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Effect of a Community-Led Total Sanitation Intervention on Sanitation and Hygiene in Pallisa District, Uganda

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Abstract. We conducted a comparative cross-sectional study to examine the potential effects of a community-led total sanitation (CLTS) intervention on sanitation and hygiene in Pallisa district in Uganda. Quantitative data were collected from households using a semi-structured questionnaire and an observation checklist, entered and analyzed using univariate, bivariate, and multivariate analyses. Overall, knowledge on sanitation and hygiene was significantly higher (64.5%; 129/200) among households in the CLTS intervention than among those in the nonintervention subcounties (54.0%; 108/200) ($P = 0.033$). Latrine quality was rated as fair in a majority (73.3%; 143/195) of the CLTS intervention households compared with 50.8% (93/183) in the non-CLTS households ($P < 0.001$). Latrine cleanliness was rated as good in more than a half (51.3%; 100/195) of households in the intervention area, whereas only 13.7% (25/183) for the nonintervention area ($P < 0.001$). In this study, 35.0% (70/200) of the households in the intervention subcounty had attained open defecation-free (ODF) status compared with only 6.0% (12/200) in the nonintervention subcounty ($P < 0.001$). Level of knowledge on hygiene and sanitation (adjusted odd ratio [AOR]: 2.23; 95% CI: 1.24–4.03) and CLTS status (AOR: 8.89; 95% CI: 4.26–18.56) were significantly associated with achievement of ODF status in the multivariate analysis. The mean cases of diarrhea were significantly lower in CLTS implementing (subcounty (0.42 [SD ± 1.03]) than in the non-CLTS implementing subcounty (0.98 [SD ± 1.39]; $t = -4.6$; $P < 0.001$). Sanitation and hygiene outcomes were better in the CLTS intervention subcounty than in the non-CLTS intervention subcounty, suggesting that scaling up CLTS could reduce ODF and the burden of diarrheal diseases.

INTRODUCTION

Globally, 2.0 billion people lack improved sanitation and 946 million practice open defecation (OD).[1] Between 2000 and 2017, the net reduction in the global population practicing open defecation decreased by 647 millions.[1] However, there were disparities in the reductions with countries in Central and South Asia recording the largest reduction of 496 million, whereas sub-Saharan Africa reduced open defecation by 5 million people.[1] A report released by the WHO in 2012 indicated that about 1.5 million children younger than 5 years die each year from sanitation-related diseases such as diarrhea, which could be prevented by community-led total sanitation (CLTS).[2] Uganda was not able to meet its 2015 millennium development goal of increasing sanitation and hygiene coverage to 75%.[3] The country has generally experienced stagnation in progress in achieving better sanitation and hygiene[4] with 18% of the population without access to at least basic sanitation, 18% had limited (shared) sanitation, and 58% had unimproved sanitation in 2017.[1] Moreover, 6% of the population was estimated to still be practising OD by 2017.[1]

The Uganda Ministry of Health with support from Global Sanitation Fund recognized and implemented the CLTS approach in selected districts including Pallisa. The approach is considered an effective and low-cost mechanism to promote better sanitation and hygiene at the household level. The focus of CLTS is to trigger the community to generate sustained behavioral change leading to spontaneous and long-term abandonment of open defecation practices and to stimulate demand for safe sanitation and hygiene facilities without provision of any facilities or subsidies.[5] Indeed, in Pakistan, effective CLTS implementation resulted in improved latrine coverage in all the target districts, which reduced open defecation practices in the communities.[6] In rural Zambia, CLTS activities elicited strong emotions, including shame, disgust, and peer pressure, which persuaded individuals and families to build and use latrines and hand-washing facilities.[7] Previous findings have also indicated that the prevalence of childhood diarrhea was significantly higher in communities where CLTS was not implemented than in the intervention areas.[8,9]

The implementation of the CLTS intervention in Uganda was expected to achieve 100% open defecation-free (ODF) status, better sanitation and hygiene status (latrine and hand-washing coverage, latrine quality, and cleanliness), reduced prevalence of diarrheal diseases, and communities with adequate knowledge on sanitation and hygiene in selected districts. In Pallisa district, although CLTS had been implemented for 7 years, its outcomes/effects had not been evaluated. This study therefore examined the potential effects of the CLTS intervention in Pallisa district by comparing CLTS implementing and non-implementing subcounties.

METHODS

Study area and population. This comparative cross-sectional study was conducted in two subcounties in Pallisa district in Eastern Uganda located 196 km from Kampala city, Uganda's capital. The district consists of 52 parishes, 301 villages, and 46,170 households with a population of 275,600 people[10] and is largely rural, with only 11.8% of the population living in urban areas. The main economic activities in Pallisa district include small-scale agriculture, fishing, and trade. The top five diseases registered in the district include malaria, diarrhea, acute respiratory diseases, intestinal worms, and skin diseases in that order.[11] The study population were residents in Apopong (CLTS intervention) and Puti-Puti (non-CLTS intervention) subcounties, and respondents were adult

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household members aged 18 years and older. Apopong subcounty was purposively selected because this is where the CLTS approach was piloted by the Ministry of Health and is also the concentration subcounty with CLTS being implemented in all parishes unlike other subcounties. Among the non-CLTS subcounties, Puti-Puti was purposively selected because it is similar in context (demographics, and rural and economic activities) and was the furthest from Apopong subcounty approximately 24 km apart and therefore limited chances of exposure to CLTS intervention. A total of 400 households (200 from each subcounty) were visited and a corresponding number of respondents interviewed.

The intervention. The CLTS intervention was implemented in Apopong subcounty starting in 2011 and involved pre-triggering, triggering, monitoring, and declaration of ODF status. During pre-triggering, local leaders, community health workers, and other opinion leaders were mobilized and briefed about the intervention (objectives, procedure, and benefits) by the health assistant and the environmental health staff in charge of a subcounty, sometimes supported by a health educator, both of whom had undergone CLTS training by the ministry of health staff. Triggering was mainly performed through transect walks which involved walking with community members through the village while observing sanitation and hygiene practices, asking related questions, and listening. During the transect walk, CLTS facilitators and community members were able to identify and visualize areas of OD and visit the different types of latrines to establish characteristics of good and safe sanitation and hygiene facilities. Interested community members (first responders) were identified, and demonstrations were made of acceptable sanitation facilities made of local materials including tippy taps by community engineers/masons. A tippy tap is a simple device for handwashing with a container that holds water, which is tipped by a foot-operated stick and rope tied through a small hole in the container cap for water to flow during handwashing. The CLTS implementation was monitored by the community sanitation committee (CSC) with the support of the health assistant. After about 4–6 months of implementation, an ODF claim (initiated by the chairperson CSC) was submitted to the health assistant. A follow-up was performed by a subcounty team (the health assistant, health educator, and the community health worker) to verify and declare the village ODF status using the predefined parameters. Implementation started with a few villages and expanded until the whole subcounty was covered. During the intervention, community education was performed through a radio talk show twice every year although efforts of community health workers in educating community members continued during the implementation. In the control community (Puti-Puti subcounty), usual activities continued, which included periodic visits from health assistants and community health workers to address general health issues including sanitation and hygiene. Some nongovernmental organizations also implemented sanitation- and hygiene-related activities majorly in schools and health facilities within the district.

Sample size and sampling. Sample size was calculated using the formula for two population proportion comparative studies with categorical outcomes.[12] The proportion of households practicing open defecation was considered because CLTS focuses mainly on eliminating open defecation practices. The calculated sample size was 200 households from each subcounty. The study participants were selected by a multistage sampling procedure. From the selected subcounties, three parishes were randomly selected from each, and three villages were randomly selected from the parishes. Systematic random sampling was then used to select households from the villages. The number of households selected from each village was based on the total number of households therein through the probability proportionate to size sampling which also determined the sampling interval. The first household was selected while at the center of the village guided by the compass direction. Where respondents were not found home, the nearest household was interviewed.

Data collection. Quantitative data on sociodemographic factors and knowledge about sanitation and hygiene were collected using a semi-structured questionnaire, whereas observational checklists were used to collect data on ODF latrine and handwashing status. The data collection instruments (Supplemental Information) were adapted from the previous literature on sanitation[13] and pretested in a similar community and necessary adjustments made. Data were collected by a team of research assistants who underwent a 2-day training on the study aspects before being deployed. At least one eligible respondent, who was an adult member in their households, was identified and interviewed. Where more than one adult was present in a selected household, preference was given to the household head, their spouse, or the next adult member. Data collection took place in May 2018.

Definition of variables. The primary outcome variable was the proportion of households that had achieved ODF status, and this was determined based on the following four CLTS standards/indicators[13] assessed using an observational checklist.

1. Absence of feces in the vicinity of the household
2. A latrine with a superstructure with a means of keeping flies from the pit (either water seal or lid)
3. Handwashing facilities with water and soap or soap substitute such as ash
4. Evidence that the latrine and handwashing facilities were being used (e.g., a well-trodden path)

Binary outcome was used based on whether the households had achieved the ODF status or not, with those that had met all the four CLTS standards/ODF indicators described as having achieved ODF status and the rest categorized otherwise. The other secondary outcome variables were as follows.

1. Latrine status defined by the availability of latrines, presence of latrines with covers, presence of latrines with covers that are tight fitting, and evidence of use of latrines (fresh feces in a pit, recent flushing for pour flush latrines, and worn track to latrine from the house).
2. Latrine quality which was described as follows.
   a. Good quality where the roof, walls, and floor were made of permanent materials; the floor was washable; complete latrine structure; the pit was lined with permanent materials; and the latrine had door to provide privacy for the user;
   b. Fair quality. The roof, walls, and floor were made of semi-permanent materials; the floor was not washable; the latrine had complete structure; the pit was either or not lined with permanent materials; and the latrine had a door/temporary shutter to provide privacy for the user;

c. Poor quality where the latrine roof, walls, and floor were made of temporary materials; the floor was made of mud and washable; the latrine had no superstructure; and the pit was not lined and lacked door/temporary shutter to provide privacy for the user.

3. Latrine cleanliness described as good, that is, no sign of excreta (feces and urine) anywhere. Clean and tidy, fair, that is, excreta (feces and urine) around squat hole/squatting plate only; and poor, that is, feces and urine on floor, walls, etc.
4. Handwashing/facility status was based on the presence of handwashing facilities; presence of handwashing facilities with only water; presence of handwashing facilities with water, soap, or soap substitute, for example, ash; and evidence of use of handwashing facilities (wetness on ground below handwashing facility, worn track, and other signs of recent use).
5. Knowledge regarding sanitation and hygiene which was determined based on the ability of the respondents to correctly identify critical times for handwashing, benefits of using a latrine and handwashing facilities, causes of diarrhea, and prevention of diarrhea. Respondents who mentioned at least four critical times of handwashing, at least four benefits of latrine use and handwashing facilities, at least four causes of diarrhea, and at least three ways of preventing diarrhea were regarded as knowledgeable and the rest classified otherwise.
6. Prevalence of diarrhea was determined based on a child younger than 5 years who experienced diarrhea in the past 2 weeks preceding the study.[14] The independent (explanatory) variables were sociodemographic variables.

Data management and analysis. The collected data were coded and entered into EpiData version 3.02 (EpiData Association, Odense, Denmark). The data were then exported to STATA 13 (StateCorp., College Station, TX) for cleaning and analysis. Descriptive statistics including frequencies and proportions for categorical variables and means and SDs for continuous variables were used to describe the study subjects at the univariate level. Chi-square (χ^2) test was used to compare the proportions between subcounties to establish whether they were statistically different based on *P*-value less than 0.05. Odds ratios were obtained to measure the associations, whereas *P*-values ($P < 0.05$) at 95% CI were used to test for any associations at bivariate and multivariate analyses—which controlled for potential confounders. Two-sample *t*-test with unequal variances was used to compare means of diarrhea cases between CLTS and non-CLTS intervention subcounties.

Ethics approval and consent to participate. The Makerere University School of Public Health Higher Degrees and Ethics Committee provided ethical clearance for the study, and the Uganda National Council for Science and Technology registered it. All study participants provided written informed consent, and confidentiality and privacy were upheld.

RESULTS

Sociodemographic characteristics of the respondents. A total of 400 households participated in the study, of which half were from Apopong subcounty (CLTS intervention area) and the rest were from Puti-Puti subcounty, the nonintervention area. Respondents in the CLTS and non-CLTS intervention communities were statistically different as regards their age, gender, tribe, monthly income, marital status, education level, religion, and duration lived in the village ($P < 0.05$). The mean age of respondents was 43.4 (SD ± 15) years in the CLTS intervention subcounty and 54.7 (SD ± 18.5) years in the non-CLTS intervention area. Among respondents, 93.0% (186/200) and 79.0% (158/200) had lived in the CLTS and non-CLTS intervention areas, respectively, for over 3 years (Table 1).

Knowledge on sanitation and hygiene among households in the two communities. Table 2 shows that a majority (91.0%; 182/200) of respondents in the CLTS intervention area and the nonintervention (86.0%; 172/200) area mentioned handwashing before eating food as one of the critical times. In addition, a high proportion (78.5%; 157/200) of respondents in the intervention area and half (50.0%; 100/200), in the nonintervention area mentioned dirty hands as causes of diarrhea. However, overall knowledge levels were higher (64.5%; 129/200) among households in the CLTS implementing area than among those in the non–CLTS-implementing subcounty (54.0%; 108/200), and the difference was statistically significant ($P = 0.033$) (Table 2).

Latrine and handwashing status among households in the two subcounties. Latrine coverage stood at 97.5% (195/200) in the CLTS intervention areas and 91.5% (183/200) in the nonintervention areas, and the difference in proportions was not statistically significant ($P = 0.100$). Moreover, a high proportion (97.4%; 190/195) of households in the CLTS and the non-CLTS (96.7%; 177/183) subcounties had traditional pit latrines. Latrine quality was rated as fair in a majority (73.3%; 143/195) of households in CLTS compared with 50.8% (93/183) for non-CLTS households. Latrine cleanliness was rated as good in more than a half (51.3%; 100/195) of households in the intervention area compared with only 13.7% (25/183) for the nonintervention area. The difference in proportions of both latrine quality and cleanliness between households in the two study areas was statistically significant ($P < 0.001$) (Table 3).

Open defecation-free (ODF) indicators and status between households in CLTS intervention and nonintervention subcounties. The overall results showed that 35.0% (70/200) of the households in the intervention area had attained ODF status compared with only 6.0% (12/200) for nonintervention subcounty, and the difference was statistically significant ($P < 0.001$). It was further observed that households in CLTS and non-CLTS intervention communities were statistically different with respect to having latrines with tight-fitting squat-hole covers, handwashing facilities with water and soap, and evidence of latrine and handwashing facility use ($P < 0.001$) (Table 4).

Factors associated with ODF status in two subcounties. Table 5 shows the crude and adjusted odds ratios for the factors associated with ODF status. Factors associated with attainment of ODF status were CLTS implementation status (crude odds ratio [COR]: 8.44; 95% CI: 4.40–16.19), knowledge on sanitation and hygiene (COR: 2.34; 95% CI: 1.36–4.03), and respondent having had post-primary education (COR: 1.97; 95% CI: 1.11–3.49). At multivariate analysis, the predictors for attainment of ODF status were CLTS status (AOR: 8.89; 95% CI: 4.26–18.56; $P < 0.001$) and level of knowledge on sanitation and hygiene (AOR: 2.23; 95% CI: 1.24–4.03; $P = 0.008$).

Prevalence of diarrhea in children younger than 5 years among households in the two subcounties. The mean number of diarrhea cases in CLTS intervention subcounty was 0.42 (SD ± 1.03) and 0.98 (SD ± 1.39) cases in the non-CLTS subcounty. Two-sample *t*-test revealed that the mean cases

TABLE 1
Sociodemographic characteristics of the respondents

Variable	CLTS intervention areas (N = 200), n (%)	Non-CLTS intervention areas (N = 200), n (%)	χ^2	P-value
Age (years)				
18–25	15 (7.5)	9 (4.5)	40.92	**< 0.001**
26–35	57 (28.5)	27 (13.5)		
36–45	50 (25.0)	36 (18.0)		
46–55	40 (20.0)	30 (15.0)		
56 and older	38 (19.0)	98 (49.0)		
Tribe				
Mugwere	17 (8.5)	91 (45.5)	90.70	**< 0.001**
Itesot	171 (85.5)	84 (42.0)		
Others	12 (6.0)	25 (12.5)		
Duration lived in the village (years)				
3 years and less	14 (7.0)	42 (21.0)	35.20	**< 0.001**
More than 3 years	186 (93.0)	158 (79.0)		
Gender				
Male	185 (92.5)	141 (70.5)	32.1	**< 0.001**
Female	15 (7.5)	59 (29.5)		
Marital status				
Married	19 (95.5)	166 (83.0)	16.3	**0.001**
Not married	9 (4.5)	34 (17.0)		
Religion				
Protestant	88 (44.0)	70 (35.0)	48.1	**< 0.001**
Others (borne again)	53 (26.5)	20 (10.0)		
Catholic	50 (25.0)	67 (33.0)		
Seventh Day Adventist	9 (4.5)	43 (21.5)		
Education level				
None	11 (5.5)	149 (74.5)	13.8	**0.030**
Primary	142 (71.0)	19 (9.5)		
Secondary	40 (20.0)	26 (13.0)		
Tertiary	7 (3.5)	6 (3.0)		
Occupation				
Peasant	171 (85.0)	177 (88.5)	3.6	0.465
Salaried worker	21 (10.5)	13 (6.5)		
Others	8 (4.0)	10 (5.0)		
Monthly income (Uganda Shillings)				
< 50,000	158 (79.0)	142 (71.0)	10.2	**0.038**
50,000 and greater	42 (21.0)	58 (29.0)		

CLTS = community-led total sanitation. Bold indicates statistically significant association.

of diarrhea were significantly lower in intervention subcounty than the non-CLTS intervention subcounty ($t = -4.6$, $P < 0.001$).

DISCUSSION

The study examined the potential effects of CLTS implementation on sanitation and hygiene status focusing on knowledge, latrine, and handwashing status, and prevalence of diarrhea in children younger than 5 years and ODF status. The study results indicated that CLTS was effective in improving knowledge levels of communities on sanitation and hygiene. Therefore, community's exposure to CLTS processes such as pre and post-triggering sessions and follow-up visits is very important in CLTS implementation as a

TABLE 2
Knowledge levels of hygiene and sanitation among households in the two subcounties

Variable	CLTS intervention areas N = 200, n (%)	Non-CLTS intervention areas N = 200, n (%)	χ^2	P-value
Knowledgeable on critical times of handwashing				
Yes	186 (93.0)	165 (82.5)	10.3	**0.001**
No	14 (7.0)	35 (17.5)		
Knowledgeable on causes of diarrhea among children				
Yes	180 (90.0)	174 (87.0)	0.9	0.347
No	20 (10.0)	26 (13.0)		
Knowledgeable on prevention of diarrhea				
Yes	172 (86.0)	134 (67.0)	20.1	**< 0.001**
No	28 (14.0)	66 (33.0)		
Appreciated the benefits of having a latrine and handwashing facility				
Yes	154 (77.0)	190 (95.0)	26.9	**< 0.001**
No	46 (23.0)	10 (5.0)		
Knowledgeable on sanitation and hygiene (overall)				
Yes	129 (64.5)	108 (54.0)	4.6	**0.033**
No	71 (35.5)	92 (46.0)		

CLTS = community-led total sanitation. Bold indicates statistically significant association.

TABLE 3
Latrine and handwashing status in the two subcounties

Variable	CLTS intervention area (N = 200), n (%)	Non-CLTS intervention area (N = 200), n (%)	χ^2	P-value
Has latrine				
Yes	195 (97.5)	183 (91.5)	6.9	0.100
Types of latrine				
Pit	190 (97.4)	177 (96.7)	1.1	0.586
Others	5 (2.6)	6 (3.3)		
Latrine has a door				
Yes	100 (51.3)	45 (24.6)	28.4	**< 0.001**
Latrine has screen walls				
Yes	158 (81.0)	150 (82.0)	0.06	0.814
Latrine has a roof				
Yes	178 (91.3)	131 (71.6)	24.5	**< 0.001**
Latrine has cover				
Yes	138 (70.8)	19 (10.4)	141.8	**< 0.001**
Presence of anal cleansing materials				
Yes	53 (27.2)	32 (17.5)	5.1	0.024
Latrine cleanliness				
Good	100 (51.3)	25 (13.7)	72.8	**< 0.001**
Fair	85 (43.6)	110 (60.1)		
Poor	10 (5.1)	48 (26.2)		
Latrine quality				
Good	30 (15.4)	19 (10.4)	38.5	**< 0.001**
Fair	143 (73.3)	93 (50.8)		
Poor	22 (11.4)	71 (38.8)		
Has a handwashing facility				
Yes	144 (72.0)	58 (29.0)	74.0	**< 0.001**
Has a handwashing facility with water				
Yes	129 (64.5)	51 (25.5)	61.5	**< 0.001**
Handwashing after using a latrine				
Yes	177 (88.5)	163 (81.5)	3.8	0.05
No	23 (11.5)	37 (18.5)		
No	23 (11.5)	37 (18.5)		

CLTS = community-led total sanitation. Bold indicates statistically significant association.

way to increase their knowledge levels on sanitation and hygiene. Individuals who have adequate knowledge on sanitation and hygiene are more likely to adopt better sanitation and hygiene practices as this determines the individual attitudes to adopt positive behavior change as found in rural Zambia.[7]

Similarly, the proportion of households that achieved ODF status had good-quality latrines and possessed handwashing facilities with water and soap, for example, ash was higher in the CLTS intervention area than non-CLTS households. This may be attributed to the fact that CLTS helps to create

TABLE 4
ODF indicators and status between CLTS and non-CLTS intervention subcounties

Variable	CLTS intervention area (N = 200), n (%)	Non-CLTS intervention area (N = 200), n (%)	χ^2	P-value
ODF indicators				
1. A functional latrine with a superstructure and has a squat hole with a tight-fitting cover or water seal			141.8	**< 0.001**
Yes	139 (69.5)	19 (9.5)		
No	61 (30.5)	181 (90.5)		
2. Presence of a handwashing facility with water and soap or soap substitute near a latrine			52.0	**< 0.001**
Yes	111 (55.5)	41 (20.5)		
No	89 (44.5)	159 (79.5)		
3. No feces seen around the vicinity			0.4	0.506
Yes	140 (70.0)	146 (73.0)		
No	60 (30.0)	54 (27.0)		
4. Evidence of latrine use and handwashing with soap or soap substitute after visiting the latrine				
Yes	117 (58.5)	63 (31.5)	–	–
No	83 (41.5)	137 (68.5)	29.5	**< 0.001**
Overall ODF status				
Yes	70 (35.0)	12 (6.0)	51.6	**< 0.001**
No	130 (65.0)	188 (94.0)		

CLTS = community-led total sanitation; ODF = open defecation-free. Bold indicates statistically significant association.

TABLE 5
Bivariate and multivariate analyses of factors associated with ODF status

Variable	ODF status		COR (95% CI)	*P*-value	AOR (95% CI)	*P*-value
	No (*n* = 318), *n* (%)	Yes (*n* = 82), *n* (%)				
Gender						
Male	254 (79.9)	72 (87.8)	1.0	–	–	–
Female	64 (20.1)	10 (12.2)	0.55 (0.27–1.12)	0.103	1.03 (0.37–2.96)	0.941
Age (years)						
18–35	84 (26.4)	24 (29.3)	1.0	–	–	–
36–55	118 (37.1)	37 (45.1)	1.10 (0.61–1.96)	0.755	1.32 (0.70–2.50)	0.390
56 and older	116 (36.5)	21 (25.6)	0.63 (0.33–1.21)	0.169	1.37 (0.64–2.92)	0.420
Household number						
1–5	100 (31.5)	20 (24.4)	1.0	–	–	–
6–10	139 (43.7)	41 (50.0)	1.47 (0.81–2.67)	0.199	–	–
11 and above	79 (24.8)	21 (25.6)	1.33 (0.67–2.62)	0.412	–	–
Marital status						
Not married	35 (11.0)	8 (9.8)	1.0	–	–	–
Married	283 (89.0)	74 (90.2)	1.14 (0.51–2.57)	0.745	0.45 (0.14–1.48)	0.190
Education level						
Primary and below	268 (84.3)	60 (73.2)	–	–	–	–
Postprimary	50 (15.7)	22 (26.8)	1.97 (1.11–3.49)	**0.021**	1.47 (0.76–2.84)	0.254
Occupation						
Farmer	280 (88.1)	68 (82.9)	1.0	–	–	–
Others	38 (11.9)	14 (17.1)	1.52 (0.78–2.96)	0.221	1.38 (0.63–3.01)	0.418
Monthly income						
< 50,0000	243 (76.4)	57 (69.5)	1.0	–	–	–
Greater than 50,000	75 (23.6)	25 (30.5)	1.42 (0.83–2.43)	0.199	–	–
Knowledgeable on sanitation and hygiene						
Yes	142 (44.7)	61 (74.4)	1.0	–	–	–
No	176 (55.4)	21 (25.6)	2.34 (1.36–4.03)	**0.002**	2.23 (1.24–4.03)	**0.008**
CLTS status						
Non-CLTS intervention area	188 (94.0)	12 (6.0)	1.0	–	–	–
CLTS intervention area	130 (65.0)	70 (35.0)	8.44 (4.40–16.19)	**< 0.001**	8.89 (4.26–18.56)	**< 0.001**
Presence of child younger than 5 years with diarrhea						
Yes	131 (41.2)	18 (21.9)	1.0	–	–	–
No	187 (58.8)	64 (78.1)	2.49 (1.41–4.40)	**0.002**	1.51 (0.80–2.56)	0.206

CLTS = community-led total sanitation; ODF = open defecation-free. Bold indicates statistically significant association.

demand for safe sanitation and hygiene through the CLTS triggering processes, which ignite individuals and families to build and use latrines and handwashing facilities. These findings are largely comparable to previous studies conducted in low- and middle-income countries including Ethiopia,[9] Kenya,[8] Niger,[13] and Uganda.[15]

It is further important to note that most latrines observed in both study areas in Pallisa district were traditional pit latrines mainly made of local materials. Use of local materials/solutions to construct latrines by households in the intervention area is consistent with findings from Ghana[16] and reinforces some of the key pillars of CLTS of ensuring local solutions and cooperation that increase the uptake of sanitation facilities. However, as previously noted, the use of local materials for construction of latrines sometimes results in poor-quality latrines, a key limitation of the CLTS approach.[17,18] Indeed, despite good latrine coverage in both the intervention and nonintervention areas, most latrines did not have tight-fitting squat-hole covers. The significant proportion of latrines without tight-fitting squat-hole covers indicated that the fecal–oral route of disease transmission was not completely interrupted, and people could have continued to be exposed to excreta through food/fluids contaminated by flies, exposing them to fecal–oral diseases. Findings in relation to latrines having squat holes with/without tight-fitting covers were consistent with those from studies conducted by WaterAid and UNICEF.[19]

Achieving ODF status was associated with CLTS implementation in multivariate analysis. The findings support the argument that participatory sanitation approaches such as CLTS trigger communities to demand for sanitation and hygiene facilities and adopt sustained behavior change leading to abandonment of open defecation practices.[2,20] In relation to other factors influencing ODF status, knowledge of sanitation and hygiene is important because it influences the individual's attitudes to adopt sustained behavioral change. This stimulates demand for sanitation and hygiene facilities without external subsidies or support in construction of facilities.[5] It is thus important that when implementing CLTS in the community, priority is given to equipping communities with sufficient knowledge about sanitation and hygiene. Moreover, beyond CLTS, behavior change communication interventions should be considered for their importance in supporting behavior adoption. In bivariate analysis, post-primary education was associated with achievement of ODF status in non-CLTS intervention subcounty. However, the association disappeared in the multivariate analysis, indicating that education level was not a standalone factor that can be linked to achievement of ODF communities. Thus, irrespective of individual's education level in households, ODF status can be achieved as long as quality triggering and follow-up of triggered communities are performed to equip communities with knowledge about hygiene and sanitation, one of the predictors for ODF status in communities.

The difference in availability of handwashing facilities with water and soap, evidence of use of handwashing facility, latrine coverage, and knowledge on sanitation and hygiene might explain the difference in diarrhea cases between the intervention and nonintervention subcounties. This supports the argument that CLTS intervention significantly contributes to the reduction in diarrheal morbidities in communities, and it demonstrates that there is adoption of sustained positive behavior change by individuals and communities.[9] However, attributing CLTS interventions to reduction in sanitation-related diseases is difficult because it is virtually impossible to isolate the effects of other interventions. The findings from this study are in line with the study conducted in Nyando district, Kenya, which established that there were significant differences in disease cases between CLTS and non-CLTS households for diarrhea.[8]

Study limitations and strengths. This study provides information regarding associations between CLTS implementation and health outcomes over a long implementation period of 6 years unlike most previous studies that usually had a short duration and/or assessed only short-term outcomes. We recognize that the study's cross-sectional design provides associations which are not indicative of causality. The study used quantitative research techniques involving semi-structured questionnaires and observational checklists, which provided reliable information. However, response biases may have affected the reliability and quality of the results as the respondents, especially in the intervention areas, may have been prone to providing socially desirable responses. Although we controlled for potential confounders in multivariate analysis, the other analysis techniques did not do so, and their findings should be interpreted in light of this. Moreover, even though the CLTS intervention did not take place in the nonintervention subcounty, we cannot rule out the possibility of other interventions such as health education in schools, and health facilities or mass media could have impacted our outcomes. However, this could only have worked to reduce the strength of the CLTS intervention during comparison of the study outcomes between subcounties.

Conclusion. Respondents in the CLTS intervention area had higher knowledge of sanitation and hygiene than those in the non-CLTS area. The proportion of households that achieved the ODF status was higher in CLTS intervention subcounty than in the non-CLTS intervention subcounty. The prevalence of diarrhea was lower in the intervention area than in the nonintervention area. Although this evidence is from a cross-sectional study, scaling up CLTS to all subcounties and equipping communities with knowledge on sanitation and hygiene could reduce ODF and the burden of diarrheal diseases in communities.

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