toilet construction, i.e., increasing the supply of toilets, but did little in terms of building or sustaining demand. Slow progress was made on basic sanitation coverage in the following decades. In 2005, the Indonesian government began to test community-led total sanitation (CLTS) after observing the success of these programs in Bangladesh (Mukherjee & Shatifan 2010). The focus of CLTS, in contrast to Indonesia's past program that focused on subsidies, is on demand creation through an intensive set of community mobilization activities (Mukherjee & Shatifan 2010). By 2008, CLTS became an underlying piece of the national strategy in Indonesia called 'Scaling-up and Strengthening Community Approaches to Total Sanitation' (STBM in the Bahasa Indonesia language). STBM prioritizes behavior as well as social change and community empowerment in its programmatic activities across five pillars of WASH, including reducing open defecation and improving handwashing with soap, safe drinking water at household level, and solid and liquid waste management.

In November 2012, the GOI and UNICEF launched a five-year sanitation and hygiene project within eastern provinces of Indonesia to scale up and strengthen the efforts underway in the STBM program (Mattson 2014). Given the investments of time and resources in the STBM program and the importance of sanitation to health and development, there is a critical need to assess the potential driving factors behind toilet ownership in order to inform the acceleration of the program. By investigating factors associated with toilet ownership along with factors for why households have not adopted improved toilets, sanitation interventions can be designed to more effectively target the drivers for scaling up improved sanitation.

Sanitation behaviors can be shaped by social and non-social influences, including: micro- and macro-level economics, legal and political determinants, religion, education and technological changes (Bronfenbrenner 2005). Increasingly, research finds that sanitation behaviors are connected to the interdependent beliefs, practices, and expectations within a reference group (Khanna & Das 2016). The beliefs about the actions of a reference group (i.e., descriptive norms: doing what others do or believe others do) or the beliefs about what others believe one should or should not do (i.e., subjective norms) especially when linked to a potential sanction (normative expectation) has been found to motivate people (Bicchieri 2005); their anticipation of positive or negative sanctions or more hidden approval or disapproval of others (Dreibelbis *et al.* 2013) can become a strong driver of change at community level. This underpins the success of the CLTS approach whereby communities support themselves to eliminate open defecation through the creation of new social norms at the community level (Dooley *et al.* 2016).

This study aimed to explore how demographic, psychosocial, normative, and structural factors are associated with toilet ownership and improved sanitation access in three provinces of Indonesia (Nusa Tenggara Timur, Papua, and South Sulawesi). Figure 1 presents the conceptual model of this study.

METHODS

This study analyzed household survey data from a total of 1,700 Indonesian households collected in February 2014; a random cluster sampling methodology was used. The survey measured latrine adoption patterns across six districts of three provinces of Indonesia, including: Jayapura (Papua), Luwu Utara, Takalar, and Barru (South Sulawesi), and Alor and Sumba Timur (Nusa Tenggara Timur). The districts of Alor, Sumba Timur, Luwu Utara, Takalar, and Barru each included a sample size of 300 respondents while Jayapura included 200 respondents.

The sampling design and sample size were developed to provide sufficient power for the analysis at the district level. The overall margin of error was estimated at 2.4%, with a confidence level of 95% based on a census population of

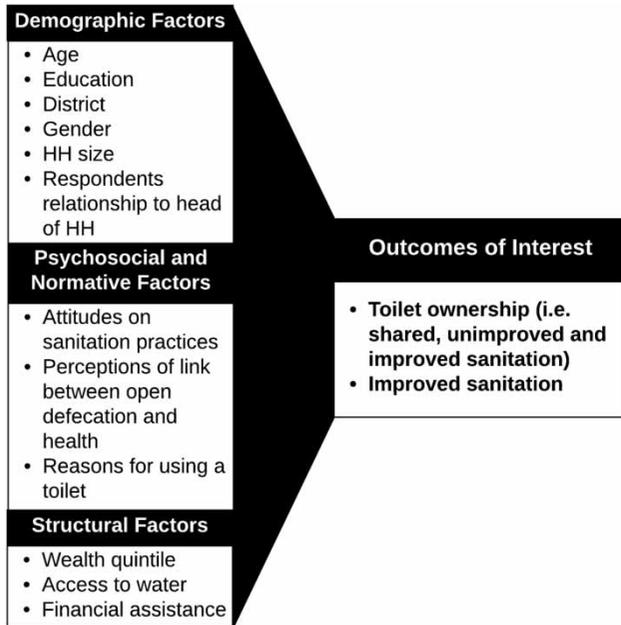


Figure 1 | Conceptual study model. (Note: Households without a toilet were used as the reference group for the analysis of toilet ownership. Households with unimproved or shared sanitation were the reference group for the analysis of households with improved sanitation.)

283,570. Based on these calculations, a sample target of 1,700 households was determined, representing 4.9% of all households in the selected districts, which was less than 1% (0.6%) of the overall total population of the targeted districts of 283,570. The study team visited 1,786 households and obtained data from 1,700 households with a response rate of 95.2%. The survey was administered with household heads or any adult household member present at the time of the survey. After conducting a list-wise deletion, 1,696 households were included as the final analytic sample.

Study variables

The dependent variables of this study were self-reported toilet ownership and improved sanitation. The survey asked if households had a toilet at the time of data collection (1 = Yes, 0 = No) with the study team directly observing the type of sanitation facilities reported to be used at each home. The proportion of households with improved sanitation facilities was estimated based on Joint Monitoring Programme (JMP) definitions (WHO/UNICEF 2015). The survey obtained the key attitudinal data only from those

households that reported to own a toilet (i.e., improve and unimproved), so the reference group for the improved sanitation outcome did not include households without sanitation facilities (see Figure 1).

The independent variables consisted of demographic, psychosocial, and structural factors that may determine the ownership and use of household sanitation facilities in Indonesia. Demographic factors were operationalized as respondents' age, education, district, gender, household size, and relationship to household heads. Psychosocial factors included respondents' attitude toward sanitation practices and reasons for using a sanitation facility. The survey included descriptive statements on sanitation practices (e.g., 'Most people in this community do not have a toilet'), and respondents reported their level of agreement to a given statement on a Likert scale. For those respondents who reported to have a household sanitation facility, they were asked reasons for using a sanitation facility in an open-ended question and if they received any financial assistance for building a toilet. Structural factors were operationalized as wealth quintiles, access to water throughout the year, and financial assistance for building a sanitation facility.

Statistical analysis

Descriptive statistics were calculated by performing count and percent calculations for each characteristic stratified by toilet ownership status. As a proxy for socioeconomic status, a wealth index was calculated with data on the possession of household assets and characteristics (Howe et al. 2012). A principal component analysis (PCA) was conducted to identify appropriate weights for each asset and calculate wealth scores, which represented relative wealth levels of each household (Howe et al. 2012). The 12 assets used for the PCA included: radio, TV, cell phone, landline telephone, refrigerator, motorcycle, bicycle, animal drawn cart, car, motor boat, agricultural land, and farm animals. Wealth scores were categorized into quintiles, which represent poorest, poorer, middle, richer, and richest classes.

Bivariate and multivariate analyses were performed with generalized linear models (GLMs) with Poisson Family and Log Link to assess the association between potential determinants and sanitation outcomes. Results

from these calculations were reported as prevalence ratios as a better alternative to odds ratios for the analysis of cross-sectional studies with binary outcomes (Thompson et al. 1998; Barros & Hirakata 2003). The statistical analyses were adjusted for the complex survey design by using STATA 12 with sampling weights and SVY command.

A multivariate analysis for toilet ownership was conducted using different models. Model 1 or the baseline specification consisted of demographic and structural variables including respondents' age, household size, gender, districts, wealth quintiles, and access to water. Model 2, Model 3, and Model 4 added psychosocial variables on open defecation, health, and sociocultural factors, respectively, to the baseline specification. Model 5 included all of the independent variables.

Additional multivariate models were used to assess the improved sanitation outcome. Model 6 included respondents' age, household size, gender, districts, and education as the baseline model. Model 7 additionally included reasons for using a sanitation facility. Model 8 added wealth quintiles, access to water, and financial assistance to the baseline model. Model 9 included all of the independent variables from Model 6 to Model 8.

Ethical considerations

The Indonesia dataset was shared by the data owner, UNICEF Indonesia. The dataset was anonymized before data analysis, and the research was determined to be exempt from human subject protection by The George Washington University Institutional Review Board given that it involved the analysis of pre-existing data. Further, ethical oversight was not obtained because the proposed uses and disclosures of protected health information involved no more than minimal risk to the privacy of individuals (45 CFR 46164.512). To maintain the highest ethical standard, we still obtained informed consent from study participants.

RESULTS

Descriptive characteristics of respondents stratified by toilet ownership are provided in Table 1. Respondents without

access to a toilet tend to have lower education and household wealth levels than those respondents from toilet-owning households. The majority of households without a

Table 1 | Descriptive statistics, by toilet ownership, reported by study participants. Chi-square analyses were used to compare households with and without toilets

	Households without a toilet (%)	Households with a toilet (%)	p-value
Age			0.0462
Young (18–35)	40.5	34.0	
Middle (36–55)	47.3	51.2	
Older (56 or older)	12.3	14.9	
Sex			0.1105
Female	53.2	48.9	
Male	46.8	51.1	
Household size			0.0395
Small (1–3)	31.2	25.4	
Middle (4–6)	55.6	57.4	
Large (7 or more)	13.3	17.2	
Relationship to household head			0.4832
Self	51.6	53.6	
Other	48.4	46.4	
Education			<0.0001
Less than primary	42.2	16.7	
Primary education	26.8	24.4	
Pre-secondary education	17.5	21.7	
Secondary or higher	13.5	37.2	
District			<0.0001
Alor	28.9	7.9	
Sumba Timur	9.9	19.3	
Luwu Utara	14.3	28.2	
Takalar	30.3	17.5	
Barru	12.6	15.8	
Jayapura	4.1	11.3	
Have access to water year-round			<0.0001
Yes	76.8	93.0	
No	23.2	7.0	
Wealth quintile			<0.0001
Poorest	33.4	13.4	
Poorer	23.0	17.6	
Middle	20.5	19.5	
Richer	16.1	23.9	
Richest	7.0	25.7	

toilet are located in Alor and Takalar districts. Households with sanitation facilities also had a greater prevalence of household-level access to water throughout the year than those households without a toilet. Most households with toilets tended to be in the higher wealth categories, and most households without toilets stated money as the primary reason for not having a toilet (96.8%). Most households without toilets were unaware of financing options available for toilet construction (77.7%), although most households with toilets did not report receiving financial assistance to build their toilet (83.2%).

When respondents without latrines were asked about their perceived cost of a toilet, the mean was almost four million Indonesian Rupiah (Rp) (approximately \$300 USD) (range of 400,000 to 8,000,000 Rp) (data not shown). Toilet construction in these areas of Indonesia has been estimated to be typically between 0.65 million and 2.6 million Rp (approximately \$50 to \$200 USD) depending on location, type of latrine, and community factors such as proximity to a water source and sea level (from UNICEF field monitoring data).

Respondents' perceptions and attitudes toward sanitation practices are presented in Table 2. The majority of respondents (81%) agreed that it is embarrassing when people can see others defecating in the open. The majority

of respondents also believed that most people feel ashamed if they lack access to a household toilet. Nearly half of respondents (52%) disagreed that people regard having household sanitation facility as modern, and almost 80% did not perceive smell as an influential factor to explain why people do not want to build a sanitation facility for the household. Large proportions of respondents also disagreed with health-related statements, such as babies' feces do not spread disease and there is no relationship between open defecation and diarrhea. The highest proportion of respondents (85.4%) agreed that women need privacy to defecate.

Bivariate associations between respondents' attitudes and self-reported toilet ownership are presented in Table 3. Respondents who agreed that most people do not have a toilet in their community (i.e., descriptive norms) were associated with 43.4% lower prevalence of toilet ownership than respondents who disagreed with the statement ($p < 0.001$). Having the perception that building a toilet is an expensive task was associated with a 27.2% lower prevalence of toilet ownership than those respondents without this perception ($p < 0.001$). Furthermore, having an accepting attitude toward open defecation (i.e., subjective norm) in general and defecating at a beach or a river was associated with 25% ($p < 0.05$) and 43.8% ($p < 0.001$)

Table 2 | Study respondents' perceptions and attitudes about sanitation behaviors and infrastructure

Statements	Disagree <i>n</i> (%)	Neither <i>n</i> (%)	Agree <i>n</i> (%)
Most people in this community do not have a toilet.	812 (47.9)	359 (21.2)	525 (31.0)
People think those who have a toilet in their house are modern.	884 (52.1)	391 (23.1)	421 (24.8)
Many people think it is too expensive to have a toilet in their house.	548 (32.3)	571 (33.7)	577 (34.0)
In this community, it is acceptable to defecate in the open.	1,260 (74.3)	312 (18.4)	124 (7.3)
It is embarrassing when people can see others defecating in the open.	117 (6.9)	196 (11.5)	1,383 (81.6)
Most people feel ashamed to not have a toilet in their house.	234 (13.8)	483 (28.5)	979 (57.7)
Many people do not want to build a toilet in their house because it smells.	1,353 (79.8)	292 (17.2)	51 (3.0)
It is not a problem defecating on the beach or in a river.	1,120 (66.1)	432 (25.5)	143 (8.4)
Most people in this community would not mind if their daughters married a person who did not have a toilet in his house.	507 (29.9)	760 (44.8)	429 (25.3)
Babies' feces do not spread disease.	1,341 (79.1)	279 (16.5)	75 (4.4)
Many people believe that women do not need privacy to defecate.	1,447 (85.4)	159 (9.4)	90 (5.3)
In most families, men are the ones who decide whether or not to build a toilet in the house.	357 (21.0)	591 (34.8)	748 (44.1)
There is no relationship between defecating in the open and people having diarrhea.	1,252 (73.9)	362 (21.4)	81 (4.8)

Table 3 | Zero-order generalized linear model (GLM) regression (Family: Poisson, Link: Log) of self-reported ownership of a household sanitation facility by respondents' attitudes and perceptions regarding sanitation practices

	Prevalence ratio	Std. error	95% CI		t-statistic
Most people in this community do not have a toilet (Ref: Disagree)					
Neither disagree nor agree	0.656***	0.405	0.581	0.741	-6.84
Agree	0.566***	0.326	0.505	0.633	-9.90
People think having toilets at home is modern					
Neither disagree nor agree	0.996	0.520	0.899	1.104	-0.07
Agree	0.973	0.056	0.868	1.090	-0.48
Many people think a toilet is too expensive to build in their house					
Neither disagree nor agree	0.863**	0.038	0.793	0.941	-3.38
Agree	0.728***	0.040	0.653	0.811	-5.75
It is acceptable to defecate in the open					
Neither disagree nor agree	0.837**	0.054	0.738	0.949	-2.79
Agree	0.750*	0.086	0.599	0.938	-2.52
It is embarrassing when people see others defecating in the open					
Neither disagree nor agree	0.746*	0.086	0.595	0.936	-2.54
Agree	1.057	0.074	0.921	1.214	0.80
Most people feel ashamed not to have a toilet in their house					
Neither disagree nor agree	0.919	0.061	0.806	1.048	-1.26
Agree	0.906	0.059	0.796	1.030	-1.51
Many people do not want to build a toilet in their house because it smells					
Neither disagree nor agree	0.867	0.055	0.766	0.981	-2.27
Agree	0.915	0.126	0.698	1.199	-0.65
It is not a problem defecating on the beach or in a river					
Neither disagree nor agree	0.811***	0.043	0.730	0.900	-3.95
Agree	0.562***	0.080	0.425	0.743	-4.06
Most people would not mind their daughters' marriage with a man without a toilet					
Neither disagree nor agree	0.740***	0.036	0.673	0.814	-6.20
Agree	0.916	0.049	0.825	1.018	-1.64
Babies' feces do not spread disease					
Neither disagree nor agree	0.846*	0.059	0.737	0.971	-2.39
Agree	0.972	0.089	0.813	1.163	0.76
Many people believe that women do not need privacy to defecate					
Neither disagree nor agree	0.929	0.077	0.790	1.093	-0.89
Agree	1.044	0.082	0.894	1.219	0.55
In most families, men make a decision on if they build a toilet in their house					
Neither disagree nor agree	1.158	0.091	0.991	1.352	1.86
Agree	1.202*	0.089	1.040	1.390	2.49
There is no relationship between OD and diarrhea					
Neither disagree nor agree	0.931	0.056	0.828	1.047	-1.19
Agree	0.838	0.096	0.669	1.050	-1.54

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

lower prevalence of toilet ownership, respectively, in contrast to respondents who are not accepting of open defecation.

The results of the multivariate analysis for self-reported toilet ownership are summarized in Table 4. Respondents' age, education, wealth levels, and year-round access to water were positively associated with toilet ownership in all models. The district variable was also significantly associated with ownership. After controlling for demographic and structural factors in Model 2, respondents who perceived low levels of toilet ownership in the community were associated with 25.4% lower prevalence of toilet ownership in contrast to respondents who disagreed with the statement ($p < 0.001$). Those respondents who had an accepting attitude toward open defecation at a beach or a river were also negatively associated with toilet ownership ($p < 0.001$). In Model 3, respondents who did not perceive a link between open defecation and diarrhea were associated with 20.4% lower prevalence of toilet ownership than those respondents who perceived the link ($p < 0.05$). In Model 4, respondents who perceived toilet construction as expensive were associated with 22.2% lower prevalence of toilet ownership ($p < 0.001$). In Model 5, the prevalence of toilet ownership was estimated to be 16.7% higher among respondents who perceived men as the decision-makers for building a toilet than those who disagreed with the statement ($p < 0.05$). Based on the adjusted Wald test statistic, Model 1 was identified as the most parsimonious model.

Table 5 summarizes a sub-population multivariate analysis for the improved sanitation outcome. Respondents' age, household size, and gender were not associated with the presence of improved sanitation across all models, while the respondent's district showed a significant association. Those respondents who use a household sanitation facility to avoid sharing it with others were associated with 17.8% higher prevalence of improved sanitation than respondents who did not have this motivation ($p < 0.001$). The perception that most households in the community have a toilet was positively associated with improved sanitation in Model 7 and Model 9 ($p < 0.005$). Avoiding embarrassment was positively associated with improved sanitation in Model 7 while such an association was lost in Model 9. In regards to structural factors, a significant association was found between wealth quintiles and improved sanitation. Yet,

financial assistance was not a significant driver for the ownership of improved sanitation facilities.

DISCUSSION

Determinants of toilet ownership

The results of this analysis suggest that poverty remains a significant factor in determining investments in household sanitation (Guiteras *et al.* 2015). A positive point for future programming was that those responding to have attended a community event on sanitation in the survey areas found no significant differences among the different socioeconomic groups in attendance and such attendance was positively associated with owning a toilet. This would suggest CLTS approaches, which have a no-subsidy policy, a key component of STBM, can reach a broad spectrum of the community and help in accelerating toilet ownership.

The perceived cost of a toilet among non-owners suggests a potential lack of awareness of the availability of lower cost options, or a desire to have more expensive types of toilets (e.g., pour flush latrines). This desire for more expensive toilets is reflected in the finding that households without toilets greatly preferred flush or pour-flush toilets, rather than basic pit latrines. That households without toilets were found to have less access to water year round could also be one of the contributing factors to their not building their desired pour-flush toilet. There were statistically significant differences between households with and without toilets regarding the perceived cost of a toilet. The cost of sanitation, both perceived and real, has been cited in several other studies as a barrier to toilet ownership in Indonesia and elsewhere, and more work is needed to determine effective approaches to reducing cost barriers as well as raising consumer demand (Jenkins & Curtis 2005; Frias 2008; Sara & Graham 2014).

Additionally, the study results found that lower levels of wealth and education were associated with not owning a toilet, which is also a common theme in other studies (Jenkins & Scott 2007) and also consistent with handwashing practice (Hirai *et al.* 2016). An interesting finding in this study is that households that did not have consistent access to water throughout the year were less likely to

Table 4 | Multivariate generalized linear model (GLM) regression (Family: Poisson, Link: Log) of self-reported ownership of a household sanitation facility by respondents' attitudes and perceptions regarding sanitation practices

	Model 1	Model 2	Model 3	Model 4	Model 5
Age (Ref: 18–35)					
Middle (36–55)	1.144***	1.113**	1.138***	1.137***	1.114**
Older (56 or higher)	1.274***	1.224***	1.271***	1.272***	1.215***
Household size (Ref: 1–3 ppl)					
Middle (4–6 people)	1.037	1.05	1.037	1.046	1.052
Large (7 or more)	1.02	1.058	1.024	1.037	1.061
Female (Ref: Male)	0.975	1.002	0.977	0.974	1.001
District (Ref: Alor and Sumba Timur)					
Luwu Utara	0.884*	0.989	0.931	0.96	0.986
Takalar	0.638***	0.703***	0.670***	0.673***	0.691***
Barru	0.826**	0.943	0.875*	0.842*	0.905
Jayapura	0.97	0.954	1	0.909	0.897
Education (Ref: Less than primary)					
Primary	1.309***	1.237***	1.307***	1.297***	1.242***
Pre-secondary	1.361***	1.248***	1.343***	1.352***	1.246***
Secondary or higher	1.482***	1.318***	1.479***	1.437***	1.318***
Wealth quintile (Ref: Poorest)					
Poorer	1.207*	1.234*	1.215*	1.193*	1.224*
Middle	1.335***	1.309**	1.355***	1.293**	1.284**
Richer	1.512***	1.446***	1.528***	1.418***	1.398***
Richest	1.676***	1.526***	1.672***	1.587***	1.501***
Having water access (Ref: No)	1.438***	1.387**	1.437***	1.391**	1.344**
Most people do not have a toilet (Ref: Disagree)					
Neither disagree nor agree		0.798***			0.823**
Agree		0.746***			0.742***
Acceptable to defecate in the open					
Neither disagree nor agree		1.027			1.045
Agree		1.077			1.079
Embarrassing when people see others defecating in the open					
Disagree nor agree		0.893			0.907
Agree		1.09			1.082
Not a problem defecating on the beach or in a river					
Neither disagree nor agree		0.915			0.926
Agree		0.644***			0.645**
Babies' feces do not spread disease					
Neither disagree nor agree			0.891		0.934
Agree			1.047		1.164*
No relationship between OD and diarrhea					
Neither disagree nor agree			0.914*		0.951
Agree			0.796*		0.930

(continued)

Table 4 | continued

	Model 1	Model 2	Model 3	Model 4	Model 5
People think it is too expensive to have a toilet					
Neither disagree nor agree				0.871***	0.872***
Agree				0.778***	0.877**
People do not want to build a toilet due to the smell					
Neither disagree nor agree				0.951	1.032
Agree				1.018	1.079
People do not mind daughters marrying someone without a toilet					
Neither disagree nor agree				0.903**	0.964
Agree				0.895	0.972
Men being the decision-makers for building a toilet					
Neither disagree nor agree				1.146*	1.187**
				1.127	1.167*
Constant	0.292***	0.344***	0.295***	0.339***	0.360***
Adjusted Wald test: F-statistic	14.64	13.50	12.96	11.24	9.56
Degrees of freedom	(17, 328)	(25, 320)	(21, 324)	(25, 320)	(37, 308)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

have a toilet than those who do have consistent access. This finding suggests that it may be important to address water access in conjunction with sanitation programming activities, particularly when pour-flush toilets are the desired option.

Social norms and acceptability of open defecation

In addition to these household determinants of toilet ownership, this study explored social norms, subjective and descriptive norms and expectations regarding sanitation. The majority of all households agreed that open defecation is not acceptable and agreed that it is embarrassing when people can see others defecating in the open. Additionally, the study found that subjective norms around household perceptions on the acceptability of open defecation were statistically associated with toilet ownership, as well as improved sanitation. Over time, it will be important to measure how the STBM program, which aims to change the social norm governing open defecation in a community, can influence these results. Furthermore, the study findings suggest a need to better integrate formative research around social norms into sanitation interventions (Curtis et al. 1997). In terms of descriptive norms, we found that

respondents who perceived low levels of toilet ownership in the community were associated with lower toilet ownership. To accelerate future sanitation programs, it will be important to address this perception at the community level to achieve open defecation free status via a shared understanding and commitment to stopping open defecation. While there are many determinants of toilet ownership, whether a household has a toilet is also likely to depend on whether others in the household's social reference network already have a toilet or believe that a toilet is beneficial. In other words, toilet ownership is not merely a function of individual choice but is also a property of reference groups of people. There are, thus, biological, psychological, and social reasons that social norms would be relevant to toilet ownership.

The study found that respondents who agreed that there is no relationship between open defecation and diarrhea were less likely to have a toilet. These findings suggest that more effort may be needed to raise the basic understanding of the fecal-oral route of disease. Even with an increased knowledge of the health impacts associated with poor sanitation, however, using health messages as a motivator for building latrines may be contingent on other factors being in place and may not be the most effective method for

Table 5 | Multivariate generalized linear model (GLM) regression (Family: Poisson, Link: Log) of access to improved sanitation among people who reported having a household sanitation facility ($n = 1,140$)

	Model 6	Model 7	Model 8	Model 9
Age (Ref: 18–35)				
Middle (36–55)	0.975	0.977	0.97	0.972
Older (56 or higher)	1.014	1.013	1.003	1.002
Household size (Ref: 1–3 ppl)				
Middle (4–6 people)	1.005	1	1	0.996
Large (7 or more)	1.044	1.025	1.015	0.999
Female (Ref: Male)	0.996	0.994	0.995	0.993
District (Ref: Alor and Sumba Timur)				
Luwu Utara	1.596***	1.568***	1.349***	1.326***
	1.401***	1.407***	1.179*	1.185*
Barru	1.538***	1.555***	1.315***	1.320***
Jayapura	1.537***	1.511***	1.394***	1.367***
Education (Ref: Less than primary)				
Primary	1.032	1.034	0.981	0.985
Pre-secondary	1.085	1.08	0.997	0.997
Secondary or higher	1.188**	1.182**	1.073	1.072
Reasons for using a household toilet facility (Ref: Not selected)				
For good health/disease prevention		1.032		1.025
Cleaner and healthier living in our home		0.996		0.986
Convenience		1.028		1.037
To be modern		1.027		1.034
To avoid sharing with others		1.178***		1.155***
To avoid embarrassment		1.066*		1.047
It's what everyone is doing		1.108*		1.087*
Wealth quintile (Ref: Poorest)				
Poorer			1.405**	1.407**
Middle			1.471***	1.464***
Richer			1.537***	1.527***
Richest			1.517***	1.506***
Having water access (Ref: No)			1.054	1.057
Received any financial assistance (Ref: No)			0.925	0.927
Constant	0.542***	0.521***	0.446***	0.432***
Adjusted Wald test: F-statistic	7.79	5.98	5.56	4.80
Degrees of freedom	(12, 302)	(19, 295)	(18, 296)	(25, 289)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

motivating behavior change. Messages concerning convenience, privacy for women, social status, and community health may be more useful for redefining social norms within rural communities based on our findings and other

studies (Mukherjee *et al.* 2012; Sara & Graham 2014). Most households with and without toilets believed that women need privacy for defecation. The survey found that while men may be viewed as the primary decision-makers,

women in particular, and potentially children, may also be influential in the decision-making process at the household level. It may be that this gender approach could be a more effective lever for improving sanitation behaviors than increasing knowledge on the link between sanitation and health. The inclusion of these social norms in household surveys helped to identify the areas where behavior change and behavior and social norms interventions can be strengthened within programs aimed at improving access to and use of improved sanitation.

Beyond the toilet ownership outcome, we assessed the factors positively associated with access to improved sanitation. These included: (1) convenience, measured as the desire to avoid sharing a toilet; (2) the perception that others use improved sanitation (descriptive norm); and (3) avoiding embarrassment.

There are many other important factors that may influence the success of a sanitation program, which we did not include in this study. Researchers have shown that villages with higher levels of social capital, not measured in this study, were more likely to build toilets, reduce open defecation, and experience corresponding health improvements (Cameron *et al.* 2015; UNICEF 2015). In sanitation programs that target whole communities (e.g., via CLTS), researchers have found greater improvements in small, remote villages with low exposure to prior sanitation projects. The researchers suggested that these programs are most effective in socially cohesive villages (Crocker *et al.* 2016).

There were several limitations to the study. The study is likely to be applicable to rural populations of Indonesia and less generalizable to urban and peri-urban populations. Moreover, this study found differences among the targeted districts, but there is limited information available as to other variables, including what sanitation programs may have occurred in these areas as well as to other factors that may have influenced latrine construction by households. Interviewer bias is one concern given the possibility that the interviewees could have responded with an answer they perceived the interviewer expected. Furthermore, broad categorical responses in certain questions of the survey may have occasionally resulted in insufficient detail for clear conclusions. For example, the survey found that an 'elected official' was one of the most commonly

mentioned primary influencers for toilet construction, however, the level of this government official was not specified. There are other examples of sanitation campaigns, such as in Thailand, where elected officials played an important part of a larger sanitation strategy (Luong *et al.* 2002). Additionally, participants were asked questions regarding beliefs, attitudes, and knowledge regarding 'toilets', as well as cost of toilets, but households were not asked these questions in the context of what type of toilets they were referring to when responding to these questions – a pit latrine or a pour-flush toilet, for example. Lastly, this study only collected data from household heads or adult household members, so perceptions of children and youths are not represented.

CONCLUSION

This study analyzed factors that are associated with current toilet ownership, as well as the factors associated with improved sanitation among rural households in the provinces of Nusa Tenggara Timur, Papua, and South Sulawesi of Indonesia. The results should be useful for sanitation activities in these districts and provinces, as well as other rural sanitation programs in Indonesia. By identifying barriers and facilitators affecting toilet ownership, interventions can target specific perceptions, norms, and behaviors to more effectively and efficiently scale up improved sanitation coverage. There remains a critical need to better understand how social norms, such as individuals' perceptions and expectations of what others do and of what others expect oneself to do, and how this affects demand for sanitation (Evans *et al.* 2014). It may be that promoting privacy and dignity for women and girls could be more important drivers for improving sanitation than the use of health messages, although we found toilet ownership higher among those who believed there was a relationship between sanitation and health. It is clear though that the most influential messages, however, will only be known with sufficient investment in formative research at the local level (Curtis *et al.* 2011).

Many of the findings of this study were similar to those found in past studies that have shown that education and household wealth, as well as the location of where one

lives, can affect toilet ownership (Sara & Graham 2014). There were, however, more novel findings related to social norms. There is a need to explore these further in future research. In terms of structural factors that affect toilet ownership, we found that year-round access to water, which may affect the functioning of a pour-flush toilet (a desired sanitation technology in the study population) was positively associated with toilet ownership. Additionally, the study identified convenience (i.e., the desire to avoid sharing a toilet) as a factor associated with ownership of improved sanitation facilities. Finally, this study highlighted a number of factors that can potentially increase the pace at which sanitation is scaled up across rural communities in Indonesia. More formative research, however, is needed to understand the differential effects of applying these findings in future sanitation programs at local level.

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