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The effect of a soap promotion and hygiene education campaign on handwashing behaviour in rural India: a cluster randomised trial

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Summary

OBJECTIVE To investigate the effectiveness of a hygiene promotion intervention based on germ awareness in increasing handwashing with soap on key occasions (after faecal contact and before eating) in rural Indian households.

METHODS Cluster randomised trial of a hygiene promotion intervention in five intervention and five control villages. Handwashing was assessed through structured observation in a random sample of 30 households per village. Additionally, soap use was monitored in a sub-sample of 10 households per village using electronic motion detectors embedded in soap bars.

RESULTS The intervention reached 40% of the target population. Germ awareness increased as well as reported handwashing (a possible indicator of perceived social norms). Observed handwashing with soap on key occasions was rare (6%), especially after faecal contact (2%). Observed handwashing with soap on key occasions did not change 4 weeks after the intervention in either the intervention arm (−1%, 95% CI −2%/+0.3%), or the control arm (+0.4%, 95% CI −1%/+2%). Data from motion detectors indicated a significant but small increase in overall soap use in the intervention arm. We cannot confidently identify the nature of this increase except to say that there was no change in a key measure of handwashing after defecation.

CONCLUSION The intervention proved scalable and effective in raising hygiene awareness. There was some evidence of an impact on soap use but not on the primary outcome of handwashing at key times. However, the results do not exclude that changes in knowledge and social norms may lay the foundations for behaviour change in the longer term.

keywords hygiene promotion, hand washing, behaviour change, soap, India

Introduction

Diarrhoeal disease is a major public health problem estimated to cause around 2 million childhood deaths annually among poor families in low-income countries (Kosek *et al.* 2003). Washing hands with soap on key occasions such as after defecation and before handling food is regarded as an effective means of preventing the transmission of diarrhoeal pathogens, possibly preventing up to 30% of diarrhoeal episodes (Curtis & Cairncross 2003; Ejemot *et al.* 2008) and may also be important in preventing respiratory infections (Luby *et al.* 2005; Rabie & Curtis 2006). In order for the full public health potential of handwashing with soap to be realized (Laxminarayan *et al.* 2006), effective hygiene promotion interventions are needed with the proven ability to change hygiene behaviours at scale.

Commercial soap manufacturers have considerable experience of designing and implementing behaviour change interventions at scale to promote the use of their products among the rural poor. We tested whether a hygiene promotion intervention modelled on an existing marketing campaign promoting the use of a commercial soap brand could achieve a high reach among the target population, increase hygiene awareness and increase actual handwashing with soap on key occasions in the short-term. A further aim of the study was to test the feasibility of rigorously evaluating actual behaviour change, a

potentially important lesson for hygiene promotion campaigns elsewhere. The intervention was built around raising awareness of germs and of the importance of hygiene practices in preventing infection.

Methods

Study site

The study was carried out in 10 villages in the poor, rural district of Mahbubbnagar in the Indian state of Andhra Pradesh. For logistical reasons the villages selected were within 10 km of the clinic of the Institute for Rural Health Studies (IRHS) the local collaborator with whom the study was carried out. The villages were agricultural and were similar socially and economically. They ranged in size from 1065 to 3194 people. Each village had a state-run primary school attended by children between the ages of 8 and 13 years.

Recruitment

The 10 study villages were stratified by size into two categories (more than and fewer than 1700 people) and then randomised within each stratum to intervention and control arm. The study procedures were initiated within a 4-week period across all study villages and continued over 4 months overall (baseline survey, intervention and follow-up survey).

Within each village a sample of 30 households was selected to participate in the study. The classroom registers of the state-run primary school in each village provided the sampling frame from which households were selected. All households in which there was at least one child registered at the primary school and at least one other child aged less than 6 years were included in the sample. As there were fewer than 30 such households in each village, the criterion of having at least 1 other child aged less than 6 years was dropped for the remaining households. These were then randomly selected from households in which there was at least 1 child registered at the primary school. Written, informed consent was sought from the heads of households and a screening question was administered to exclude households having members with skin conditions that might prevent soap use. The final sample included 143 intervention and 145 control households. The structure of the trial is shown in Figure 1.

The intervention

The intervention followed closely the approach taken by an existing commercial soap marketing campaign in rural India. The hygiene promotion intervention was delivered over a series of visits by an intervention team of two trained communicators from a marketing agency with experience of commercial soap marketing. The intervention team visited each intervention village four times over a period of 8 weeks. This was similar to the delivery of the commercial campaign from which the intervention was taken. It was intended to achieve repeated exposure to campaign messages, allowing time between visits for activities undertaken at each visit to take effect while still being logistically feasible for scale-up by a team covering a large geographic area. The primary target audiences for the campaign were children aged 8–13 years and women. The content of the intervention is described in Table 1. Control villages received no intervention.

Questionnaire surveys

Background social, demographic and economic data were collected at the outset of the study in each of the study households from the head of household or another adult (if the former was not available) using a verbally administered questionnaire.

Awareness of and exposure to the intervention were assessed in all study households using a verbally administered questionnaire within 6 weeks of the intervention's end. Mothers (whenever possible) or another adult household member were asked whether they had heard of germs and whether they had heard of the intervention. They were also asked if they had seen or participated in each of the intervention's main components (the glo-germ demonstration, the children's rally, the flipchart presentation, the stencils on village walls and the height and weight check for children and mothers). Self-reported soap use was assessed at baseline and after the campaign in a sub-sample of 10 households per village.

Observation of handwashing practices

The proportion of key occasions (faecal contact, eating or giving food to a child) that were accompanied by handwashing with soap was measured in all study households at baseline and again within 6 weeks of the final intervention visit (prior to the final questionnaire survey). These data were collected by direct observation according to methods described in detail elsewhere (Curtis *et al.* 1997; Biran *et al.* 2005). The observations were carried out by female fieldworkers, 2 or 3 of whom were recruited from each study village. Having young, local women carry out the observations was acceptable to the study householders who may have felt less comfortable (and so less likely to behave as normal) in the presence of older men or

Table 1 Content of the intervention

Visit to village by communication team	Session	Activity
Visit 1	School Visit	*Preparation* The communication team visited the school and got permission from the head teacher to carry out intervention activities with the school children. They erected a canopy and stage with a public address system and publicity banners promoting a healthy life through soap use. *Flip chart story* The school children were assembled. The team used an illustrated flip chart to tell a story with a soap theme in which demon germs are fought and defeated by a soap superhero. Germs were explained as invisible green creatures that cause diarrhoea when eaten, infect wounds and cause eye infections thus making children sick and preventing them from having fun. The story stressed the importance of washing hands with soap after defecation and before eating, bathing with soap and washing wounds with soap. *Glo-germ demonstration* Two children volunteers rubbed their hands in a white powder. They then washed their hands with water but only one of them used soap. They put their hands into a dark box with a window in the front and a UV light was shone onto them. Traces of the powder showed up green on the hands of the child who had not used soap. The children were told that this light was allowing them to see the invisible germs that cannot be removed without soap. This demonstration took place in front of the assembled children. *Discussion and quiz* The team engaged the children in a discussion about hygiene habits, health, germs and the importance of using soap. They used a lot of questions to keep the children involved. This was followed by a quiz relating to the discussion with some small soap-related prizes for the winners. *Children's rally* The children were given 'soap for health' flags to wave and were led on a march through the village chanting slogans about health, hygiene and soap. This event provided a talking point to raise awareness of the intervention among the adults in the village. *Stenciling walls* Children were sent out in teams with paint and stencils. They used these to stencil some of the village walls with slogans about health, hygiene and soap. These helped spread awareness of the intervention in the village. *Germ-killer game* The children were given germ masks and soap hero masks to wear. They were organized into teams and played a chasing game with a germ-killer theme in the school playground. *Site clean-up* An area in or near the school (for example around the school pump or in the classrooms) was selected and the children agreed to work on cleaning it up after the visit. *Wrapper redemption* The children were encouraged to collect soap wrappers that they would subsequently be able to exchange for small gifts at a future visit of the intervention team.
	Opinion leaders meetings	*Preparation* Two meetings were held in a public place in the village. One with a group of men and one with a group of women. The intervention team set up a canopy, seats and banners and a public address system. Respected and influential village leaders and elders were specifically invited to these meetings. Other villagers were free to attend. *Flipchart talk* An illustrated flip chart was used to give presentations about the dangers of germs and the importance of using soap. The purpose of the intervention was also explained. The presentation to men focused on the financial consequences of family illness. The pre sentation for women looked at the importance of soap for keeping the family healthy and ended with the distribution of a printed sheet of 13 hygiene practices.

Table 1 (*Continued*)

Visit to village by communication team	Session	Activity
Glo-germ demonstration Both groups were shown the glo-germ demonstration in the same way as for the school visit.		
Visit 2	*The* 'Healthy mother and child day'	*Preparation* The team set up a canopy, banners and a public address system in the school and scales and a height chart in one of the classrooms. Through the school, mothers of pre-school children had been informed about the event. Further publicity took place door to door on the morning of the event. *Flipchart presentations* The mothers were assembled under the canopy. Illustrated flipcharts were used for two presentations. One presentation was about germs, the importance of washing with soap and the importance of teaching children to wash with soap. The second presentation was about the causes of diarrhoea and the use of oral re-hydration in its treatment. *Glo-germ demonstration* Mothers were shown the glo-germ demonstration. *Height and weight check* The heights and weights of children and mothers were taken. While this was being done the communicators talked to mothers about germs and the importance of using soap. Plaques and certificates were given to a number of mothers whose children appeared particularly healthy, clean and presentable. *Soap wrapper redemption.* School children were given the opportunity to exchange their soap wrappers for small gifts.
Visit 3	Interim visit The intervention team visited the school to check on progress and preparations for the final visit.	
Visit 4	Second school visit.	*Preparation* Preparation took place and the children were assembled as for visit 1. *Review session.* The team again presented the flipchart story and material covered in visit one, asking the children about the material in the form of a review session. *Glo-germ demonstration* Thiswas repeated as on the first visit. *Soap wrapper redemption* The children were given another opportunity to exchange soap wrappers for small gifts. *Songs and stories* The children were invited to sing songs and tell stories and jokes. Some of these had a health and hygiene theme. *Prizes for artwork* Pictures drawn by some of the children, usually as part of their science lessons were displayed and judged. The best two received a certificate. *Flag waving* The children were given 'soap for health' flags to wave and chant slogans about health, hygiene and soap to reinforce the message. *Tree planting* The session ended with a talk about the wider environment and the importance of trees. The head teacher or the village leader planted a tree within the school grounds.

outsiders. It also helped overcome logistical problems associated with getting fieldworkers to rural households early in the morning. After extensive training in structured observation, the fieldworkers visited each household for a period of 3 h beginning between 05:00 and 05:30. This period was chosen because it is a common time for defecation, eating, washing and bathing. Faecal contact was assumed when participants were observed going for defecation, cleaning the bottom of a child who had defecated or cleaning up or handling any faeces (e.g. removing children's faeces from the yard or handling cow dung).

Whenever faecal contact by any household member occurred, details of their handwashing practice immediately after the event were observed and recorded by the fieldworkers. Whenever a household member fed a child or ate, details of their handwashing practice immediately before the event were recorded. Details were recorded of whether one hand, both hands, or neither hand was washed and whether soap, ash or water alone was used. Safe handwashing was defined as washing both hands with soap or ash and water (although use of ash as a handwashing agent was not seen). Bathing with soap was also considered as safe hand-washing if it occurred immediately after defecation or before food handling.

In order to collect valid data on handwashing by direct observation it is necessary that subjects are not aware of the precise nature of the data being collected. In this study subjects were told that 'routine domestic practices and child care' were being observed.

Electronic soap use loggers

Soap use was monitored using electronic data loggers (motion detectors). This was a pilot test of a new technology and was therefore not intended as the primary outcome measure. Data loggers were used in a random sub-sample of 10 households per village. The data loggers were embedded in bars of soap. The logged bars were given to households to use in place of their existing bathing soaps which were collected and removed. The logged soap bars were left in households for 7 days and data were recorded on days 2 to 6. The loggers recorded movements of the soap bars giving an indication of use. Householders were aware that the soap bars contained electronic devices that recorded soap movements. Since soap movement alone did not allow us to determine what soap was used for, we attached similar loggers to water cans (*chumbus*) used exclusively for anal cleansing. Any soap movement occurring within 5 min of the recorded use of a *chumbu* was assumed to represent soap use after defaecation.

Statistical analysis

An *a priori* decision was taken that the primary analysis would be a comparison of pre- and post-intervention data at the household level (intervention and control arm treated separately) and that a secondary analysis would directly compare intervention and control villages at the village (cluster) level. This was because sample size calculations prior to the study showed that the power of a cluster-level analysis to detect a significant difference in handwashing between control and intervention villages would be limited. The primary outcome of the study was therefore the comparison of the proportion of observed 'key occasions' on which hands should have been washed (defined as faecal contact, eating or giving food to a child) that were accompanied by safe handwashing before and after the intervention. The primary hypothesis was that safe handwashing would increase in the intervention villages and remain constant in the control villages. We estimated that the study would have 80% power to detect an increase in safe handwashing from 5% to 15% (at $P < 0.05$), allowing for clustering of safe handwashing in households and assuming 4 events observed per household before and after the intervention. The difference in handwashing proportions before and after the campaign was calculated using a binomial regression model (identity link) with an observed event as the unit of analysis, adjusted for clustering on household level using GEE.

For the comparison of safe handwashing between intervention and control villages (the secondary analysis) we calculated the village-level safe handwashing proportions measured at follow-up after the intervention, and compared these between intervention and control villages using an ANOVA model. The model was adjusted for the pre-campaign village-level handwashing proportions and weighted according to the numbers of events observed at follow up.

Categorical and ordered categorical outcome variables were compared using multinomial logistic and ordered logistic regression adjusted for clustering on household level with robust standard errors. All calculations were performed using STATA 9.

Results

Social and demographic characteristics of the study population are shown in Table 2. There was little difference between the intervention and control arm indicating appropriate randomisation. Most household heads lacked formal education. Ownership and use of latrines were very rare in both arms. Most households relied on a water source situated beyond the confines of their home or

Table 2 Sociodemographic characteristics

	Control arm		Intervention arm	
	n	%	*n*	%
All	145	100	143	100
Level of education of household head				
None	100	69	97	68
Some Primary	23	16	22	15
Completed Primary	6	4	5	4
Some Secondary	7	5	6	4
Completed Secondary	6	4	10	7
Higher Education	2	1	3	2
Occupation of household head				
Student	2	2	1	1
Labourer	44	35	51	43
Labourer + own farm work	43	34	29	24
Small Farmer	30	24	36	30
Small Business	6	5	2	2
other	1	1	0	0
Household income (rupee)				
0–999	31	21	27	19
1000–1499	33	23	34	24
1500–1999	29	20	39	28
>2000	52	36	41	29
Land ownership (acres)				
0	59	41	61	43
0–0.9	18	12	21	15
1–1.9	37	26	36	25
>2	31	21	25	17
Electricity	117	81	123	86
Floor material				
Dung/dirt	56	39	73	51
Cement/stone/tiles	89	61	70	49
Defecation facility				
Field/bush	145	100	136	96
Latrine	0	0	5	4
Flush toilet	0	0	1	1
Type of water supply				
Tap/standpipe	113	78	105	73
Open well	1	1	0	0
Hand pump	0	0	17	12
Reservoir/tank	31	21	21	15
Location of water source				
House	3	2	11	8
Yard	7	5	13	9
Elsewhere	135	93	119	83

compound. Most houses had a tank in the front yard in which they stored water for washing, cleaning and bathing purposes. Soap was available in nearly all households (96%).

In the intervention villages, about 40% of respondents had heard of the campaign and had been exposed to at least one component directly (Table 3). Exposure varied little among the different components of the intervention.

Table 3 Intervention reach (measured post-intervention)

	Intervention (*n* = 139)	Control (*n* = 143)
Heard of intervention?	38%	1%
Heard of germs?	36%	15%
Seen or participated ≥ 1 intervention component	40%	1%
Number of components seen or participated in		
0	60%	99%
1 or more	40%	1%
2 or more	27%	0%
3 or more	19%	0%
4 or more	12%	0%
5 or more	8%	0%
Exposure to single components		
Flipchart presentation	23%	0%
Glo-germ	19%	0%
Graffiti	19%	0%
Children's Rally	24%	1%
Height & Weight	20%	0%
Exposure by village (any component)		
Village 1	32%	–
Village 2	36%	–
Village 3	57%	–
Village 4	20%	–
Village 5	54%	–

However, there were marked differences in exposure between intervention villages (range 20–57%). There was no correlation between village size and level of exposure ($r = -0.002$). In intervention villages 36% of respondents said they had heard of germs compared with 15% in non-intervention villages.

The average number of 'key occasions' (i.e. occasions for handwashing) observed per household declined from 8.6 (SD = 4.0) at baseline to 5.9 (SD = 2.9) at follow up ($P < 0.001$) with little difference between intervention and control arms (Table 4, top half). In both arms this was largely due to a decline in the numbers of eating and food-giving events observed. The number of observed faecal contact events remained fairly constant (Table 4, top half).

Handwashing of any type regardless of soap use slightly decreased after the campaign in the intervention arm, while the proportion of events where hands were not washed increased (Table 4, bottom half). Further analysis showed that the drop in handwashing in the intervention arm was mostly due to fewer eating and food-giving events recorded at follow up, as handwashing was far more common before food handling than after faecal contact (11% *vs.* 1%). Adjusting the comparison between before and after handwashing practices (Table 4, bottom half) for type of event

Table 4 Observed potential handwashing occasions and handwashing practices after key occasions in intervention and control arm at baseline and follow up

	Intervention			Control		
	Baseline	Follow up		Baseline	Follow up	
Total number of events observed	1143 (100%)	825 (100%)	P	1344 (100%)	862 (100%)	P
Type of occasions observed						
Before handling food	625 (55%)	296 (36%)	<0.001*	772 (57%)	275 (32%)	<0.001*
After defecation	405 (35%)	432 (52%)		415 (31%)	440 (51%)	
After cleaning child	74 (6%)	65 (8%)		53 (4%)	38 (4%)	
Other faecal contact	39 (3%)	32 (4%)		104 (8%)	109 (13%)	
Hand-wash practice after occasion						
No	655 (57%)	533 (65%)	0.01†	787 (59%)	503 (58%)	0.99†
One hand	171 (15%)	102 (12%)		143 (11%)	107 (12%)	
Both hands	216 (19%)	132 (16%)		340 (25%)	198 (23%)	
Body wash	98 (9%)	58 (7%)		69 (5%)	53 (6%)	
Not observed	3 (0.3%)	0 (0%)		5 (0.4%)	1 (0.1%)	

*Multinomial logistic regression adjusted for household clustering.
†Ordered logistic regression adjusted for household clustering.

resulted in *P*-values of 0.27 (intervention) and 0.31 (control), indicating no evidence for a behaviour change in either group.

The results of the before/after comparison of safe handwashing in intervention and control villages separately (primary outcome) are shown in Table 5. The proportion of key occasions accompanied by safe handwashing slightly decreased from 8% to 5% in the intervention group, while remaining constant in the control group. However, after adjusting for the type of event (faecal contact *vs.* eating/food-giving), the decrease was only 1%. Analyses restricted to school children or women in the intervention arm (expected to be the most exposed groups) also revealed no change in handwashing with soap. Handwashing with soap after faecal contact was very low in both groups before and after the campaign. Washing both hands (with or without soap) also showed no increase in either arm regardless of adjusting for type of event. Soap was much more commonly used for bathing (84%) then for washing both hands (4%). However, excluding those faecal contact events that were followed by bathing with soap still indicated no change in safe handwashing behaviour. Reported soap use for bathing increased strongly in the intervention arm, but remained constant in the control arm. Reported soap use for handwashing was very rare in both study arms before and after the intervention (Table 5).

The secondary outcome of the study was the comparison of the proportion of key occasions accompanied by safe handwashing between intervention and control villages (Table 6). The proportion of key occasions with safe handwashing varied greatly between villages, but there was good correlation between the safe handwashing proportions before and after the campaign ($r = 0.8$), indicating

Table 5 Before/after comparison of handwashing with soap and reported soap use in intervention and control households

	Intervention arm				Control arm			
	Before	After	Change	95% CI	Before	After	Change	95% CI
Hands washed with soap and both hands	8%	5%	−1%*	[−2%/+3%]*	5%	6%	+0.4%*	[−1%/+2%]*
Hands washed with soap (school age children)	15%	9%	−2%*	[−5%/+1%]*	8%	9%	+1%*	[−2%/+4%]*
Hands washed with soap after faecal contact	1%	0.4%	−1%†	[−2%/+3%]†	2%	1%	−1%†	[−2%/+1%]†
Hands washed with soap or water and both hands	28%	23%	−1%*	[−5% +3%]*	31%	29%	+1%*	[−3%/+6%]*
Reported soap use (bathing)‡	72%	90%	+18%	[+1%/+35%]	85%	83%	−2%	[−17%/+13%]
Reported soap use (hand washing)‡	0%	4%	+4%	[−3%/+11%]	2%	2%	0%	[−8%/+8%]

*Binomial regression adjusted for household clustering and type of event.
†Binomial regression adjusted for household clustering.
‡Conditional logistic regression (sub-sample of 10 households per village).

Table 6 Village level comparison between intervention and control arm

Arm	Village number	Proportion of occasions followed by handwashing with soap	
		Baseline	Follow up
Intervention villages	1	0.4%	0.0%
	2	4.6%	1.7%
	3	5.6%	2.7%
	4	13.9%	16.4%
	5	20.0%	14.8%
	Mean*	8%	5%
Control villages	6	0.4%	0.0%
	7	4.5%	0.6%
	8	4.9%	11.6%
	9	5.6%	2.0%
	10	7.6%	10.8%
	Mean*	5%	6%
Crude difference*			−1% [−10%/+9%]
Adjusted difference†			−2.6% [−9%/+4%]

*Weighted by number of events observed at follow up.
†Adjusted for handwashing proportion before campaign.

that within each village safe handwashing remained fairly constant. There was no indication of a difference in the proportion of safe handwashing events between intervention and control villages.

Analysis of the logger data suggested that the number of soap movements per household per day rose from 3.9 to 4.4 in the intervention arm ($P = 0.02$) and fell from 5.0 to 4.4 in the control arm ($P = 0.11$). However, the proportion of *chumbu* uses that were followed by soap use (a proxy for soap use after defaecation) did not change (in both study arms 5% at baseline and 4% at follow up, $P = 0.83$ and $P = 0.93$).

The analysis of household-level determinants of safe handwashing is shown in Table 7. None of the socioeconomic characteristics was associated with safe handwashing nor was awareness of germs or intensity of exposure to the intervention. In contrast, water availability was associated with safe hand-washing. Households having a water source in the house practiced safe handwashing around 6% more than those who having a water source in the yard who again were observed to practice safe handwashing more than those who had to collect their water from elsewhere.

Discussion

The intervention achieved a wide reach among the target population and increased reported knowledge of germs. However, at least in the short term, there was no effect on actual handwashing behaviour at key times.

There are several potential explanations for this. The intervention may have failed to reach its target audiences, the intervention may have failed to deliver effective hygiene education and raise germ-awareness, or hygiene education and germ-awareness may be ineffective drivers for hygiene behaviour change. It may also be that the timescale of our study was too short to capture changes in behaviour, which may occur over a much longer period.

It seems unlikely that failure to reach the target audience alone explains the lack of an effect. Although there is clearly room for improvement, 40% of adult respondents reported exposure to at least one component of the intervention and exposure among school children is expected to have been even higher. Furthermore, we found no evidence for any effect, even among the households with highest reported levels of exposure to the intervention.

Our data show that the intervention is associated with a higher level of self-reported germ-awareness among adults, but show no association between germ-awareness and handwashing with soap. However, we did not assess whether germ-awareness equates with understanding or acceptance of germs as causal agents of infection or of handwashing with soap as a means of preventing infection. We cannot therefore distinguish between the intervention as an ineffective means of educating and hygiene education as an ineffective means of bringing about behaviour change. Both of these explanations may have played a role. We cannot rule out the possibility that an intervention based on germ-awareness could change behaviour if its content and delivery were more carefully matched to the needs of the target audience taking into account cultural beliefs surrounding dirt and hygiene (Kaltenhaler & Drasar 1996). It may also be necessary to address potential barriers to handwashing, such as the convenient availability of water. Raising awareness of a health issue is only one possible factor in changing behaviour and a successful intervention may need to address other factors such as social support and personal competencies (Abraham & Michie 2008). However, the study results are consistent with the view that traditional hygiene education may be ineffective in changing behaviour even when accompanied by participatory activities for children and that additional and innovative techniques are needed (Hoque 2003; Luby *et al.* 2005; Curtis *et al.* 2007; Scott *et al.* 2007). These might include marketing techniques for hygiene promotion that focus on emotional motivations for behaviour change (Scott *et al.* 2008) rather than on knowledge about health (Scott *et al.* 2007) as well as more concerted efforts to engage the active involvement of mothers in supporting handwashing at home. However, these approaches have

Table 7 Association between socio-economic factors, water availability, exposure to the campaign and handwashing practices

	n	Handwashing with soap (both hands)	*P**	Handwashing with or without soap (both hands)	*P**
Socioeconomic factors					
Income					
<1000	58	5%	0.7	27%	0.7
1000–1499	67	6%		30%	
1500–2000	68	6%		27%	
>2000	93	7%		27%	
Education of HH head					
None	197	7%		28%	0.96
Some primary	56	4%		27%	
Some secondary or higher	34	6%		30%	
Electricity					
Yes	240	6%	0.63	29%	0.53
No	48	5%		28%	
Land (acres)					
0	120	7%	0.44	28%	0.89
0.1–0.9	39	7%		27%	
1–1.9	73	5%		28%	
>2	56	5%		29%	
Water availability					
Type of supply					
Tap/reservoir	270	6%	>0.001	29%	0.01
Handpump/well	18	0.4%		17%	
Water source					
House	14	15%	0.03	37%	0.18
Yard	20	9%		22%	
Elsewhere	254	5%		27%	
Knowledge about germs and exposure to the intervention					
Heard about germs					
Yes	209	7%	0.12	29%	0.46
No	73	6%		27%	
Heard about campaign†					
Yes	54	4%	0.39	23%	0.78
No	85	6%		22%	
Number of components seen†					
0	87	6%	0.54	28%	0.24
1	17	9%		32%	
2–3	17	7%		29%	
4–6	22	5%		22%	

*Adjusted for clustering by household (binomial regression with GEE).
†Restricted to households in the intervention arm.
Analysis done on level of observed occasions (n = 4174). Numbers given refer to numbers of households, not occasions).

not yet been rigorously evaluated with regard to behaviour change. It may also be helpful to increase the involvement of male heads of households if formative research suggests that their support is critical in facilitating behaviour change in their wives and children.

Finally, it is possible that behaviour change takes place over a longer period of time that was not captured by our evaluation. The increase in reported soap use for bathing in the intervention arm may indicate a shift in the social desirability of using soap that might lead to a later change in handwashing behaviour.

Our data once again point to the importance of water availability and convenience in facilitating safer hygiene practices. Households having closer or more convenient water sources practiced more handwashing with soap. This finding echoes earlier work showing that better water availability is associated with an increase in water used and an increase in the quantity used for hygiene purposes

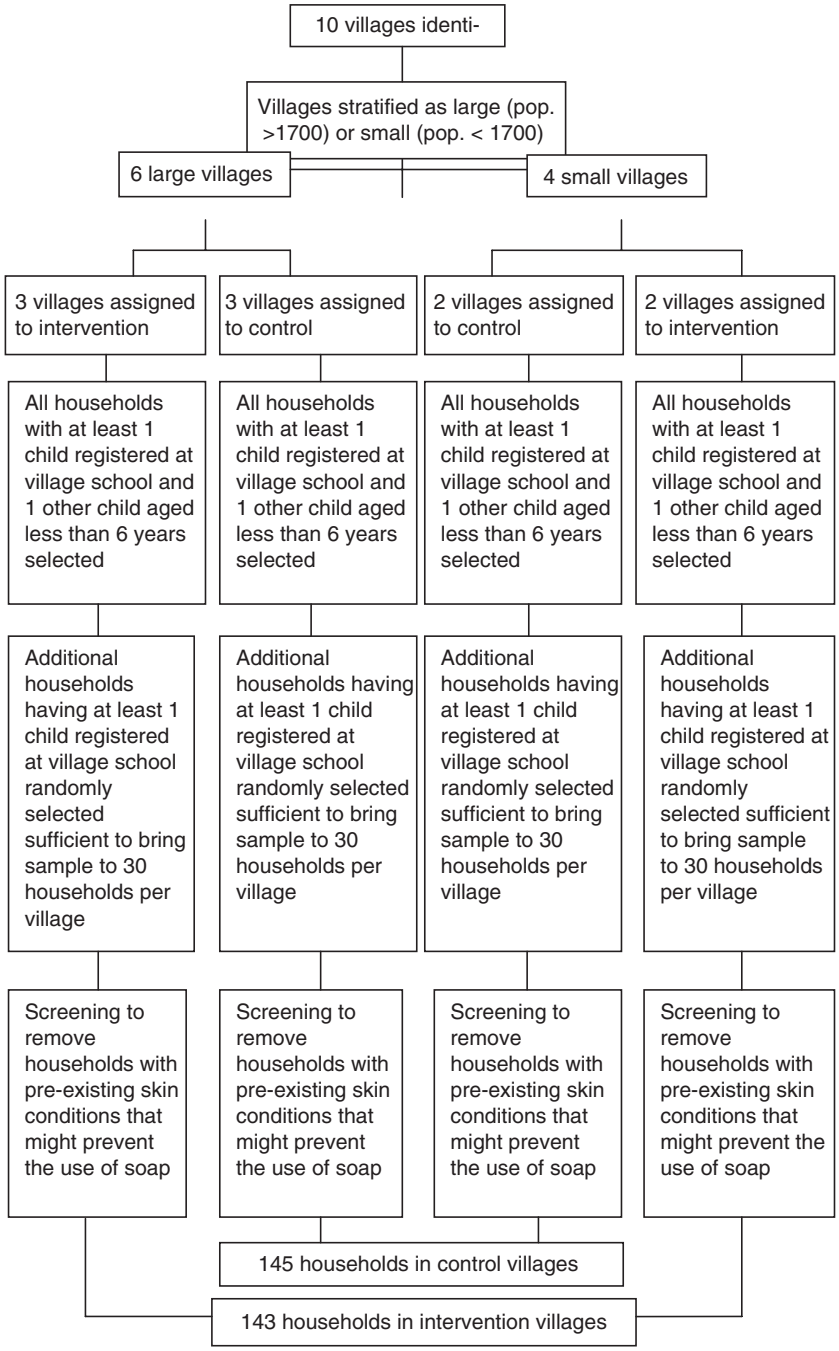

Figure 1 Structure of the trial.

(Cairncross & Cliff 1987; Cairncross & Feachem 1991).Our study was able to corroborate these findings by systematic observation of handwashing practices. Thus hygiene promotion interventions should, if possible, address facilitating factors such as the availability of convenient water.

The lack of change in handwashing at key times is further confirmed by the soap logger data. Although these

data are compatible a small increase in overall soap use in the intervention arm, there was no indication that soap use after defecation (defined as soap use following use of the *chumbu* water can used for anal cleansing) changed. Interestingly, the proportion of *chumbu* uses followed by logged soap movement (around 4–5%) was close to the proportion of observed defecation events followed by handwashing with soap recorded by structured observation (1–2%). The somewhat higher proportion derived from the logger data can be explained by coincidental soap use by a different person occurring in temporal proximity to *chumbu* use, something that direct observation would have distinguished. Nevertheless, these results suggest that soap use immediately following *chumbu* use may be a valid proxy marker for post defaecation handwashing with soap. This proof of principle of measuring a socially desirable behaviour unobtrusively may have far reaching implications for hygiene promotion programmes in general. A more detailed methodological description of the validity of the soap loggers will form a separate paper.

The decrease in the number of observed food handling occasions over the study period points to the difficulties faced by the observers in deciding what constitutes a single event with a clear beginning and end. It may also reflect seasonal variation in activity patterns. However, variation of handwashing with soap after faecal contact was much smaller. Furthermore, the village-level proportions for handwashing with soap before and after the campaign were strongly correlated, i.e. the field workers were consistent in their recording of hygiene practices suggesting that the inter-village variation does not compromise the validity of the study results.

Perhaps surprisingly, the study participants' handwashing practices under observation do not appear to be influenced by the presence of an observer. If reactivity to an observer were an issue we would have expected to find a greater effect in the intervention arm than in the control arm post intervention. This was not the case. Since bias would have been expected to occur in the direction of finding an effect we are confident that our observational data provide a good estimate of (lack of) behaviour change. A more intensive hygiene intervention may have a greater potential for reactivity in observational data, as participants exposed to an intensive campaign may alter their behaviour under observation more than unexposed participants. Therefore demonstrating a behaviour change under observation does not prove actual behaviour change. However, our results suggest that the absence of behaviour change can reliably be demonstrated. Plausible evidence for a change in behaviour may be regarded as a necessary although not sufficient condition in assessing the causal chain between intervention and health outcome and should be provided if health benefits are claimed (Blum & Feachem 1983;Cairncross 2008). Our study suggests that structured observation can play a role in this.

The negative findings of our study may have implications for health promotion campaigns in general, especially those using a traditional educational approach. Our findings confirm the need to identify other motivators for behaviour change and to establish the effectiveness of campaigns in actually changing the targeted behaviour prior to or in parallel with any assessment of health impact.

Conclusions

Although the intervention evaluated in this study was suitable for implementation on a large scale, the current content of the intervention was not effective in bringing about changes in domestic handwashing practices at key times in the short term. However, the results provide some evidence suggesting that the intervention increased the use of soap, and do not exclude that changes in knowledge and social norms may have occurred laying the foundations for behaviour change in the longer term.

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