CLTS implementation in Malawi: process evaluation of a sanitation and hygiene intervention

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Abstract

Community-Led Total Sanitation (CLTS) seeks to eliminate open defecation by empowering households to adopt improved sanitation and hygiene behaviours through latrine use. Widely integrated into national sanitation strategies in low- and middle-income countries, CLTS is implemented through pre-triggering, triggering, and post-triggering activities. However, limited evidence exists on how implementation process promotes behaviour change.

This study retrospectively evaluates a community-based intervention in Chiradzulu District, Malawi, that employed CLTS alongside market-based sanitation and hygiene promotion campaigns. Using the UK Medical Research Council process evaluation framework, we analysed project documentation and collected data from household surveys (n=1,151), interviews (n=36), and focus group discussions (n=14).

All planned activities were implemented, though adaptations affected fidelity and required additional household visits. Intervention reach was suboptimal: 46% of households attended triggering events, 64% received visits, 16% were exposed to market-based sanitation, and 47% received hygiene campaigns. Exposure to both triggering sessions and household visits increased the likelihood of latrine availability (OR = 1.63; CI = 1.55–1.72) and HWF presence (OR = 1.39; CI = 1.03–1.86). High costs, limited awareness of masons, and extreme weather events affected latrine adoption. Our findings emphasize the need for multi-level engagement, flexible delivery, and addressing barriers for sustainable sanitation adoption.

Key words

Community-led total sanitation; process evaluation; sanitation; WASH, Malawi

Introduction

Access to improved water, sanitation, and hygiene (WASH) is integral for public health [1] and a fundamental human right [2]. Despite progress, a significant proportion of the global population does not have access to the necessary services to practice safe WASH-related behaviours [3, 4]. Although 'safely managed' sanitation has increased from 49% to 57% globally between 2015–2022, 3.5 billion people still lack this level of service, with an estimated 419 million practising open defecation (OD), and two billion lacking access to basic hygiene services [3]. To accelerate the progress needed to attain Sustainable Development Goal (SDG) 6 to "ensure availability and sustainable management of water and sanitation for all" [5], resources must be allocated to essential infrastructure, in combination with effective mechanisms to drive behaviour change [6, 7].

One approach purported to support rapid and transformative change in rural sanitation is Community Led Total Sanitation (CLTS), an approach adopted in governmental policy in many countries, including Malawi [8, 9]. CLTS requires active community participation to eradicate OD practice and promote hygiene in rural areas [10, 11] through a 3-stage process: pre-triggering (selection of a community, community leader engagement, and planning triggering); triggering (participatory sanitation profile analysis); and post-triggering (community action planning and household follow-up visits).

The effectiveness of the CLTS approach has generally been mixed [7]. Several studies using CLTS have reported successful changes in latrine coverage, sanitation related behaviour change, and enteric infections [12–17]. However, maintaining the intended behaviour and infrastructure after declaring an area open defecation free (ODF) has been reported as challenging, affected by issues such as community social capital, size, socio-economic status,

intervention fidelity, capacity of natural leaders, infrequent follow-ups, and rains [17–22]. Since the adoption of CLTS, the majority of research has examined long-term outcomes without exploring the integrity of the implementation process, which may affect sustainability. More evidence is needed to understand the delivery process and how these may affect CLTS.

This study describes a retrospective process evaluation of a World Vision Malawi and Water for People 'WASH for Everyone' (W4E) intervention that implemented CLTS at community level. Our study addresses existing evidence gaps by determining how closely a specific CLTS programme adhered to its set protocol and explore the implication of this on the implementation fidelity (including adherence, integrity, and quality) [23]. We also explore dose, reach, acceptance, and adaptation of the CLTS programmes, and explore the possible mechanisms that may influence long-term impact of a programme [23, 24].

Methods

Process evaluation

Adapting previously published guidelines for process evaluation [25], we assessed context, planned implementation and the mechanism of impact of a community-based sanitation and hygiene programme in rural Malawi (Fig 1).

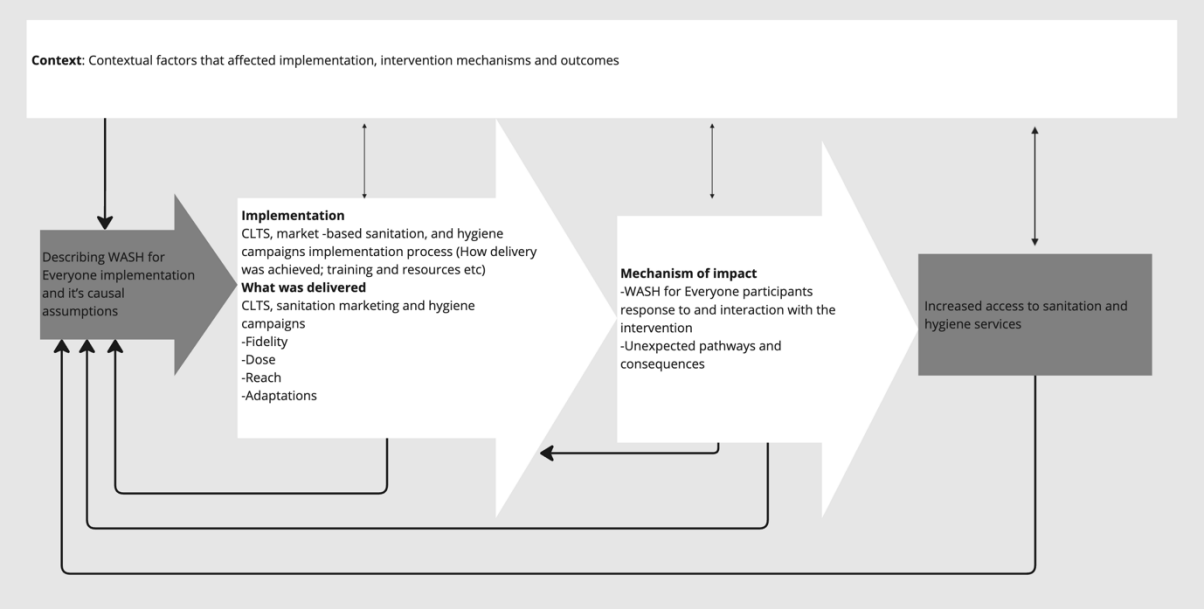

Figure 1: Process evaluation framework adapted from Medical Research Council guidance [25].

Study setting

The intervention was implemented in Chiradzulu District in the southern region of Malawi. Chiradzulu District, with a population of approximately 360,000 [24], is divided into 10 administrative areas known as Traditional Authorities (TAs) [26]. In 2017, an estimated 75% of households in this rural district lacked access to improved sanitation and 2.1% practised OD [26]. Targeting 100% coverage, progress by November 2018, reported 440 out of 831 (53%) communities were ODF although only 49 had been certified ODF by the National ODF Task Force [27]

The WASH for Everyone intervention

This evaluation was set within the Water, Sanitation, and Hygiene for Everyone (W4E) programme, a three-year (2022 – 2024) district-wide intervention implemented by two non-governmental organisations (NGOs), World Vision Malawi and Water for People. The programme was implemented across all 10 TAs in Chiradzulu District in three years, from January 2022 to December 2024. W4E aimed to ensure that everyone in the district had access to improved WASH services through the provision of services in institutions, such as health

facilities and primary schools, and promotion of sanitation and hygiene at community level through CLTS.

A Theory of Change (ToC) was developed by the research team with input from the implementing partners. The ToC was used to inform data collection and analysis by mapping the projects intended deliverables (inputs and activities) with outputs and target outcomes (Fig 2). This was used to inform the assessment of the various process evaluation components (context, planned implementation, and mechanism of impact).

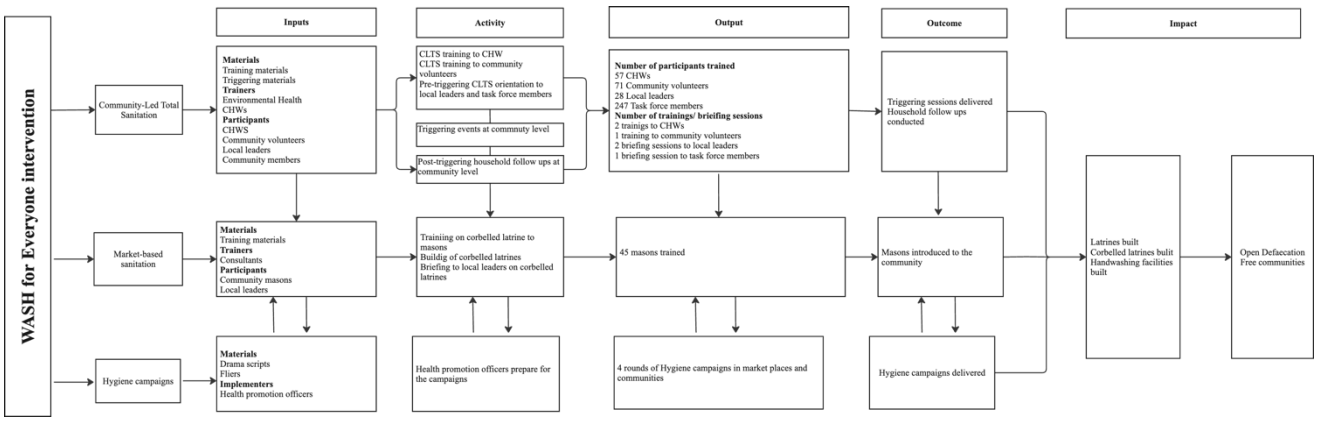

Figure 2: Theory of Change (ToC) for W4E implementation and outcome co-developed between the research and implementing teams

To assist with delivery, the project intended to train 60 CHWs and 38 local leaders over both TAs, and 120 local Care Group members in TA1. The Year 1 community sanitation and hygiene component of the programme was implemented in two TAs (TA Likoswe (TA1) and TA Mpama (TA2) from January 2022 to February 2023 and primarily employed the CLTS approach [9], in line with the Malawi National Sanitation and Hygiene Strategy [8]. CLTS delivery was primarily delivered by government Community Health Workers (CHWs), locally referred to as Health Surveillance Assistants (HSAs).

CLTS implementation in TA1 involved pre-triggering events where the communities were sensitized to the project, triggering events to promote sanitation and hygiene and selection of natural leaders, and post-triggering which consisted of household follow-up visits. CLTS triggering activities focused on visual and participatory demonstrations of faecal-oral transmission to trigger shame and disgust. After the triggering events, community members were to nominate 'natural leaders' responsible for conducting four follow-up activities with households to encourage adoption of behaviours. Natural leaders were intended to be supported by CHWs, a local Care Group (volunteers who usually promote maternal and child health, while mitigating malnutrition), and local leaders (chiefs). TA2 was officially declared ODF in 2021, therefore post-triggering household follow-up visits were used to verify the presence and usage of latrines during this implementation period. These follow-up visits were to be conducted by community task force members (community committee that help in various community developments) with support from CHWs and chiefs.

Market-based sanitation was implemented to support CLTS, which involved promoting the construction of improved, durable, low-cost sanitation technologies to community members. The corbelled latrine has a below ground, cement free brick-built dome-shaped sub-structure to mitigate the risk of collapse, and a traditional superstructure, all constructed utilising locally accessible materials [28, 29]. The project planned to provide practical training for 20 community masons per TA on how to construct corbelled latrines, equipping them with the skills to build these latrines for a fee (maximum charge for substructure was 17 USD, fee for erecting the superstructure varied). Local leaders recruited one community mason per sub-TA, who were to be provided with construction tools on completion. Trained masons were to be

introduced to the community by local leaders, local Care Group members and CHWs during triggering, community meetings, and household follow-ups to activate demand.

The intervention planned to collaborate with the district hospital Health Promotion Office (HPO) to deliver hygiene promotion campaigns in addition to CLTS. They intended to use pre-established sanitation and hygiene messages from the Ministry of Health (MoH), through a series of four campaigns. Each campaign was to last five days using a mobile van to disseminate hygiene messages, and the distribution of leaflets.

Process evaluation study population

The evaluation included individuals who were responsible for implementing the intervention and the community recipients. Intervention implementers consisted of project officers from World Vision Malawi and Water for People, and staff from the District Health Office (DHO), i.e. District Health Promotion Officer and CHWs. Community stakeholders included natural leaders, community volunteers, community task force members, local leaders and trained community masons (Table 1).

Data collection

Primary data were gathered from two separate rounds of data collection at the end of the Year 1 implementation period. Round one of data collection was process evaluation data, collected from May to June 2023, consisting of: a household survey; in-depth interviews (IDIs) with W4E Project officers, District Health Promotion Officer, CHWs, W4E trained masons, local leaders and natural leaders; and focus group discussions (FGDs) with community members, community task force members and community volunteers (Table 1). The household surveys, guides for IDIs, and FGD tools were initially prepared in English and subsequently translated

into the local language, Chichewa. Following participant approval, IDIs and FGDs were recorded. Data were collected by seven enumerators hired by the research team, all with a minimum of a bachelor's degree in environmental or public health. The process evaluation household survey included 130 households in each TA. Simple random sampling was used to select 13 villages from each TA and 10 households per village. Qualitative data collected through IDIs with key stakeholders used purposive sampling to capture a range of stakeholders involved in the intervention delivery (Table 1). Recruitment was continued until saturation was reached either in terms of the stakeholders available or the nature of responses was consistent.

The second round of primary data consisted of the household survey implemented as part of the W4E programme annual survey (referred to as Year 1 endline). This was conducted from June and July 2023 and consisted mainly of open-ended questions with pre-coded responses. Respondents were community members, and the data collection team consisted of 11 enumerators hired by the implementation NGOs, with a minimum of a bachelor's degree.

Sample size for the Year 1 endline mirrored a programmatic baseline completed by implementing partners in 2022 (World Vision Malawi and Water for People, 2023). In each of the two TAs, a targeted 450 households across 15 Enumeration Areas (EAs) were identified for recruitment; EAs are geographic areas canvassed by one government census representative and is composed of one or more adjacent villages. The Year 1 endline survey provided additional nuance to the process evaluation survey to understand the context and implementation process against the ToC.

The data collection teams did not participate in the design or implementation of the intervention. Before collecting data, both teams underwent two-day separate training sessions

to introduce the study, orientate them on research ethics, data collection tips, and the data collection tools, followed by one day of pre-testing.

Secondary data were sourced from intervention quarterly reports and project log frames.

Table 1: Data sources used to assess implementation of the WASH for Everyone project

Data collection method	Data collection tool	Study participants	Sample size		Implementation aspect assessed			
			Targeted	Achieved	Fidelity	Dose	Adaptation	Reach
Quantitative	W4E endline household survey	Intervention beneficiaries (community members)	900	893	√	√		√
	PE household survey	Intervention beneficiaries (community members)	260	258	√	√		√
Qualitative	In-depth Interviews	W4E Project officers	2	2	√	√	√	√
		District Health Promotion Officer	1	1	√	√	√	√
		Community Health Workers	9	9	√	√	√	√
		W4E trained mason	8	8	√	√	√	√
		Local leaders	6	6	√	√		√
		Natural Leaders	10	10	√			√
	Focus Group Discussions	Intervention beneficiaries (community members)	8 (80 participants)	8 (69 participants)	√	√	√	√
		Task force members	3 (30 participants)	3 (27 participants)		√		√
		Community volunteers	3 (30 Participants)	3 (30 participants)	√	√	√	√
Quantitative	W4E project log frame	N/A	1	1		√		√
Qualitative	W4E quarterly reports	N/A	4	4	√	√	√	√

Note: √ means that the process evaluation aspect was assessed using that data collection tool

Data Management and analysis

Quantitative data

Where possible, quantitative data were combined across both the process evaluation and Year 1 endline survey. The number of people reached with CLTS trainings, and market-based sanitation and hygiene campaigns were extracted from the project log frame and project reports, and imported into Microsoft Excel Version 16 (Microsoft corporation, Redmond, WA, USA) where descriptive statistics were analysed. Additional quantitative data from the household surveys was analysed in STATA 18 (StataCorp LP, College Station, TX). Descriptive statistics, including frequencies and proportions, were used to assess the attendance and participation in triggering events, household follow-ups and hygiene campaigns.

Chi-square test was used to assess the relations between attending triggering events and demographic characteristics. Logistic regression models were used to explore the relationship between intervention exposure and presence of a latrine and/or handwashing facility in the home. Models were adjusted for demographic characteristics i.e. age, gender, level of education etc.

Qualitative data

IDIs and FGDs were audio recorded. Audios files were transcribed and translated back to English. Data related to intervention implementation project reports were extracted. Thematic analysis [30] techniques were followed where all qualitative data were coded against pre-identified themes (implementation fidelity, reach, dose, adaptation and mechanism of impact).

We integrated the qualitative data with the analysed quantitative data through a manual triangulation process. This involved systematically comparing themes and patterns identified in the qualitative data with the statistical findings from the quantitative analysis.

Ethical considerations

The study was approved by the Ethics Committee at the London School of Hygiene and Tropical Medicine (LSHTM Ethics Ref: 28249), and the National Commission for Science and Technology (NCST) in Malawi (P.09/22/673). Informed written consent was obtained from all study participants prior to enrolment.

Results

Description of study participants

A total of 1,151 individuals were included across both household surveys (process evaluation and year 1 endline survey). The household survey respondents were between 18-84 years old and predominantly male (74%). 58% were married, 36% never attended school, and 62% were unemployed (Table 2). The average household size was four. Additionally, 149 community members participated in 16 FGDs.

Thirty-six participants responsible for delivering the intervention participated in in-depth interviews, and 117 individuals participated in 12 FGDs. The study participants (9 CHWs, 30 community volunteers, 6 natural leaders, 27 community task force members, and 8 masons), were between 24 and 48 years old and had extensive experience across various fields, with a mean of 8 years' work experience for CHWs, 10 years among the task force members, and 12 years for the masons.

Table 2: Description of the household survey sample (n=1151)

Variable	Frequency (%)
Traditional authority	
Likoswe (TA1)	578 (50.20)
Mpama (TA2)	573 (49.80)
Gender	
Male	855 (74.28)
Female	296 (25.72)
Age of respondent	
18-39	537 (46.66)
40-59	404 (35.10)
60+	210 (18.25)
Number of people per household	
<=3	575 (49.96)
>=4	576 (50.04)
Respondent level of education	
No education	416 (36.14)
Primary	464 (40.31)
Secondary	244 (21.20)
Tertiary	27 (2.35)
Head of household occupation	
No occupation	718 (62.38)
Informal employment	265 (23.02)
Formal employment	168 (14.60)

Process evaluation findings

The results of the process evaluation are aligned with the Medical Research Council (MRC) framework [25] (Figure 1) and are reported according to implementation context, planned implementation, and the mechanism of impact.

Implementation context

Process evaluation results from all data sources found three key contextual factors affecting the intervention implementation and participant response to the intervention: i) previous exposure

to sanitation and hygiene programmes; ii) community's economic status; and iii) climate change and extreme weather events.

Previous exposure to sanitation and hygiene programmes: Multiple international NGOs have implemented sanitation and hygiene programmes in Chiradzulu in the years preceding W4E, including Development Aid from People to People (sanitation), Evidence for Action, and Water for People (water). These initiatives were a potential enabler for the uptake of promoted behaviours; increasing the familiarity of the local population with sanitation and hygiene messages enabled behavioural adoption.

Community's economic status: 62% of survey participants were unemployed.; 23% reported small scale farming or businesses. Only 15% of respondents stated they were formally employed. A total of 77% of the individuals involved in the study reported a monthly household income of less than $23, representing a potential barrier to rapid adoption of the promoted behaviours. This highlights the economic constraints faced by most of the study population, which directly impact their ability to invest in latrine construction (delayed construction of latrines) or reconstruction after collapsing.

Climate change and extreme weather events: Following completion of intervention implementation, the district was hit by Cyclone Freddy (March 2023) which significantly damaged and destroyed infrastructure including toilets. The destruction of latrines posed a substantial challenge to the sustainability of behaviour change since one of the key pillars of sustained sanitation behaviour is the continued availability and functionality of latrines, which facilitate hygiene practices and discourage open defecation. When infrastructure is destroyed, communities are forced to OD practices, undermining the gains made during the project.

Planned implementation

The implementation process was evaluated against the agreed Theory of Change (Figure 2) by documenting how delivery of the various components (CLTS, market-based sanitation and hygiene promotion campaigns) was achieved, and exploring the implications of the delivery on fidelity, dose, reach and adaptation of the intervention. To achieve CLTS implementation, the project collaborated with CHWs, community stakeholders and natural leaders who emerged during the triggering event, and community volunteers, task force members, and local leaders to support household follow-ups. For effective intervention delivery, the CHWs and community stakeholders were trained on CLTS implementation and topics related to ending OD (Transect Walk, water with faeces demonstration, food with faeces demonstration, shit calculation etc).

The CHWs were supported with resources like stationery for report writing and lunch allowances of 3.5 USD per day.

The market-based sanitation component included training of community masons and providing them with construction tools (measuring tape, building level, trowel, set square, and shovel) to support their work. To deliver the hygiene campaigns, the project worked with the district health promotion office by supporting the team with fuel and lunch allowances of 3.5 USD per day.

Fidelity, reach, dose and adaptation of CLTS Implementation

In total, the project trained 57 of the 60 CHWs in both TAs. All interviewed CHWs (n=9) verified their participation in CLTS training. Five full days of training were planned for CHWs; however, three of the five days of training were delayed because CHWs were involved in the delivery of polio vaccine campaigns scheduled for the same time. To maintain programme

timelines, additional training days were not added. Some CHWs who had previously participated in other CLTS trainings felt training was rushed.

> "Maybe the project had strict deadlines. This training seemed rushed compared to previous trainings I have attended in my 15 years of working as a CHW. Not sure how easy it was for new CHWs to follow and understand" [KII, TA1, CHW].

Despite the initial intention to involve local Care Groups in the delivery of the sanitation and hygiene programmes, Care Groups were not formally established in TA1. Local volunteers, referred to as community volunteers, were trained instead.

> "No active care groups were found in the intervention area when we began implementation. So, although we planned to use care groups, we trained community volunteers instead" [KII, Project officer].

CLTS orientation was intended to share CLTS knowledge to community stakeholders. Project reports indicated that all local leaders (n= 38) from both TAs, 71 community volunteers (instead of 120 planned care group members) in TA1, and 247 community task force members in TA2 were reached with CLTS orientation meetings, enabling them to assist CHWs in conducting CLTS household follow-ups. All community volunteers (n=30) who participated in FGDs verified their attendance and participation in a CLTS briefing. However, some members of the community task force team indicated that they had not attended the CLTS briefing, but did participate in conducting household follow-ups.

During pre-triggering, community members were intentionally invited to the triggering events without explicitly stating the purpose of the gathering. Depending on community preference, the invitation messages were spread by community volunteers, community criers, and CHWs. Household surveys indicated that 54% (n= 625) of participants received an invitation via one or more of these channels. Of these 85% (n = 529) reported attending a triggering event,

representing 46% of the total households surveyed. Triggering events were conducted during the week in the afternoon. Due to tight project timelines, some triggering events were conducted during a market day, which resulted in a low turnout.

Each of the community members who attended the triggering events stated that two to three additional individuals from their family also attended the sessions; however, most households indicated that children and the elderly members did not attend. In cases where children attended the event, most triggering events did not separate adults from children. CHWs were required to complete forms (CLTS triggering forms), detailing the number of individuals who attended, and the activities conducted during the triggering event, but these forms were not available for analysis.

Participants attending the triggering events reported that some activities such as 'the walk of shame', community mapping, shit calculation, medical expenses, and transmission of diseases through water and food contaminated with faeces, took place. However, fidelity of some activities was low. Many community members indicated that topics related to faecal-oral transmission were mostly explained verbally rather than using visual demonstrations as per CLTS protocols.

> "Hmmm no, they did not show us how faeces can reach our food. They just explained to us during the meeting" [Female FGD participant, TA1].

The process of selecting natural leaders during triggering events was reported as inconsistent. According to CLTS protocols, natural leaders should be selected from individuals who participate and engage in triggering sessions. However, some respondents reported that natural leaders were selected by CHWs based on previous relationships, even when these individuals did not attend triggering sessions.

> "We did not choose a natural leader at the triggering event, but a man came to inspect WASH facilities at our household. He usually works with the CHW to weigh and vaccinate our kids" [Female FGD participant, TA1].

Based on survey data, 46% of respondents reported participating in triggering events. Age and number of people per household were not associated with triggering event participation. Men, respondents with at least some education, and respondents who reported no employment were more likely to attend triggering sessions (Table 3). Nine percent of the survey respondents (n = 98) reported that triggering events were their only exposure to the intervention.

Table 3: Association between attending triggering event and demographic characteristics

Variable	Respondents attending triggering event			Respondents only attending triggering event		
	% (n/N)	**Chi-square**	**P-Value**	**% (n/N)**	**Chi-square**	**P- Value**
Age		3.87	0.144		3.59	0.166
18-39	45% (239/529)			50% (49/98)		
40-59	38% (201/529)			29% (28/98)		
60+	17% (89/529)			21% (21/98)		
Gender		8.83	**0.003**		3.03	0.082
Male	70% (371/529)			82% (80/98)		
Female	30% (158/529)			18% (18/98)		
Number of people per household		0.01	0.931		0.04	0.826
<=3	50% (265/529)			51% (50/98)		
>=4	50% (264/529)			49% (48/98)		
Level of education		5.58	**0.018**		0.28	0.595
Never attended education	33% (172/529)			34% (33/98)		
Attended education	67% (357529)			66% (65/98)		
Occupation status		6.57	**0.01**		0.04	0.85
No occupation	58% (309/529)			63% (62/98)		
Has occupation	42% (220/529)			37% (36/98)		

Following the triggering events, the project planned to conduct four household follow-up visits in each village to enhance uptake of sanitation facilities. 64% of respondents (n = 731) reported post-triggering household follow-up visits. Of the 731, 58% received one household follow-up visit. Overall, most household visits were conducted by CHWs (59%), followed by natural leaders (30%), local leaders (7%) and finally community volunteers (4%). FGDs with community volunteers revealed their limited capacity to carry out the household follow-ups.

> "We were called for a meeting in March 2022 where they told us about our role in this project. However, since that meeting, we never met again'' [FGD, Community Volunteer, TA1].

According to project documents, only 75% of households in the intervention communities had a latrine after the fourth round of household follow-up visits. Programme implementation was adapted and up to six household follow-up visits were conducted to ensure 100% sanitation facilities coverage in both TAs.

> "We initially planned to conduct four rounds of follow-up visits. Since some individuals lacked latrines at the conclusion of the fourth visit, we opted to add more visits. Increased follow-ups impacted our timelines; however, they facilitated the attainment of our objective." [KII, project officer].

Fidelity, reach, dose and adaptation of market-based sanitation

In total, 45 local masons (44 male, 1 female) were reached with the trainings, exceeding the target of 40. It was noted that two of the nine masons sampled resided outside the TA area. Masons were primarily recruited by local leaders; several CHWs were critical of this approach: "I wish we (CHWs) were involved in the identification of which masons to be trained. From the time I have worked with the community, I have seen bias in such initiatives

because people think they may get monetary benefits if they involve a person close to them" [KII, TA2, CHW].

Upon completion of the training, the project planned to provide each mason with construction tools to support their work. However, exceeding training targets were not met with adequate materials.

> "We were promised that each one of us will be given tools after the training, but we were later told that the tools are not enough, so three of us who were from the same sub-TA level area had to share the materials'' [KII, TA2, Mason].

Project documentation recorded 30 corbeled latrines built by the trained masons during the project period. IDIs and surveys highlighted this lack of progress was associated with a lack of awareness about the masons, and the type of latrine being promoted. Masons indicated frustration with this situation and were keen to market latrine construction when possible.

> "When I noted that time was going, I reached out to the sub-TA and other leaders, and requested them to organise a community meeting where I could market myself, but it never happened'' [KII, TA 1, Mason]

Among households with a latrine at the time of data collection, 69% reported to have built their own latrine, 25% used an untrained community mason, while 6% used the project's trained masons to construct primarily traditional latrines for them. Interviews with community members who were aware of the existence of the masons, revealed that most perceived hiring mason as costly.

> "The latrines they want us to build are expensive. Our mason told us that labour charge to dig and build the pit only (i.e. no super-structure or slab) for the corbelled latrine will

cost MWK 30,000.00 ($17.30), yet I can spend that amount to build a complete traditional latrine" [FGD, TA2, Community member].

Fidelity, reach, dose and adaptation of hygiene campaigns

All four rounds of hygiene campaigns were successfully completed within the schedule. Nevertheless, adherence to implementation protocols was compromised affecting implementation fidelity. For example, only 2% of the survey participants reported receiving a leaflet during the campaign. Interviews with the project officers revealed that the leaflets were out of stock at the District Health Promotion Office as they were all used during the COVID-19 hygiene campaigns.

"Normally the district health promotion team use default sanitation and hygiene messages developed by MoH. If you remember, in 2021 to 2022 we had a lot of COVID-19 cases so most of the materials were utilised that time. We later realised that they have few hygiene leaflets when we had already started conducting the campaigns, so few people received them. However, people got the message from the drama and songs that were played during the campaigns" [KII, Project officer].

Forty-seven percent of household survey participants reported hearing or attending health promotion campaigns which were conducted at marketplaces (8%), in their own village (86%), or a neighbouring village (6%). Forty-six percent of the participants reported being exposed to the messages once, 35% twice, and 19% more than twice.

Hygiene and sanitation messages were only one of the many public health messages that were delivered during the project period.; 14% of the study participants who reported hearing and attending the health promotion campaigns indicated that the messages they heard were about

cervical cancer screening, rabies, or polio vaccination. In addition, 15% of respondents indicated that they had trouble understanding the messages being communicated.

Mechanism of impact

Following intervention delivery in February 2023, TA1 was declared ODF after successfully achieving complete coverage of latrines and handwashing facilities. Achieving this objective took more resources than anticipated, primarily extending the number of household visits required to reach 100% coverage.

TA2 achieved 92% coverage of latrines and 64% coverage of handwashing facilities. Although TA2 received CLTS household follow-ups after the slippage, project partners were not able to achieve full ODF status by the end of the study period.

The process evaluation revealed that 9% (n=98) of household survey respondents were exposed to triggering sessions only, 26% (n=300) exposed to household follow-up visits only, 37% (n=431) exposed to both triggering and household visits, and 28% (n=322) to none of the CLTS components. Adjusting for confounding factors such as demographic characteristics of the study participants, being exposed to triggering event alone had a statistical significance on the availability of latrine but not the availability of handwashing facility. Exposure to household visits alone had no statistical significance on the availability of latrine but on handwashing facility at a household. However, combined exposure (exposed to both triggering event and household visit) significantly increased the likelihood of both latrine and handwashing facility availability at household level (Table 4).

Table 4: Logistic regression estimation with availability of pit latrine and handwashing facility as the outcomes

Respondents participated in:		Intervention reach		Observed latrine at HH		HWF observed at HH	
Triggering	HH Follow-ups	n	%	Odds Ratio*	95% CI	Odds Ratio*	95% CI
Yes	No	98	9	1.68	(1.02 - 2.78)	1.01	(0.43 - 2.35)
No	Yes	300	26	1.09	(0.97 - 1.23)	1.15	(1.13 - 1.16)
Yes	Yes	431	37	1.63	(1.55 - 1.72)	1.39	(1.03 - 1.86)

Note: To guarantee robust inference, models were adjusted for (respondent's age, gender, respondent's level of education, employment of the head of the family, and number of individuals per household), as well as clustering. Fully adjusted model in Supplemental Table 1

Exposure to hygiene campaigns did not have a significant effect on the presence of a latrine (OR: 0.7, p> 0.05) and handwashing facility (OR: 1.2, p> 0.05) at household level.

To achieve intended outcomes, the project employed adaptability and flexibility in project delivery. For example, no active care groups were found in TA1, where the project expected to employ pre-existing care groups for CLTS. Since time and resources were insufficient to develop or remodel care groups, volunteers were trained to fill this job. Additionally, to improve the likelihood of households adopting and consistently practicing the recommended sanitary measures, the project increased household follow-up visits from four to six.

After intervention delivery in both TAs and following ODF declaration in TA1, the arrival of Cyclone Freddy (March 2023) compromised the ODF status of both TAs. Project reports indicate that three months after Cyclone Freddy hit the area, In TA1 alone, 68% of latrines across both TAs were severely damaged or lost [31]. Recognizing this slippage, the project promoted latrine reconstruction through multiple visits across April to June 2023[31]. This demonstrates the project's adaptability and determination to promote the reconstruction of collapsed latrines, although most rebuilt basic latrines.

Discussion

We conducted a mixed-methods process evaluation of the 'W4E' project that sought to improve access and use of sanitation and hygiene facilities through CLTS, market-based sanitation and hygiene campaigns in rural Malawi. Our process evaluation findings provide insights to the challenges of CLTS delivery in this setting and the potential impact of these on sanitation and hygiene outcomes. The process evaluation identified three key areas for consideration in effective CLTS implementation: adaptability and flexibility in intervention delivery, the need for community members to be exposed to messages through multiple channels, and the challenge of achieving sustained change in areas that are prone to extreme weather events.

Adaptability and flexibility of intervention delivery

Despite the clearly laid out programme of activities in the Malawi MOH CLTS manual, it was clear that real world implementation requires district teams to operate with a degree of adaptability and flexibility without compromising the fidelity. For example, we report a clash for CHWs between CLTS training and the implementation of a polio vaccination campaign, a common scenario given the substantial workload of CHWs in Malawi. CHWs are tasked not only with environmental health services, but also with Maternal Child Health (MCH), family planning, and HIV/AIDS services [32, 33]. As such, flexibility to reschedule training, and complete them in full rather than reducing the number of training days, should have been considered to minimise the impact on the quality of subsequent programme delivery. Allocating sufficient time for CLTS training is crucial, as inadequate training can result in unsatisfactory delivery, which in turn leads to poor receipt and understanding among recipients [34]. Importantly, CLTS trainings should aim to incorporate both educational and practical components, as this tends to be more effective in generating the desired behaviour change [35–38].

While CLTS offers flexibility for facilitators to select activities for triggering, there are mandatory areas which require to be included such as the identification of natural leaders. Utilising existing community-based structures can be an effective way of identifying natural leaders and supporting CHWs to conduct household follow-ups. However, if CHWs are to utilise existing volunteers in these roles, it is essential that they participate in the triggering event and are subsequently supported, so that they themselves are triggered and have an adequate understanding of their role in ongoing implementation and follow-ups [39]. In our study, some natural leaders performed this role without attending the triggering session, potentially lacking an understanding of CLTS principles. Their lack of knowledge on CLTS may explain our finding that only 30% of the community members reported being visited by a natural leader.

Similarly, the training of community volunteers to replace care groups was an effective adaptation to implementation plans, but these volunteers did not receive subsequent support and were not fully involved in follow-up activities. Natural leaders function as change agents in their communities, serving as role models, and accelerate the uptake of latrines and HWF among community members [18, 19]. In agreement with other researchers, community volunteers of any sort need to be supported to ensure effective intervention delivery [36, 39–41]

Improving the effective use of community volunteers in household follow-ups could also have reduced the need for increasing the number of household visits required, although it is acknowledged that teams need to be flexible enough to increase the number of visits conducted if necessary. Additional household visits were unable to return TA2 to ODF status. In contrast, Harter et al. (2018) found that a higher frequency of follow-up visits led to an increase in latrine coverage [42]. In this location, the prior ODF status, coupled with the recent impact of Cyclone

Freddy, likely influenced the community's response. The cyclone caused the collapse of sanitation facilities that were built the previous year, possibly leading to fatigue or reluctance to construct latrines again. This indicates the necessity of enhancing behaviour change communication to bolster confidence among households so that they can rebuild latrines when they collapse (recover), as well as facilitating the construction of climate-resilient latrines capable of withstanding extreme weather events [43]. More research is needed to understand the mediators for ensuring confidence in recovery in this context.

A study by Sigler et al. (2015) asked programme managers to rank CLTS activities in terms of importance, both for habit formation and sustaining sanitation behaviours [44]. The findings revealed that hygiene promotion ranked low among CLTS implementers, which may correlate with the more extensive and consistent advancements observed in sanitation coverage compared to hygiene [4, 44]. Exposure to household visits significantly increased the likelihood of having a handwashing facility in our study. This finding may be linked to (1) as households constructed latrines there was a shift of focus to HWF during visits, and/or (2) household visits provided a more personalised interaction which highlighted HWF compared to wider community triggering. We recommend that CLTS implementers ensure flexibility and long-term engagement to enable holistic gains in both CLTS's primary and secondary outcomes.

Multiple exposures in intervention delivery

Our study results infer that exposure to both triggering sessions and household visits is more likely to result in the presence of both latrine and HWF at a household. Our findings are similar to other research, indicating that WASH programs are more effective when individuals are engaged at both community and household levels (multi-level) [[43, 45]. As such, it is important to ensure that community members are aware of the triggering events [46], and that

these are scheduled in a way that enables maximum participation from diverse groups and increases the overall number of people who attend [36, 47]. Exposure to hygiene campaigns, which were delivered through mass communication, did not have a significant effect on presence of a latrine and handwashing facility. However, if delivered effectively, these can reinforce messages from triggering and household visits. Careful management of content and timing is therefore essential.

Achieving and sustaining intervention outcomes

Multi-level exposure requires households to be reached through follow-up visits as well as attending triggering session. Considering the substantial workload of CHWs in Malawi, involving community volunteers and natural leaders in delivering household visits can increase the initial and continued exposure of community members to key messages. As found in other studies, engaging existing local structures, such as community volunteers, is essential for disseminating health information, fostering healthy behaviours in households, and, most importantly, ensuring the sustained efficacy of community health initiatives [48, 49].

As described elsewhere, CLTS has faced criticism for its focus on the provision of basic sanitation services, often leading to the construction of poor-quality, unimproved facilities with a limited life span [16, 50, 51]. This is of particular concern in relation to the sustainability of sanitation infrastructure, compounded by the increased risk of extreme weather events which lead to latrine collapse and ODF slippage [22]. As such, W4E provided an option for more resilient infrastructure by delivering CLTS alongside market-based promotion of corbelled latrines to ensure the sustainability and resilience of latrines [52]. However, the process evaluation found a low uptake of this type of latrine [28], which was attributed to limited marketing of the available masons for latrine construction and relative high costs for the promoted latrines. Mara et al [53] found that unlocking customer demand (demand activation)

is a key aspect of sanitation marketing. The reported high costs for the promoted latrines in our study concurs with others that low socio-economic status hinders the adoption of improved sanitation [54–57]. Promoting and implementing a cost-effective design of latrines that utilize local resources and align with consumers' financial constraints encourages adoption of improved latrines [58]. Hence the need for implementers to assess, how much people are willing to pay for improved sanitation facilities before promoting a specific sanitation option in the various contexts. This can be achieved by conducting willingness to pay studies, using a contingent valuation method [59]. We suggest a more in-depth barrier analysis in this setting to further understand the limitations surrounding the low adoption of the corbelled latrines.

Masons would also benefit from the development of entrepreneurship skills to market themselves and reduce reliance on community leaders to build their customer base [60].

Study limitations

Data inconsistencies between the two household surveys, particularly in tracking follow-up visit frequency, limited our ability to fully assess how visits influenced latrine and handwashing facility adoption. Furthermore, the research team was unable to access specific reports for certain activities, which affected the evaluation of some process evaluation components, for example, the lack of reports and materials utilized during the hygiene campaigns, affected the fidelity assessment of the hygiene campaigns.

Conclusion

This process evaluation of the W4E project highlights key considerations for effective CLTS implementation in rural Malawi. Adaptability and flexibility in intervention delivery are critical, especially given the substantial workload of CHWs. Comprehensive training, clear role

definition, and consistent support for natural leaders and community volunteers are essential to sustain ODF status.

Multi-level exposure, combining community triggering sessions and household follow-up visits, was crucial for achieving both sanitation and hygiene outcomes. Our findings also suggest that mass communication hygiene campaigns, while potentially reinforcing key messages, must be strategically designed and timed for greater efficacy.

Frequent extreme weather events, like Cyclone Freddy, underscores the need for resilient infrastructure and strategies to support recovery and sustained behaviour change. Barriers such as the high cost and low awareness of climate-resilient latrines hinder adoption, pointing to the need for development of entrepreneurial skills among masons to enhance market engagement, cost-effective design, and tailored interventions informed by willingness-to-pay studies.

Future programs would benefit from flexible training programmes, community-led leadership and better coordination with masons to better facilitate adoption of improved sanitation behaviours. Our study findings contribute to the growing body of evidence on WASH interventions and shows the importance of reaching people through both community meetings and household level engagements to achieve lasting public health improvement.

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Disclosure of interest

The authors report there are no competing interests to declare

Data Availability Statement

All data underpinning this publication are openly available from the University of Strathclyde KnowledgeBase at https://doi.org/10.15129/b868b0b9-d056-4962-b508-96fac4742787

Author Contributions

Conceptualization, M.P., K.C., C.M., R.D.,T.B, and T.M.; data curation, M.P., K.C., C.M., R.D.,T.B, and T.M; formal analysis, M.P., K.C., R.D. and T.M.;funding acquisition, R.D.; methodology, M.P., K.C., C.M., R.D.,T.B, and T.M.; resources, R.D.; software, M.P; validation, M.P., K.C., C.M., T.K., R.D.,T.B, and T.M.; visualization, M.P., K.C., C.M., T.K., R.D.,T.B and T.M.; writing—original draft, M.P., K.C., and T.M.; writing—review and editing, M.P., K.C., C.M., T.K., R.D.,T.B, and T.M.;.;. All authors have read and agreed to the published version of the manuscript.

References

[1] Mara D, Lane J, Scott B, et al. Sanitation and health. *PLoS Med* 2010; 7: e1000363.

[2] WHO. *Progress on household drinking water, sanitation and hygiene 2000-2020: five years into the SDGs*. World Health Organization, https://www.who.int/publications/i/item/9789240030848 (21 September 2021, accessed 1 September 2023).

[3] UNICEF, WHO. *Progress on household drinking water, sanitation and hygiene: A focus on gender*. New York, https://www.unicef.org/wca/reports/progress-household-drinking-water-sanitation-and-hygiene (2023, accessed 13 August 2024).

[4] WHO, UNICEF. Joint Monitoring Programme (JMP), https://washdata.org/monitoring/sanitation (2022, accessed 9 October 2023).

[5] United Nations. Sustainable Development Goal 3:Ensure availability and sustainable management of water and sanitation for all. *United Nations*, https://sdgs.un.org/goals/goal6 (2015, accessed 9 September 2024).

[6] McMichael C, Robinson P. Drivers of sustained hygiene behaviour change: a case study from mid-western Nepal. *Soc Sci Med* 2016; 163: 28–36.

[7] Andres LA, Borja-Vega C, Fenwick C, et al. Overview and meta-analysis of global water, sanitation, and hygiene (WASH) impact evaluations. *World Bank Policy Research Working Paper*.

[8] Government of Malawi, MOH. National Sanitation and Hygiene Strategy 2018-2024, https://www.wesnetwork.org/wp-content/uploads/2020/03/National-Sanitation-and Hygiene-Strategy.pdf (2018, accessed 1 November 2023).

[9] Malawi Government. *OPEN DEFECATION FREE (ODF) MALAWI STRATEGY 2011-2015*, https://wesnetwork.org/wp-content/uploads/2021/08/Malawi-Open-Defaction-Free-Strategy_2011_2015.pdf (2011, accessed 14 August 2024).

[10] Zuin V, Delaire C, Peletz R, et al. Policy diffusion in the rural sanitation sector: lessons from community-led total sanitation (CLTS). *World Dev* 2019; 124: 104643.

[11] Kar K, Chambers R. *Handbook on community-led total sanitation*. PLAN UK, https://bloodwater.org/content/uploads/2023/10/rc314.pdf (2008, accessed 14 July 2023).

[12] Mukherjee N. Factors associated with achieving and sustaining open defecation free communities: Learning from east java. *Water and sanitation program* 2011; 2011: 1–8.

[13] Pickering AJ, Djebbari H, Lopez C, et al. Effect of a community-led sanitation intervention on child diarrhoea and child growth in rural Mali: a cluster-randomised controlled trial. *Lancet Glob Health* 2015; 3: e701–e711.

[14] Garn J V, Sclar GD, Freeman MC, et al. The impact of sanitation interventions on latrine coverage and latrine use: A systematic review and meta-analysis. *Int J Hyg Environ Health* 2017; 220: 329–340.

[15] USAID. *An Examination of CLTS's Contribution Toward Universal Sanitation* , https://www.globalwaters.org/resources/assets/waspals/examination-cltss-contributions-toward-universal-sanitation (25 April 2018, accessed 31 October 2023).

[16] Venkataramanan V, Crocker J, Karon A, et al. Community-led total sanitation: a mixed-methods systematic review of evidence and its quality. *Environ Health Perspect* 2018; 126: 026001.

[17] Cameron L, Olivia S, Shah M. Scaling up sanitation: evidence from an RCT in Indonesia. *J Dev Econ* 2019; 138: 1–16.

[18] Harter M, Inauen J, Mosler H-J. How does Community-Led Total Sanitation (CLTS) promote latrine construction, and can it be improved? A cluster-randomized controlled trial in Ghana. *Soc Sci Med* 2020; 245: 112705.
[19] Kapatuka D. Natural leaders energising change in villages to attain and sustain open defecation free status: A case study of Plan Malawi impact areas–Mulanje and Lilongwe districts (traditional authorities Juma and Njewa). In: *IRC Symposium*. 2013.
[20] Kennedy M, Meek A. Extension agent reorganization into a 'block'system for CLTS implementation and monitoring in Salima and Zomba Districts, Malawi. *Toronto, ON, Canada: Engineers Without Borders https://www ircwash org/sites/default/files/kennedy_and_meek_block_system_for_clts_implementation_and _monitoring pdf [accessed 15 December 2015]*.
[21] Stuart K, Peletz R, Albert J, et al. Where does CLTS work best? Quantifying predictors of CLTS performance in four countries. *Environ Sci Technol* 2021; 55: 4064–4076.
[22] Hinton RGK, Macleod CJA, Troldborg M, et al. The status of sanitation in Malawi: is SDG6. 2 achievable? *Int J Environ Res Public Health* 2023; 20: 6528.
[23] Linnan L, Steckler A. Process evaluation for public health interventions and research, https://d1wqtxts1xzle7.cloudfront.net/37799296/0787959766-libre.pdf?1433209139=&response-content-disposition=inline%3B+filename%3DProcess_Evaluation_for_Public_Health_Int.pdf&Expires=1730243870&Signature=IGFmaCFOXyj82J4GcFkTMe1Hl5pSuLpJFIHotuJ-BtC8Pj9ss0RaGwi8ObdbULi~YAdxZ-L1Srb1Nj4yU8~u~DI2LbVR90juESdHZxlPjh8Ovb5xl8~49Ofc~MOMygupedHjOM1VYdGeJ7H7SFGP8-~mZ~kUpGi~yM3vWmKMeio7lCREgkXQ2iRZcelcD5U8etmE4rrB3pcjxFHqFr4Hfy1KiILQX8Y4JQjnXEwiv0CyPLGr7ofnbU7HgQTImfb~EA5yHwgeve~ZyGqV9sejmt8hDYKrxcnbsn8tVXfWdn~beuDMaSzhLMmUdwku4~TCErkgjPrf4R0p0elRKX0Idw__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA (2002, accessed 12 June 2023).
[24] Peters DH, Tran NT, Adam T. *Implementation research in health: a practical guide*. World Health Organization, 2013.
[25] Moore GF, Audrey S, Barker M, et al. Process evaluation of complex interventions: Medical Research Council guidance. *bmj*; 350.
[26] NSO. *2018 Malawi Population and Housing Census*, http://www.nsomalawi.mw/index.php?option=com_content&view=article&id=226&Itemid=6 (2019).
[27] Government of Malawi. *CHIRADZULU DISTRICT COUNCIL DISTRICT: WATER AND SANITATION STRATEGIC INVESTMENT PLAN*, https://www.washagendaforchange.org/wp-content/uploads/2020/04/district_strategic_investment_plan_in_chiradzulu_-_nov_2018.pdf (November 2018, accessed 2 November 2023).
[28] Holm R, Tembo M, Njera D, et al. Adopters and non-adopters of low-cost household latrines: a study of corbelled pit latrines in 15 districts of Malawi. *Sustainability* 2016; 8: 917.
[29] Chidya RCG, Holm RH, Tembo M, et al. Testing methods for new pit latrine designs in rural and peri-urban areas of Malawi where conventional testing is difficult to employ. *Environ Sci (Camb)* 2016; 2: 726–732.
[30] Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol* 2006; 3: 77–101.
[31] MacLeod C, Sidira G, Kapazga T, et al. The impact of a climate-related disaster on sanitation coverage in rural Chiradzulu District, Malawi, pre-and post-Cyclone Freddy.

[32] Kok MC, Muula S. Motivation and job satisfaction of health surveillance assistants in Mwanza, Malawi: an explorative study. *Malawi Medical Journal* 2013; 25: 5–11.
[33] Greco G, Daviaud E, Owen H, et al. Malawi three district evaluation: Community-based maternal and newborn care economic analysis. *Health Policy Plan* 2017; 32: i64–i74.
[34] Toomey E, Hardeman W, Hankonen N, et al. Focusing on fidelity: narrative review and recommendations for improving intervention fidelity within trials of health behaviour change interventions. *Health Psychol Behav Med* 2020; 8: 132–151.
[35] Hatfield TG, Withers TM, Greaves CJ. Systematic review of the effect of training interventions on the skills of health professionals in promoting health behaviour, with meta-analysis of subsequent effects on patient health behaviours. *BMC Health Serv Res* 2020; 20: 1–9.
[36] Panulo M, Chidziwisano K, Beattie TK, et al. Process Evaluation of "The Hygienic Family" Intervention: A Community-Based Water, Sanitation, and Hygiene Project in Rural Malawi. *Int J Environ Res Public Health* 2022; 19: 6771.
[37] Goh LML, Wong AXY, Ang GY, et al. Effectiveness of nutrition education accompanied by cooking demonstration. *British Food Journal* 2017; 119: 1052–1066.
[38] Pang J, Chua SWJL, Hsu L. Current knowledge, attitude and behaviour of hand and food hygiene in a developed residential community of Singapore: a cross-sectional survey. *BMC Public Health* 2015; 15: 1–12.
[39] Crocker J, Abodoo E, Asamani D, et al. Impact evaluation of training natural leaders during a community-led total sanitation intervention: a cluster-randomized field trial in Ghana. *Environ Sci Technol* 2016; 50: 8867–8875.
[40] Woldie M, Feyissa GT, Admasu B, et al. Community health volunteers could help improve access to and use of essential health services by communities in LMICs: an umbrella review. *Health Policy Plan* 2018; 33: 1128–1143.
[41] Moran AM, Coyle J, Pope R, et al. Supervision, support and mentoring interventions for health practitioners in rural and remote contexts: an integrative review and thematic synthesis of the literature to identify mechanisms for successful outcomes. *Hum Resour Health* 2014; 12: 1–30.
[42] Harter M, Mosler H-J. Determining the effectiveness and mode of operation of Community-Led total Sanitation: The DEMO-CLTS study. *Dübendorf, Switzerland: Eawag Aquatic Research*.
[43] Harter M, Mosch S, Mosler H-J. How does Community-Led Total Sanitation (CLTS) affect latrine ownership? A quantitative case study from Mozambique. *BMC Public Health* 2018; 18: 1–10.
[44] Sigler R, Mahmoudi L, Graham JP. Analysis of behavioral change techniques in community-led total sanitation programs. *Health Promot Int* 2015; 30: 16–28.
[45] Sclar GD, Routray P, Majorin F, et al. Mixed methods process evaluation of a sanitation behavior change intervention in rural Odisha, India. *Global Implementation Research and Applications* 2022; 2: 67–84.
[46] Routray P, Torondel B, Jenkins MW, et al. Processes and challenges of community mobilisation for latrine promotion under Nirmal Bharat Abhiyan in rural Odisha, India. *BMC Public Health* 2017; 17: 1–15.
[47] Moschonas D, Batagol B, Prescott MF, et al. Reflecting on Water and Sanitation infrastructure: A toolkit for WASH practitioners on gender and socially inclusive participatory design approaches in urban informal settlements.
[48] Lewin S, Munabi-Babigumira S, Glenton C, et al. Lay health workers in primary and community health care for maternal and child health and the management of infectious diseases. *Cochrane database of systematic reviews*.

[49] Rosato M, Laverack G, Grabman LH, et al. Community participation: lessons for maternal, newborn, and child health. *The Lancet* 2008; 372: 962–971.
[50] Alemu F, Kumie A, Medhin G, et al. A socio-ecological analysis of barriers to the adoption, sustainablity and consistent use of sanitation facilities in rural Ethiopia. *BMC Public Health* 2017; 17: 1–9.
[51] UNICEF. *GUIDANCE ON MARKET-BASED SANITATION*. New York, https://watershedasia.org/wp-content/uploads/2020_UNICEF-MBS-Guidance.pdf (2020, accessed 21 August 2024).
[52] Chidya RCG, Holm RH, Tembo M, et al. Testing methods for new pit latrine designs in rural and peri-urban areas of Malawi where conventional testing is difficult to employ. *Environ Sci (Camb)* 2016; 2: 726–732.
[53] Mara D, Evans B. The sanitation and hygiene targets of the sustainable development goals: scope and challenges. *Journal of Water, Sanitation and Hygiene for Development* 2018; 8: 1–16.
[54] Peletz R, Cock-Esteb A, Ysenburg D, et al. Supply and demand for improved sanitation: results from randomized pricing experiments in rural Tanzania. *Environ Sci Technol* 2017; 51: 7138–7147.
[55] Gross E, Günther I. Why do households invest in sanitation in rural B enin: Health, wealth, or prestige? *Water Resour Res* 2014; 50: 8314–8329.
[56] Tough H, Abdallah A-K, Zemp E, et al. Gender dynamics of community-led total sanitation interventions in Mpwapwa District, Tanzania. *Glob Public Health* 2023; 18: 2053733.
[57] Whaley L, Webster J. The effectiveness and sustainability of two demand-driven sanitation and hygiene approaches in Zimbabwe. *Journal of Water, Sanitation and Hygiene for development* 2011; 1: 20–36.
[58] Cole B. Going beyond ODF: combining sanitation marketing with participatory approaches to sustain ODF communities in Malawi. *UNICEF Eastern and Southern Africa Regional Office: Nairobi, Kenya*.
[59] Carson RT. Contingent valuation: A user's guide. *Environ Sci Technol* 2000; 34: 1413–1418.
[60] Munkhondia T, Simangolwa WM, Maceda AZ. CLTS and sanitation marketing: aspects to consider for a better integrated approach. *Sustainable Sanitation for All: Experiences, challenges, and innovations* 2016; 101.

Supplementary information

Table 1: Logistic Regression Analysis Predicting Availability of Pit Latrines and Handwashing Facilities

	Availability of pit latrine				Availability of handwashing facility			
Predictor	**Odds Ratio**	**SE**	**p**	**95% CI**	**Odds Ratio**	**SE**	**p**	**95% CI**
Participation								
Yes triggering / no follow-ups	1.68	0.43	0.043	[1.02 - 2.78]	1.01	0.44	0.985	[0.43 - 2.35]
No triggering / yes follow-ups	1.09	0.067	0.142	[0.97 - 1.23]	1.15	0.008	0.000	[1.13 - 1.16]
Yes triggering / yes follow-ups	1.63	0.045	0.000	[1.55 - 1.72]	1.39	0.21	0.029	[1.03 - 1.86]
Age of Respondent	1.01	0.005	0.009	[1.00 - 1.02]	0.99	0.002	0.001	[0.99 - 1.00]
Gender of Respondent (Male)	1.23	0.32	0.433	[0.74 - 2.04]	0.26	0.16	0.031	[0.08 - 0.88]
Highest Level of Education (Primary)	1.66	0.23	0.000	[1.26 - 2.18]	1.19	0.24	0.383	[0.80 - 1.76]
Main Occupation of Household Head	1.15	0.18	0.377	[0.8 - 1.57]	0.88	0.096	0.252	[0.71 - 1.09]
Number of People per Household	1.16	0.032	0.000	[1.10 - 1.22]	1.01	0.000	0.000	[1.01 - 1.01]
Intercept	0.32	0.068	0.000	[0.21 - 0.49]	0.8	0.24	0.447	[0.45 - 1.43]