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A cluster-randomised trial to evaluate an intervention to promote handwashing in rural Nigeria

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ABSTRACT

Handwashing with soap at critical times helps prevent diarrhoeal diseases. Changing handwashing practices through behaviour change communication remains a challenge. This study designed and tested a scalable intervention to promote handwashing with soap. A cluster-randomised, controlled trial compared our intervention against standard practice. Subjects were men, women and children in 14 villages in Cross-River state, Nigeria. The primary outcome was the proportion of observed key events on which hands were washed with soap. Binomial regression analysis calculated prevalence differences between study arms. The intervention had minimal effect on the primary outcome (+2.4%, p = 0.096). The intervention was associated with increased frequency of handwashes without soap before food contact (+13%, p = 0.017). The intervention failed to produce significant changes in handwashing with soap at key times. The low dose delivered (two contact points) may have increased scalability at the cost of effectiveness, particularly in the challenging context of inconvenient water access.

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Handwashing; hygiene promotion; behaviour change; randomised controlled trial

Introduction

Washing hands with soap at critical times offer a plausible route to reducing the risk of diarrhoeal diseases. However, changing household handwashing practices at scale through behaviour change communication remains a challenge (Freeman et al. 2014; Ejemot-Nwadiaro et al. 2015). Combining handwashing promotion with sanitation promotion might bring synergistic effects by tackling multiple transmission routes simultaneously. This was a feature of the Participatory Hygiene and Sanitation Transformation (PHAST) approach (World Health Organization 2000). However, evidence for synergy remains equivocal (Briceño et al. 2017).

Community-Led Total Sanitation (CLTS), like PHAST, incorporates messages to promote handwashing with soap (HWWS) through participatory activities, either to demonstrate transmission routes for infection or to trigger a sense of disgust (Maulit 2014). However, these activities are limited in scope and have not been subject to rigorous evaluation. The teams of facilitators used to implement CLTS could provide a useful channel for promoting handwashing among rural communities if an effective intervention were developed.

Previous large-scale handwashing campaigns (for example, targeting 10 districts in Tanzania (Briceño et al. 2017), 20 million people in Bangladesh (Huda et al. 2012) and 2 districts in India (Lewis et al. 2018)) have failed to demonstrate changes in handwashing practices. In contrast, small-

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scale, intensive intervention trials have often shown a behavioural impact. Increases in handwashing rates ranging from 4% to 47% have been observed in trials in India, Nepal, Ethiopia and Bangladesh. These interventions targeted 7 villages in India (Biran et al. 2014), 4 villages in Nepal (Gautam et al. 2017), 84 households in Bangladesh (George et al. 2016), 1 Kebele (approximately 500 households) in Ethiopia (Contzen et al. 2015) and 253 women in Bangladesh (Ram et al. 2017).

SuperAmma, an intervention that used non-health messages to promote handwashing with soap (HWWS) in rural Indian households, achieved a degree of behaviour change which was sustained over the course of a year (Biran et al. 2014). This trial tested a relatively intensive intervention. Given that the trial included only seven intervention villages, doubts remain regarding the scalability of this intervention.

Following the *SuperAmma* model of using activities and video to amplify motivational drivers of handwashing practice, we worked with a creative agency to design a handwashing intervention for implementation by CLTS facilitators within the context of their ongoing sanitation promotion in rural Cross River state, Nigeria. In this paper we report the results of a trial to evaluate the effectiveness of that intervention. We hypothesised that a behaviour change intervention using the affiliation and disgust motives and delivered by CLTS facilitators over the course of 2 days would achieve a greater change in observed rates of handwashing with soap in rural Nigerian households than standard CLTS practice.

Methods

Trial design

The study was a cluster randomised, controlled trial. Clusters were the communities (villages or sub-village units) which formed the units of delivery for CLTS. The trial had three arms; standard CLTS, standard CLTS with the addition of a novel handwashing promotion intervention, *Respect People* (henceforth referred to as CLTS+) and a no intervention arm which received no intervention prior to data collection (this arm received the standard CLTS intervention after the conclusion of data collection). The trial was primarily intended to compare outcomes between standard practice (CLTS) and the novel approach (CLTS+). The no-intervention arm was added to explore whether CLTS alone had an impact on HWWS.

Participants/eligibility

Households were eligible to participate in the study if they included a child aged 5 years or under. Survey respondents were adult, female, primary caregivers. Observation data were collected from observation of all household members present at the time of data collection.

Settings study site

The study took place in Bekwara Local Government Area (LGA) in Cross River State, Nigeria. The majority of the population were subsistence farmers living in villages. Villages were clusters of houses surrounded by farmland. Houses were generally grouped into compounds, often comprising related households. Sanitation coverage was around 50%, mainly unimproved latrines which were often shared between households in a compound. Water was supplied through communal boreholes. Not every community had a functioning borehole and those that did not made use of boreholes in neighbouring communities at distances of up to about 1 km. At the time of the study, CLTS was being implemented in a number of LGAs in Cross River State with support from the Global Sanitation Fund and as part of the Nigerian government strategy to increase sanitation coverage in rural areas.

Interventions

Intervention design

The intervention, called *Respect People*, was developed in collaboration with a UK-based creative agency (StepJump Marketing) and used the Behaviour Centred Design framework to inform the design process (Aunger and Curtis 2016). Qualitative research was carried out over a period of 2 weeks in villages adjacent to the study site. The research used observation, interviews and group discussions to explore reactions to a range of potential motivational drivers of HWWS as well as to understand daily, weekly and seasonal routines, aspirations, elements of mannerly behaviour and greetings.

The research found that these communities had strong existing social structures and hierarchies. People lived communally in compounds, readily noticing the behaviour of their neighbours and friends. Consequently, cultural traditions and demonstrations of mannerly behaviour were highly valued and socially rewarded. Handwashing with soap was uncommon and even hand rinsing was rarely practiced. The majority of people practiced open defecation and reported that handwashing with soap was inconvenient and easy to overlook in the absence of handwashing facilities or other visual cues. Although there was a perceived cultural norm of handwashing before eating, this was rarely observed to happen, since adults were busy and children were often impatient to eat. Hand rinsing (without soap) tended to take place after eating or after returning from agricultural work when hands were greasy or visibly dirty.

Informed by the results of the formative research, the creative agency developed a communication concept based on the disgust and affiliation motives (affiliation is a motive for social behaviour and group membership) (Aunger and Curtis 2016). The intervention intentionally avoided health-based messages and aimed to heighten the disgust and affiliation motives through surprising activities and an aspirational story conveyed through a video. A second round of qualitative research was undertaken to assess reactions to initial executions of this concept, primarily by confirming comprehension, acceptability and plausibility.

The *Respect People* intervention comprised a video and activities for use at the levels of community and compound (neighbouring households). This package was implemented in two communities (not among those included in the study sample) by an experiential marketing agency and observed by a group of experienced CLTS facilitators who then gave feedback. Revisions were made based on feedback and recommendations from the facilitators. The revised package was tested by the CLTS facilitators in three communities over the course of a week with further, final adjustments made to the timing and language prior to implementation in the actual trial. A campaign guide was written to ensure consistency in the intervention delivery.

Intervention theory of change

The intervention sought to change behaviour by using communication to change perceptions of the desired behaviour without the provision of hardware to make the behaviour easier. The communication was intended to increase the value attached to the desired behaviour by increasing the strength of the association between the behaviour (handwashing with soap at key times) and affiliation (adherence to norms) and the avoidance of disgust.

The content of the intervention is summarised in Table 1.

Intervention implementation

CLTS

All communities in the CLTS arm received standard CLTS which followed a format described in detail elsewhere (Kar and Chambers 2008). In each community, a triggering session was facilitated by a team of six trained facilitators using standard CLTS tools to raise awareness of the problem of open defecation and discuss solutions. Subsequent visits to the community by facilitators were used to support planning, monitoring and progress towards increased latrine coverage and the end of

Table 1. *Respect People* intervention components in the order of implementation.

Activity	Description	Purpose
Community Meeting, (duration 1 hour), Day 1, morning.		
Introductions and 'What is respect' discussion	Community members are asked to share their perspectives about how to show respect through a short interactive discussion	Establish that mutual respect is an important part of community life and that greetings are a part of respectful behaviour.
Disgust handshake	Audience shake hands with neighbour and then imagine they have just come from defecation.	Elicit disgust and fear of social rejection. Establish that it is disrespectful to shake hands if hands are not clean.
The 4 events	Members of the audience act out 4 key events for HWWS. Audience guesses what they are acting.	Reminder of key times of HWWS (before eating, after cleaning child before cooking and after defecation).
Voting and Mr Clean/Mr Dirty	Group of volunteers 'vote' by placing a stone in 1 of 2 buckets to indicate whether everyone in the community washes hands with soap at key times. Audience lines up behind Mr Clean or Mr Dirty posters to indicate who they want to be like. Votes from buckets are counted publicly.	Establish that washing hands with soap at key times is an injunctive norm. Establish that it is known that not everyone adheres to this norm Raise awareness that breaches of the injunctive norm may be noticed by others.
Film	A short, humorous film telling the story of a man who fails to wash hands after defecation, faces social exclusion as a result and finally is redeemed and socially accepted after washing hands with soap.	Establish that poor handwashing practice may be noticed and punished through social exclusion while good handwashing practice may be rewarded with social inclusion.
Compound Meetings (duration approx. 1 hour), day 1 afternoon and days 2 and 3		
Introduction	Short, interactive discussion	Explain the purpose of the meeting, remind participants about the community meeting and/or summarise for those who did not attend.
Respect Code	Interactive discussion through which compound members develop a 3-point code of respect for their compound, of which 1 point is HWWS on key events. Write the code on a poster.	Establish HWWS as part of a repertoire of respectful, mannerly behaviour that is valued in the compound.
Pledging Ceremony	Adults and children separately take a public pledge to follow the respect code and to HWWS on key events. Adults also pledge to behave as role models for children.	Establish public commitment to HWWS.
Children's Report Card	Each child is given a report card on which to record their handwashing practice, with help from an adult or older sibling, over the course of a week.	Encourage and incentivise repeat practice. Position handwashing as a behaviour that is noticed and observed.
Hardware Inspection	Householders show facilitators their current handwashing places and discuss things they might do to make HWWS easier for all.	Encourage householders to take steps to make HWWS easier and therefore more likely.
Door Stickers	A large sticker with the intervention logo and the words 'We respect people' placed in a prominent place on, or beside, the front door of each house.	Public display of support for the intervention and generate the impression that supporting the intervention, and therefore HWWS, is a social norm.

open defecation. The total number of visits varied according to the perceived need for support as well as the accessibility of the community. 'CLTS communities' were not necessarily administrative units but were geographical clusters of roughly 70 households that formed the units for CLTS triggering and follow-up. Meetings with key stakeholders at the level of the ward (a formal administrative unit comprising several villages) took place prior to the triggering events with the aim of ensuring buy-in and support of local leaders.

The tool available to the CLTS facilitators to promote handwashing with soap was called *shit and shake*. This activity involved a facilitated discussion about what happens if hands contact with faeces during anal cleansing and are subsequently used for a handshake greeting. The purpose was to raise awareness on handwashing and increase the sense of disgust associated with not washing hands with soap (Maulit 2014). However, this tool was not always used, since facilitators were free to use their judgement with respect to the CLTS tools used at each triggering session and follow-up visit.

CLTS+

All communities in the CLTS+ arm received standard CLTS as described above. In addition, these communities received the *Respect People* intervention. *Respect People* was implemented in the CLTS+ communities approximately 1 month after CLTS triggering. This time-period was chosen to avoid overloading communities with messages and activities during their initial drive towards ending open defecation, while still being sufficiently close to the triggering event to benefit from familiarity with the facilitators and raised awareness about faecal contamination. The *Respect People* intervention was delivered by a team of eight facilitators. These facilitators had been members of the CLTS triggering teams in the CLTS and CLTS+ arms and had participated in the later stages of intervention design and testing (described above). They received an additional 3 days of training, specific to delivering the *Respect People* intervention. The *Respect People* intervention was delivered over 2–3 consecutive days depending on the size of the community. On the morning of the first day, the implementation team facilitated the community meeting. A team was required to effectively manage the crowd, facilitate the activities and to operate the generator and video equipment. On the afternoon of the first day and over the course of the subsequent day or 2 days, implementers split into pairs to carry out smaller group activities, aiming to cover all compounds in the community.

Implementation and indicators of exposure

One of the authors (BA) was present during implementation in every community. All community events were observed in full and compound events were monitored by moving between compounds during implementation. The following process monitoring data were recorded: approximate number of men, women and children present at the start of each community meeting, number of households reached during compound meetings, any substantial technical issues or deviation from the intended content during community or compound meetings. Community attendance rates were estimated on the basis of headcounts during implementation and community population figures from local government records.

Self-reported attendance at 'a community meeting about handwashing during which a film was shown' and at 'a household/compound visit (by a facilitator) during which handwashing was discussed and a pledging ceremony took place' were used as indicators of respondent exposure to the intervention.

Outcomes

The primary outcome measure was the proportion of observed 'key events' accompanied by handwashing with soap. 'Key events' were defined as; before eating or serving a meal, after defecation or latrine-use and after cleaning a child's bottom post-defecation.

Seventeen secondary outcomes were defined across the four categories of; Observed handwashing practices, Knowledge of critical times for HWWS, Normative beliefs and Proxy indicators. These are listed below.

Observed handwashing practices:

- Observed proportion of potential faecal contact occasions (latrine use, return from assumed open defecation, cleaning a child's bottom post-defecation) followed by HWWS
- Observed HWWS before eating
- Observed HWWS at other times
- Observed Handwashing (HW) with or without soap at all key events
- HW with or without soap after faecal contact (post defecation and post cleaning a child)
- HW with or without soap before eating

Knowledge of critical times for HWWS:

- Post-defecation stated as a time when HWWS should take place
- After cleaning a child's bottom stated as a time when HWWS should take place
- Before eating stated as a time when HWWS should take place
- Before serving or handling food stated as a time when HWWS should take place

Normative beliefs:

- Stated belief that most people in the community HWWS before eating
- Stated belief most people in the community HWWS after defecation
- Stated belief people in the community HWWS more often than in neighbouring communities

Proxy indicators:

- Observed presence of water close to latrine
- Observed presence of soap close to latrine
- Observed presence of tippy-tap (a handwashing device made by the household from a plastic bottle) close to latrine

Data collection

The intervention was implemented in November and December 2015 and outcome data were collected in July 2016 to assess whether there had been a sustained change in handwashing behaviour. A 6-month gap was allowed between implementation and data outcome evaluation to give an indication of sustainability and to reduce the likelihood of the data collection being associated with the intervention in the minds of the participants (and the associated risk of reactivity or respondent bias). No baseline data were collected, again to minimise the opportunity for the participants or observers to deduce the purpose and nature of data collection.

Sample size

We calculated that with 88 key occasions per arm we would have an 80% power to detect a 15percentage-point difference in handwashing with soap prevalence after key occasions (from 5% to 20%) between the CLTS and the CLTS+ arm. Based on our pilot data, we expected six key occasions to be observed in each household during the 3-h observation session and anticipated a design effect of 6 due to within-household and within village clustering of handwashing (as observed in our previous study in Andhra Pradesh; Biran et al. 2014) hence we required 528 observations per study arm. Recruiting 15 households per village resulted in 90 observations per village, i.e. 6 villages per arm so as to observe more than 528 occasions per arm. We increased this to 10 villages per arm, to allow for uncertainties in the design effect.

Recruitment

Thirty CLTS communities were selected from Bekwara LGA on the basis of size (between 50 and 250 households) and proximity to each other (iteratively removing villages that were within 2 km of at least two other study villages). Ten of these were subsequently lost to the sampling frame after CLTS was implemented in them in error several months before the study was due to take place. Of the remaining 20 communities 7 were randomly allocated to receive CLTS+, 7 to receive CLTS and 6 to the no intervention arm.

Figure 1 shows a flow diagram of the study.

Data collection

Data on handwashing practices were collected by a team of trained enumerators using direct, structured observation. Enumerators were employed and managed by a professional market

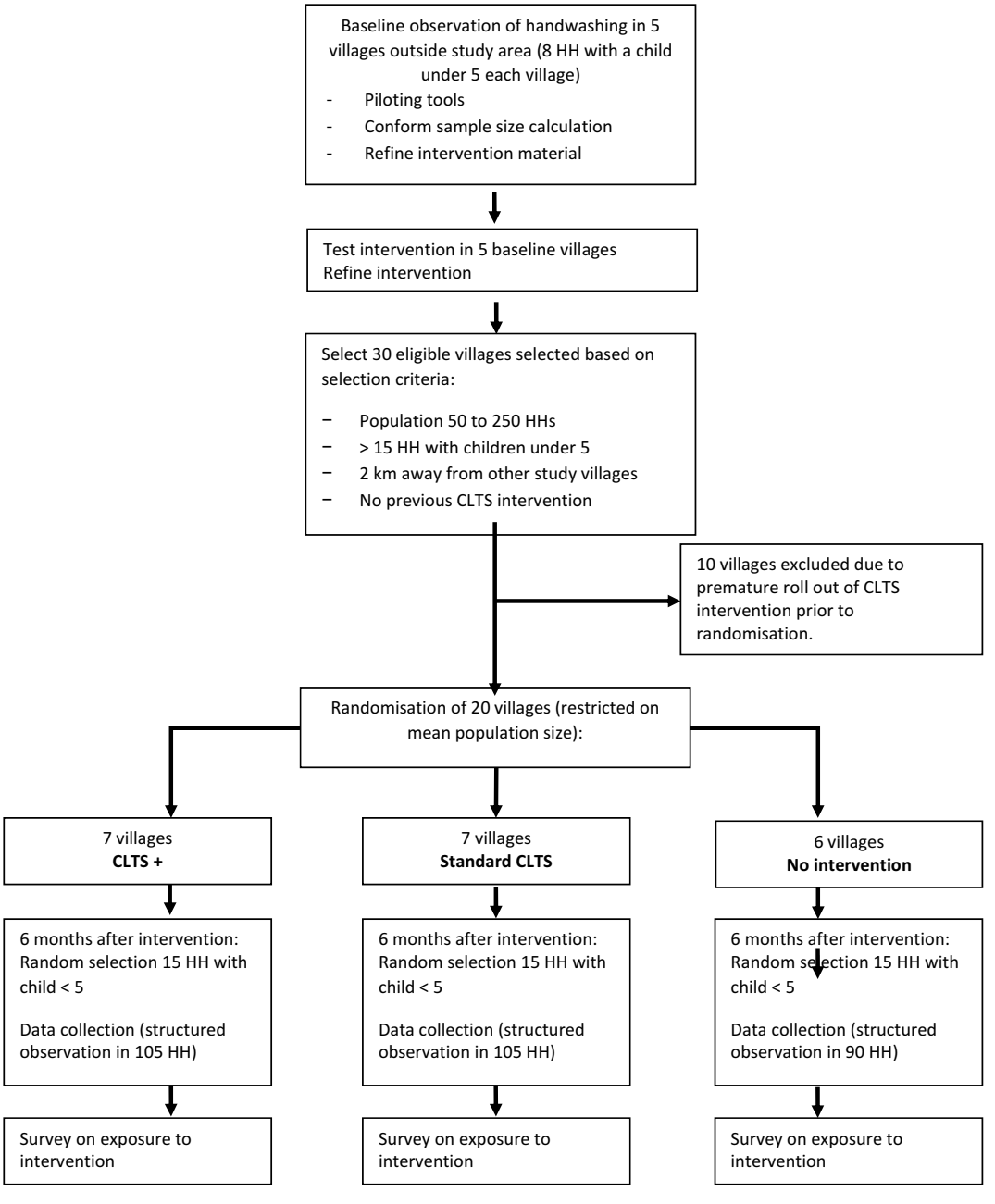

Figure 1. Flow diagram of the study.

research agency and had no prior involvement with intervention development or implementation. The data collection agency provided one supervisor for every 5 enumerator/observers in the field. Additionally, one of the authors (KA), who was not associated with the implementing agency and who had not been present in the field previously during intervention development or implementation, acted as an independent quality assurance manager and was present in the field with the data collection team throughout data collection.

All observers and supervisors attended a week-long training involving both classroom and practical sessions. All observation record sheets and survey sheets were checked for completeness and consistency on the day of data collection.

One enumerator observed each household. Observation started at 5:30 am and continued for 3 hours or until the last household member left home to proceed with their daily activities, whichever was the sooner. Observation was carried out on the first or second day following recruitment. Data were not collected on Sundays. Data were collected from all participating households in a single community at the same time, to reduce the possibility of participants learning details of the study from their neighbours prior to data collection and changing their behaviour as a result.

Enumerators recorded every instance of any of four key events (before eating or serving a meal, after defecation or latrine-use and after cleaning a child's bottom post-defecation) and the associated handwashing practice (hands not washed, washed with water only, washed with soap and water, full bath). Enumerators also recorded every instance of handwashing or bathing that was not associated with a key occasion, noting whether soap was used.

Background social and demographic data were collected at the time of recruitment using a verbally administered questionnaire. Data on household sanitation and handwashing facilities were also collected at this time using spot-check observation. Data on exposure to the intervention and perceptions of normative handwashing practices were collected immediately after the end of the observation period using a verbally administered questionnaire. Respondents were the primary female caregivers in participating households.

Blinding

The intervention status of the study communities was not disclosed to the data collection team and enumerators were not told that data were being collected to evaluate an intervention. The precise nature of the data being collected was not disclosed to participants, only that this was a study of routine domestic practices and water use. The study itself was referred to as the Water-use study.

Statistical analysis

We used binomial regression analysis to calculate prevalence differences (binomial distribution, identity link). Clustering at village-level was accounted for by using Generalized Estimating Equations (GEE) and robust standard errors. The main pre-specified analysis was intention-to treat. Mean and standard deviation (SD) of outcomes were calculated based on cluster level means. Analyses were done in Stata 12.0.

Rates of handwashing were calculated as the % of events at which hands were washed (hadwashing with or without soap) and the % of events at which hands were washed with soap (HWWS).

Ethics

Ethical approval was obtained from the Ethics Committee of the London School of Hygiene and Tropical Medicine and from the Cross River State Health Research Ethics Committee.

Results

Sample characteristics

In each community, data were collected from 15 randomly selected households. Household selection was a 2-stage process. In each community, 15 compounds were randomly selected from a list provided by the community leader. In each compound, all households having a child aged less than 5 years were identified by asking compound residents. One household was randomly selected from among these. A household was defined as a woman, her dependent children and any other adults who usually shared the same dwelling and ate from the same pot. Informed written consent was obtained from adult women at recruitment.

Table 2. Respondent household characteristics (6 months post-intervention).

	No intervention (n[a] = 90)	CLTS (n = 105)	CLTS+ (n = 105)
Household size (Standard Deviation)	6.2 (2.4)	6.4 (2.5)	6.0 (2.3)
Education care-giver, n (%)			
Never attended school	7 (7.8)	11 (10.5)	9 (8.6)
Some primary school	14 (15.6)	16 (15.2)	27 (25.7)
Completed primary school	18 (20.0)	25 (23.8)	28 (26.7)
Some secondary school	25 (27.8)	27 (25.7)	24 (22.9)
Completed secondary school	22 (24.4)	18 (17.1)	11 (10.5)
Higher education or training	4 (4.4)	8 (7.6)	6 (5.7)
Education household head, %			
Never attended school	6 (6.7)	9 (8.6)	5 (4.8)
Some primary school	5 (5.6)	6 (5.7)	13 (12.4)
Completed primary school	13 (14.4)	13 (12.4)	18 (17.1)
Some secondary school	19 (21.1)	21 (20.0)	16 (15.2)
Completed secondary school	25 (27.8)	24 (22.9)	36 (34.3)
Higher education or training	22 (24.4)	32 (30.5)	17 (16.2)
Main occupation farming, %	61 (67.8)	76 (72.4)	80 (76.2)
Owns agricultural land, %	87 (96.7)	99 (94.3)	104 (99.1)
Owns livestock, %	80 (88.9)	91 (86.7)	89 (84.8)
Owns a car, %	7 (7.8)	12 (11.4)	6 (5.7)
Owns a motorcycle, %	58 (64.4)	64 (61.0)	60 (57.1)

[a]n = sample size, i.e. the number of households in each arm.

The social and demographic characteristics of the respondents' households at the time of data collection (approximately 6 months after intervention implementation) are shown in Table 2. Wealth and education appeared somewhat lower in the CLTS+ arm. Education of the caregiver beyond primary school was less common in the CLTS+ arm, as was higher education of the household head. In this arm, car ownership was lower and farming as the main occupation more common than in the CLTS and the no intervention arms. No other major imbalances were observed.

The types of handwashing key events observed were broadly similar across arms (Data not shown). Defecation and eating were the most common events. Observations of cleaning a child's bottom or feeding a child were rare. A large percentage of observed handwashes (about 40%) were not clearly associated with any key event.

Outcomes

Table 3 shows the mean rates per community of HWWS and handwashing (HW) with or without soap, associated with the pre-specified, key events in the three study arms. The table shows the differences in handwashing rates when CLTS+ and the no intervention arms were compared with standard CLTS (the reference group).

Primary Outcome

The mean rate of handwashing with soap associated with key events (the primary outcome) was 5.1% in the CLTS+ arm compared with 2.9% in the CLTS arm, a difference of +2.4% ($p = 0.096$). The mean rate of HWWS in the no intervention arm was 4.8%, a difference of +1.8% when compared with standard CLTS ($p = 0.2$).

Secondary Outcomes

Handwashing with soap after faecal contact was somewhat more common in the CLTS+ arm than in the standard CLTS arm (+6.3%, $p = 0.083$). The prevalence of handwashing with or without soap (i.e. handwashing of any sort) associated with key events was 43% in the CLTS+ arm compared with

Table 3. Effect of the intervention on handwashing.

	n[a]	Mean[b]	SD[b]	difference‡	95% CI lower	95% CI upper	P value
Handwashing with soap							
All key events							
no intervention	820	4.8%	3.6%	1.8%	−0.9%	4.5%	0.2
CLTS	701	2.9%	1.5%	ref	-	-	-
CLTS+	799	5.1%	3.7%	2.4%	−0.4%	5.1%	0.096
After faecal contact							
no intervention	254	9.7%	7.5%	2.8%	−3.2%	8.8%	0.365
CLTS	257	6.8%	3.4%	ref	-	-	-
CLTS+	284	13.4%	9.8%	6.3%	−0.8%	13.4%	0.083
Before food contact							
no intervention	566	1.4%	1.7%	0.4%	−1.0%	1.9%	0.548
CLTS	444	0.8%	1.2%	ref	-	-	-
CLTS+	515	0.6%	1.1%	−0.1%	−1.2%	0.9%	0.81
Handwashing ± soap							
All key events							
no intervention	820	39.0%	6.8%	5.9%	−1.7%	13.6%	0.13
CLTS	701	33.2%	8.2%	Ref	-	-	-
CLTS+	799	43.0%	12.5%	10.0%	−0.5%	20.4%	0.062
After faecal contact							
no intervention	254	42.0%	9.4%	2.3%	−8.3%	12.9%	0.671
CLTS	257	38.7%	11.4%	Ref	-	-	-
CLTS+	284	43.2%	18.2%	3.5%	−11.4%	18.5%	0.644
Before food contact							
no intervention	566	36.4%	7.0%	7.1%	0.0%	14.1%	0.05
CLTS	444	30.4%	7.7%	Ref	-	-	-
CLTS+	515	42.9%	13.4%	13.0%	2.4%	23.6%	0.017
SOAP use during other handwash							
no intervention	599	30.8%	17.8%	−10.8%	−27.2%	5.5%	0.194
CLTS	461	41.6%	13.1%	Ref	-	-	-
CLTS+	544	34.9%	12.9%	−6.7%	−19.7%	6.3%	0.312

[a]number of events observed; [b]mean and standard deviation (SD) of cluster level means;[c]percentage difference estimated using binomial regression (identity link, binomial distribution) with GEE/robust standard errors to adjust for clustering by village

33.2% in the standard CLTS arm (+10.0%, p = 0.062). The prevalence of handwashing with or without soap before food contact was 42.9% and 30.4% in the CLTS+ and CLTS arms, respectively (+13.0%, p = 0.017).

Table 4 shows the outcomes relating to indicators of knowledge and normative beliefs. Compared to standard CLTS, respondents in the CLTS+ arm were more likely to report 'after defection' (+8.6%, p = 0.053) as a time when hands should be washed with soap, and 'after defection' was more likely to be the first among the key times reported (+13.3%, p = 0.017). There were no differences in the extent to which HWWS post-defecation or prior to eating were perceived as normative practices within the respondents' communities.

Both the standard CLTS and the CLTS+ interventions markedly increased latrine ownership and the presence of water for handwashing near the latrine compared to the no intervention arm. More households in the CLTS+ arm had tippy-taps (handwashing devices made by households from old plastic bottles) near the latrine than in the other two arms (23.4% in the CLTS+ arm compared to 8.6% in the CLTS arm, a difference of +15.1%, p = 0.061). The effect of the intervention on hygiene and sanitation hardware is shown in Table 5.

Exposure to the CLTS+ intervention

Table 5 also shows indicators of exposure to the intervention. The majority of respondents (67%) reported having attended a community meeting about sanitation at which a film was shown and 81% reported being present when a compound/household visit took place during which sanitation was discussed and a pledging ceremony was held. The campaign sticker was present in over 70% of

Table 4. Effect of the intervention on knowledge and normative beliefs about handwashing.

	Mean[a]	SD[a]	difference[b]	95% CI lower	95% CI upper	P value
HWWS knowledge and beliefs						
mentions HWWS before cooking						
no intervention (n = 90)	16.7%	9.2%	−9.0%	−19.5%	1.4%	0.09
CLTS (n = 105)	25.7%	11.2%	ref	-	-	-
CLTS+ (n = 105)	33.3%	9.4%	7.6%	−2.7%	17.9%	0.147
mentions HWWS before eating						
no intervention (n = 90)	56.7%	9.2%	6.2%	−4.4%	16.8%	0.252
CLTS (n = 105)	50.5%	11.5%	ref	-	-	-
CLTS+ (n = 105)	55.2%	11.4%	4.8%	−6.6%	16.1%	0.411
mentions HWWS after defecation						
no intervention (n = 90)	72.2%	14.2%	−4.9%	−18.3%	8.5%	0.471
CLTS (n = 105)	77.1%	11.5%	ref	-	-	-
CLTS+ (n = 105)	85.7%	4.6%	8.6%	−0.1%	17.3%	0.053
mentions HWWS after cleaning child						
no intervention (n = 90)	6.7%	4.2%	−1.9%	−6.7%	2.8%	0.432
CLTS (n = 105)	8.6%	5.0%	ref	-	-	-
CLTS+ (n = 105)	9.5%	6.5%	1.0%	−4.8%	6.7%	0.747
HWWS after defecation first mention						
no intervention (n = 90)	45.6%	7.8%	−2.1%	−11.1%	7.0%	0.654
CLTS (n = 105)	47.6%	9.8%	ref	-	-	-
CLTS+ (n = 105)	61.0%	11.8%	13.3%	2.5%	24.1%	0.015
believes that people commonly use soap after defecation in this village						
no intervention (n = 90)	51.1%	13.8%	4.4%	−9.8%	18.7%	0.54
CLTS (n = 105)	46.7%	13.9%	ref	-	-	-
CLTS+ (n = 105)	51.4%	9.2%	4.8%	−7.0%	16.5%	0.426
believes that people commonly use soap before eating in this village						
no intervention (n = 90)	40.0%	0.0%	−5.7%	−14.9%	3.4%	0.221
CLTS (n = 105)	45.7%	13.0%	ref	-	-	-
CLTS+ (n = 105)	50.5%	8.5%	4.8%	−6.2%	15.7%	0.393
believes that HWWS more in this village than others						
no intervention (n = 90)	76.7%	14.5%	−6.2%	−19.7%	7.3%	0.369
CLTS (n = 105)	82.9%	11.5%	ref	-	-	-
CLTS+ (n = 105)	81.0%	11.8%	−1.9%	−13.5%	9.7%	0.747

[a]mean and standard deviation (SD) of cluster-level means; [b]percentage difference estimated using binomial regression (identity link, binomial distribution) with GEE/robust standard errors to adjust for clustering by village

households of respondents in CLTS+ villages (6 months after the intervention), and was rarely found in the other arms, suggesting little evidence for contamination across arms.

The CLTS+ community meetings were estimated to reach 27% of the population of the communities in which they were implemented. The compound events reached 98% of compounds and an estimated 67% of the population. The audience reached comprised 50% children, 30% women and 20% men.

Discussion

The handwashing intervention as received in the CLTS+ arm had only a small effect on the primary study outcome (the rate of handwashing with soap associated with key events). The results suggest a pattern of change in the desired direction across a number of secondary outcome variables including an increase in knowledge and top-of-mind indicators relating to the use of soap after defecation, as well as the actual use of soap at this time, and an increase in handwashing prior to food handling, but without the use of soap. These increases were measured at 6 months post-intervention. However, most differences were below the size which the study was powered to detect and the results should be interpreted cautiously, particularly in view of the number of secondary variables investigated. Although indicative of some possible effects of the intervention, the changes were too small to be of public-health benefit.

Table 5. Water and sanitation hardware and markers of exposure to the intervention.

	Mean[a]	SD[b]	difference[c]	95% CI lower	95% CI upper	P value
Sanitation and handwashing hardware						
House has latrine						
no intervention (n = 90)	46.7%	13.3%	−25.7%	−39.5%	−11.9%	<0.001
CLTS (n = 105)	72.4%	13.6%	ref	-	-	-
CLTS+ (n = 105)	73.3%	10.2%	1.0%	−11.0%	12.9%	0.876
Soap present at latrine§						
no intervention (n = 42)	6.7%	7.6%	−4.3%	−18.8%	10.2%	0.564
CLTS (n = 76)	10.7%	18.5%	ref	-	-	-
CLTS+ (n = 77)	9.9%	10.8%	−1.2%	−16.5%	14.2%	0.882
Water present at latrine§						
no intervention (n = 42)	4.9%	7.6%	−21.2%	−39.2%	−3.2%	0.021
CLTS (n = 76)	25.9%	23.3%	ref	-	-	-
CLTS+ (n = 77)	15.7%	16.8%	−9.9%	−30.7%	10.9%	0.351
Tippy-tap near latrine§						
no intervention (n = 42)	6.0%	10.3%	−4.0%	−14.6%	6.7%	0.465
CLTS (n = 76)	8.6%	11.8%	ref	-	-	-
CLTS+ (n = 77)	23.4%	18.3%	15.1%	−0.7%	31.0%	0.061
Markers of exposure to the intervention						
heard of village event						
no intervention (n = 90)	75.6%	8.1%	10.8%	2.8%	18.8%	0.008
CLTS (n = 105)	64.8%	7.4%	ref	-	-	-
CLTS+ (n = 105)	88.6%	5.0%	23.8%	17.5%	30.1%	<0.001
present at village event						
no intervention (n = 90)	28.0%	7.5%	1.4%	−8.8%	11.7%	0.782
CLTS (n = 105)	26.7%	12.2%	ref	-	-	-
CLTS+ (n = 105)	66.7%	12.2%	40.0%	27.9%	52.1%	<0.001
heard of household visit						
no intervention (n = 90)	52.2%	13.6%	−9.7%	−21.5%	2.1%	0.107
CLTS (n = 105)	61.9%	8.4%	ref	-	-	-
CLTS+ (n = 105)	96.2%	3.6%	34.3%	27.9%	40.7%	<0.001
present at household visit						
no intervention	20.2%	14.5%	−8.4%	−22.7%	6.0%	0.254
CLTS	28.6%	13.2%	ref	-	-	-
CLTS+	81.0%	10.5%	52.4%	40.5%	64.2%	<0.001
house has campaign sticker						
no intervention (n = 90)	0.0%	0.0%	−4.8%	−11.8%	2.3%	0.184
CLTS (n = 105)	4.8%	10.0%	ref	-	-	-
CLTS+ (n = 105)	71.4%	15.3%	66.7%	53.8%	79.5%	<0.001

[a]mean and standard deviation (SD) of cluster-level means;[b]percentage difference estimated using binomial regression (identity link, binomial distribution) with GEE/robust standard errors to adjust for clustering by village; § responses restricted to households with latrine

The increase in observed handwashing before food contact was the largest shift in behaviour associated with the CLTS+ intervention. Why this was the case is not clear. It may be that messages associated with affiliation were more effective in relation to a social activity, such as eating, where more people may have been present and potentially aware of individual handwashing practices, than in relation to the more private, individual practices around defecation. No soap-use accompanied the increase in handwashing. Formative research revealed concerns that the use of soap prior to food handling may taint the flavour of the food. This may make it additionally challenging to increase soap use at these key times. It has been suggested that handwashing without soap prior to food contact may nevertheless confer some health benefits (Luby et al. 2011).

Latrine ownership was not an outcome in this study. The rates of ownership in the CLTS and CLTS+ arms presumably reflect the success of CLTS in increasing sanitation coverage. Construction of tippy-taps was also promoted through CLTS and was probably reinforced through the 'hardware inspection' element of the compound visits. However, actual numbers of tippy-taps were too low to allow any meaningful exploration of their association with the presence of soap and water at the latrines.

The *Respect People* intervention was implemented as intended (observations made during implementation revealed no major problems or deviation from implementation protocol) and achieved good reach among the target audience, yet failed to bring about significant changes in handwashing practice. The results were poorer than expected given the apparent success of *SuperAmma* (which shared the same theoretical underpinning and a broadly similar implementation format). Below we explore potential reasons for this.

It is possible that, despite following a similar design process to that used for *SuperAmma*, we failed to identify the most appropriate motivational drivers and/or the framing and delivery of messages based on these drivers was less resonant with the target audience. We lack tools with which to make a reliable assessment of the relative effectiveness of different potential content in producing behaviour change. RCTs are unsuitable tools for distinguishing between the many, many different options for framing and delivering behaviour change content.

SuperAmma was a more intensive intervention than Respect People, with a longer community event with multiple elements, separate, school-based activities, door-to-door reminder visits and the active seeking out of women who had not attended community events to expose them to elements of the intervention. The intensity of SuperAmma presented a problem because of the resources which would be needed for implementation at a national, or even regional scale. For this reason, *Respect People* was intentionally less intensive (although at 16–24 person-days of implementation time per community the human resources required for delivery of Respect People were not insignificant). Results from Zambia (Greenland et al. 2016) have suggested that a low received dose was a factor contributing to a lack of behaviour change following a handwashing intervention. Similarly, a review of interventions to reduce diarrhoeal disease (Pickering et al. 2019) concluded that the intensity of the intervention, as indicated by the frequency of contact between implementers and target groups, was a key difference between those interventions that reported a reduction in disease rates and those that did not. It is likely that our short-duration intervention with two potential contacts lacked the intensity needed to change behaviour.

The Nigerian and Indian contexts differed in ways that may have impacted the effectiveness of the intervention. The Indian communities appeared to have a higher level of material wealth (indicated, for example, by better quality housing and greater prevalence of television) and greater availability of convenient water. Water at the Indian study site was provided through multiple standpipes that were close to houses (Biran et al. 2014). By contrast, in the CLTS+ arm of the current study, only one community had a functioning borehole. The other communities relied on neighbouring boreholes which lay within a 1 km radius. Thus, soap and water were less available and less affordable in this Nigerian setting than in the Indian context. It is possible that in the Indian context of relatively good soap and water availability, the additional push of a communication intervention was sufficient to encourage 30% of the population, who were presumably the most motivated, early adopters, to take up the practice, while in Nigeria the practical barriers remained too high and/or would require a stronger or more intensive intervention to achieve the same result.

Observational studies have reported a positive association between hardware and handwashing practice (Biran et al. 2005, 2009; Schmidt et al. 2009; Friedrich et al. 2017). A review by White et al. (2020) postulates that providing access to water and soap through a convenient and desirable handwashing facility may be the most effective means to influence behaviour (White et al. 2020). However, results of a small before-and-after study of water supply and sanitation intervention in Peru (Oswald et al. 2014) found that provision of household water and sanitation connections was associated with only a small improvement in handwashing practice. We cannot say whether the provision of handwashing hardware alone would have been sufficient to increase rates of handwashing in our study population in the absence of behaviour change communication. We concur with the conclusions of previous authors (Oswald et al. 2014; White et al. 2020) that a combination of hardware and software is likely to be necessary.

Another possibility is that some of the apparent effect of *SuperAmma* was the result of bias (reactivity, observer bias or both). In the Nigeria study, additional steps were taken to reduce the

likelihood of bias. These included; a single round of data collection, which allowed less opportunity for enumerators and subjects to discern the nature of the study, data collection at the same time on the same day for all subject households in a community, which allowed no opportunity for households to learn about the data collection process prior to being observed, the use of a questionnaire with dummy variables administered to subjects prior to observation to further disguise the nature of the study from subjects and enumerators and the use of an independent, market research agency from a different part of Nigeria to collect data, reducing the likelihood of subjects making a link between data collection activities and the intervention implementation. It is possible that these additional steps resulted in a more accurate (lower) estimate of effectiveness. A similarly designed trial in India (testing a different intervention) also showed no major effect on handwashing (Lewis et al. 2018).

Despite the study being adequately powered to detect a 15% difference in handwashing prevalence, the confidence intervals were wide, and effect estimates not always in line with what was expected. In particular, the arm receiving no intervention tended to show higher handwashing prevalence than the CLTS-only arm. It is possible that imbalance in the study arms reduced the apparent effect of the intervention. With hindsight, it may have been better to restrict the study to a two-arm trial to achieve more precision in the comparison between CLTS and CLTS+.

The results suggest that it may be unrealistic to expect substantial and sustained changes in deeply rooted practices such as handwashing to arise from short, one-off, behaviour change communication interventions, even if an appeal to strong motives is used in place of rational, health education. Achieving the full public health potential of handwashing with soap may require a sustained communication effort using a variety of communication channels and with a message content that evolves over time as well as better infrastructure. An intervention such as *Respect People*, which is designed for delivery through an existing delivery structure could play a useful role as one element of such an effort.

Conclusion

The CLTS+ intervention, *Respect People*, did not result in substantial changes in handwashing practice. The intervention performed slightly better than CLTS, particularly with regards to handwashing before food handling and to top-of-mind recall of post-defecation as a key time for handwashing with soap. However, the effects would likely be insufficient to bring public health benefits.

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