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Sustained improvements in handwashing indicators more than 5 years after a cluster-randomised, community-based trial of handwashing promotion in Karachi, Pakistan

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Abstract

OBJECTIVE—To evaluate handwashing behaviour 5 years after a handwashing intervention in Karachi, Pakistan.

METHODS—In 2003, we randomised neighbourhoods to control, handwashing promotion, or handwashing promotion and water treatment. Intervention households were given soap +/− water treatment product and weekly handwashing education for 9 months. In 2009, we re-enrolled 461 households from the three study groups: control (160), handwashing (141), and handwashing + water treatment (160) and assessed hygiene-related outcomes, accounting for clustering.

RESULTS—Intervention households were 3.4 times more likely than controls to have soap at their handwashing stations during the study visit [293/301 (97%) *vs*. 45/159 (28%), $P < 0.0001$]. While nearly all households reported handwashing after toileting, intervention households more commonly reported handwashing before cooking [relative risk (RR) 1.2 (95% confidence interval (CI) 1.0–1.4)] and before meals [RR 1.7 (95% CI, 1.3–2.1)]. Control households cited a mean of 3.87 occasions for washing hands; handwashing households, 4.74 occasions; and handwashing + water treatment households, 4.78 occasions ($P < 0.0001$). Households reported purchasing a mean of 0.65 (control), 0.91 (handwashing) and 1.1 (handwashing + water treatment) bars of soap/person/month ($P < 0.0001$).

CONCLUSIONS—Five years after receiving handwashing promotion, intervention households were more likely to have soap at the household handwashing station, know key times to wash hands and report purchasing more soap than controls, suggesting habituation of improved handwashing practices in this population. Intensive handwashing promotion may be an effective strategy for habituating hygiene behaviours and improving health.

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Keywords

handwashing; behaviour; Pakistan; soaps

Introduction

Handwashing has many important health benefits in community settings: it can substantially cut rates of diarrhoeal and respiratory disease, two leading causes of death in children <5 years of age (Rabie & Curtis 2006; Ejemot *et al.* 2008; Black *et al.* 2010); reduce transmission of gastrointestinal illness in households (Sandora *et al.* 2005) and work environments (Hubner *et al.* 2010; Savolainen-Kopra *et al.* 2012); reduce school absenteeism (Bowen *et al.* 2007; Talaat *et al.* 2011); and may improve developmental outcomes among young children in low-resource settings (Bowen *et al.* 2012). However, little evidence exists to guide the design of interventions to produce sustained adoption of appropriate handwashing habits. A recent review found that maintenance of handwashing behaviours was assessed >1 year after the intervention in only four of 30 handwashing behaviour change studies (Vindigni *et al.* 2011). Thus, our understanding of effective and cost-effective strategies for achieving sustained, appropriate handwashing habit adoption is poor. A better understanding of how to improve and sustain handwashing habits globally could have broad public health impact.

In a study conducted in informal settlements in Karachi, Pakistan, in 2003, neighbourhoods were randomised to receive household-level handwashing promotion and free soap for 9 months or to serve as controls (Luby *et al.* 2006). Participants in intervention households reported 53% less diarrhoea than did those in control households (Luby *et al.* 2009a). Between August 2005 and September 2006, we reassessed diarrhoea burden and handwashing knowledge and practices among these households (Luby *et al.* 2009a). Children in the intervention groups appeared to experience less diarrhoea during the first 5 months of the study, although the difference across the entire study period was not statistically significant (Luby *et al.* 2009a). Intervention households were also 1.5 times more likely to have a place for handwashing that included soap and water and were more than twice as likely to demonstrate rigorous handwashing, suggesting that improved handwashing behaviour had become habitual and persisted more than 2 years after the intervention ended (Luby *et al.* 2009a). We returned to these households to re-evaluate handwashing knowledge and practices in 2009, more than 5 years after the original intervention.

Methods

Setting

The study was set in central Karachi among multi-ethnic informal settlements. Health-Oriented Preventive Education (HOPE), a local non-governmental organisation that administers health clinics, schools and community development programming in Pakistan, conducted the field-work.

Design and interventions

The 2003 study was a community-based, cluster-randomised, controlled trial of handwashing and drinking water interventions (Luby *et al.* 2006). Forty-seven neighbourhood clusters were identified, and consenting households with at least one child <5 years of age were enrolled. The clusters were randomised as previously described to five groups: nine neighbourhoods served as the control group (control); nine neighbourhoods received soap and handwashing promotion (handwashing); 10 neighbourhoods received soap, handwashing promotion and flocculent-disinfectant for drinking water treatment (handwashing + water treatment); and two additional groups received education and supplies to improve drinking water. Fieldworkers arranged neighbourhood meetings during which they used slide shows, videos and pamphlets to educate participants about health problems associated with contaminated hands or water and explained how to use the intervention products assigned to the respective neighbourhood. Recipients of the handwashing intervention were given 90-g bars of generically packaged Safeguard® soap (Procter & Gamble, Mason, OH, USA) that was not imprinted with a brand or logo and were instructed to wash hands by wetting hands, lathering them completely with soap and then rubbing hands together for 45 s. Participants old enough to understand (generally persons >30 months of age) were asked to wash hands after defaecation, before preparing food, before eating and before feeding infants. Recipients of the flocculent-disinfectant water treatment product were also given a plastic vessel for safely storing drinking water and sachets of the water treatment product, PuR® (Procter & Gamble). Control households regularly received children's books, notebooks, pens or pencils but no messaging about handwashing or water treatment. Fieldworkers visited households at least weekly from April to December 2003 to encourage use of the interventions, answer questions and re-supply soap or water treatment products as needed. They interviewed the female head of household about water and hygiene issues and observed hygiene infrastructure at baseline and then assessed diarrhoea incidence weekly during this time (Figure 1).

Households from the control group and the two study groups that received handwashing promotion were enrolled in a follow-up study in 2005 (Luby *et al.* 2009a). We interviewed intervention and control households at baseline and weekly from August 2005 to September 2006 about diarrhoea and hand soap purchases; the fieldworkers did not provide health education or handwashing and water treatment supplies during this study.

In 2009, we attempted to re-enrol households from the same three groups with children who participated in the 2005 study and who would have been <96 months of age upon re-enrolment. We selected this age range because our primary objective was to assess developmental impacts of handwashing promotion during the first 2 years of life; results are reported elsewhere (Bowen *et al.* 2012). Although group allocation was not disclosed to fieldworkers during this study, some fieldworkers had been employed during the 2003 study and might have recalled the original study allocations.

Measurements

We used standard questionnaires in the local language to interview a female adult from each household about household characteristics and drinking water and handwashing practices.

During the interview, we also asked the respondent to free-list occasions during which they believed hands should be washed; similar responses were grouped for analysis. Fieldworkers directly observed handwashing technique and handwashing and drinking water supplies and infrastructure. We defined a handwashing station as a place to wash hands inside the house, and we estimated *per capita* soap consumption for each household by dividing the reported numbers of bars of soap purchased by the household each month by the number of household members.

Statistics

We used statistical survey methods accounting for clustering by neighbourhood using SURVEYFREQ and SURVEY-REG SAS 9.3 procedures (SAS Institute, Cary, NC, USA) to compare characteristics of household who did or did not re-enrol and to compare re-enrolled households across the study arms. Because the handwashing promotion programme delivered to the two intervention arms during the original study was identical, and because we did not detect substantial heterogeneity across the intervention groups, we combined the two groups to simplify presentation of relative risks (RR). We report Rao–Scott design-adjusted, second-order *P* values for categorical variables.

Ethics

An adult in each household provided written informed consent for the household. The protocol was approved by the institutional review boards at the Centers for Disease Control and Prevention and HOPE.

Study funds were provided by the Procter & Gamble Company (Cincinnati, OH, USA). The funder did not participate in data collection, analysis or interpretation and did not have approval rights over the publication.

Results

We re-enrolled 160, 141 and 160 households in the control, handwashing and handwashing + water treatment groups, respectively, representing 84% of eligible households from the original study (Figure 2). Households who re-enrolled did not differ significantly on many key variables, including neighbourhood of residence and study group allocation, from those who declined re-enrolment or were lost to follow-up (Bowen *et al.* 2012). Reenrolled households were similar across study groups with respect to household size, parental education/literacy and socioeconomic indicators (Table 1).

Water sources were also similar across groups, but water treatment practices differed (Table 2). Most homes in all groups received drinking water from the municipal system and/or purchased it from delivery trucks, and storage of drinking water was nearly universal. Control households were significantly more likely to report not typically treating their drinking water, while households from both intervention groups were more likely to report usually boiling their drinking water. Across groups, fewer than 3% of households reported typically using filters, alum or bottled water, and no respondents reported using bleach, disinfectant tablets or PuR® (Procter & Gamble) to treat their drinking water.

Bar hand soap was the most commonly used hand cleansing material among all groups; however, many also reported using water alone (Table 2). No households reported typically using liquid hand soap or ash to cleanse hands. During handwashing demonstration, mothers from intervention households were 14 times more likely both to rub hands at least three times with soap [95% confidence interval (CI), 5.5–35] and to lather hands for at least 10 s (95% CI, 5.5–38) than were mothers from control households.

Each study group generated an identical list of occasions to wash hands during the free-list exercise, and participants cited these occasions in very similar rank order across groups (Table 2). More than 93% of respondents in each group reported washing hands after using the toilet. Respondents from intervention households were significantly more likely to report washing hands before cooking [relative risk (RR) 1.2 (95% CI 1.0–1.4)] and before eating or feeding others [RR 1.7 (95% CI, 1.3–2.1)], although only about half of intervention households reported washing hands before meals. Intervention households generated significantly longer lists of occasions to wash hands (mean number of occasions cited per group: handwashing, 4.74; handwashing + water treatment, 4.78; and control, 3.87; $P < 0.0001$).

Intervention households were more likely than control households to have a handwashing station with both soap and water present during the study visit in 2009 (Table 3). In 2009, 8 (3%) intervention households kept soap intended for handwashing at a location other than the handwashing station, compared with 114 (72%) control households [RR 0.036 (95% CI 0.015, 0.088)]. All households in 2009 also reported purchasing hand soap during the past month, but significantly more bars of soap, and more bars of soap *per capita*, were purchased by intervention households (Table 3).

Discussion

Changing – and then sustaining – personal health-related behaviours can be difficult. This may be particularly true for health behaviours that must be repeated many times daily throughout life, like using seat belts, eating healthful foods and washing hands. To habituate such behaviours, individuals must recurrently choose to perform them until the behaviours acquire a degree of unconscious automaticity (Ouellette & Wood 1998; Verplanken 2006). Interventions designed to change these types of behaviours are, therefore, typically intensive (Ouellette & Wood 1998; Verplanken & Wood 2006). Successful interventions to change the dietary habits and physical activity of people at risk for diabetes generally involve weekly coaching for several months, followed by intermittent contact for many additional months (Venditti & Kramer 2012). Interpersonal communication during frequent household visits over a period of months, as employed in this study, is also likely to be more effective than less intensive strategies for effecting the adoption of handwashing (Wilson & Chandler 1993; Cairncross & Shordt 2004; Cairncross *et al.* 2005). Improved environmental cues, such as a fully stocked functional handwashing station at the exit to the latrine, can also serve as a visual reminder and reduce the effort required to perform a behaviour (Verplanken & Wood 2006). As handwashing is repeated in this context, it may begin to require minimal thought about whether to wash hands with soap, how to perform the steps of handwashing or where to locate soap or fetch water; it becomes habitual. This process is

crucial for successful handwashing promotion because habituation may be the strongest determinant of handwashing behaviour (Whitby *et al.* 2007; Aunger *et al.* 2010).

Although the intervention in this study was intensive, with handwashing reminders and soap provided to participants at no cost for 9 months, it was not designed to foster long-term changes in handwashing habits. Furthermore, no interventions were provided during the years between the trial and the present evaluation, although both intervention and control households were repeatedly questioned about soap purchases in 2005. Nonetheless, intervention households appear to have adopted improved handwashing behaviours and maintained them for more than 5 years after handwashing promotion ceased. We observed soap and water at the handwashing station in 139 (99%) handwashing and 154 (96%) handwashing + water treatment households, but in only 41 (26%) control households in 2009. Although most households in the study were able to produce a bar of soap when asked to demonstrate handwashing, control households were 24 times more likely than intervention households to keep the soap at a location other than the handwashing station. Intervention households were also significantly more likely to report washing hands during several of the occasions in which handwashing can prevent disease transmission, to list a larger number of occasions they believed handwashing was appropriate and to demonstrate appropriate handwashing technique. Additionally, intervention households reported purchasing approximately 50% more hand soap per household member than control households in 2009. Together, these findings suggest that at least some people in intervention households developed the habit of washing hands with soap and water.

In contrast, access to well-stocked handwashing stations appeared to worsen over time among control households (Table 3). Among control households, 104 (53%) were observed to have a handwashing station with soap and water upon re-enrolment in 2005, but only 41 (26%) did so in 2009. Although it is unclear why reported soap purchases among controls varied so widely over time, control households reported buying less soap, and less soap per household member, in 2009 than they did in 2005 (Table 3). Thus, they might have purchased insufficient quantities of soap in 2009 to keep the handwashing station stocked at all times. Alternatively, the decreased access to soap at control handwashing stations in 2009 may be related to the group's tendency to store soap away from the handwashing station. Because hand soap is considered a luxury in many settings, sequestering it to keep it clean, or to prevent domestic animals from consuming it or children from squandering it, is not uncommon (Wilson & Chandler 1993; Curtis *et al.* 2009). It is possible that by 2009, study children had reached an age at which they were especially likely to squander soap, and control parents reacted differentially by removing it from children's reach.

The presence of soap at the handwashing station is likely to affect handwashing behaviour in a number of ways. If soap is not immediately available, household members may find it inconvenient to retrieve the soap and therefore might develop the habit of washing hands with water alone. Indeed, women in Bangladesh were more than twice as likely to wash hands with soap after faecal contact if soap was available at the handwashing station (Luby *et al.* 2009b). Ease of access to and visibility of handwashing stations were strongly associated with observed handwashing behaviour in a Kenyan community (Schmidt *et al.* 2009) and among healthcare workers in the United States (Nevo *et al.* 2010). Storing soap

where hands are washed, rather than in a distant location, may particularly benefit children, who might not otherwise know where soap is being stored or be able to access it independently and who are at greatest risk for diseases that can be transmitted by hands. Future handwashing promotion efforts may benefit by stressing the importance of storing soap at the handwashing station.

We believe that handwashing becomes habitual after the behaviour is repeated sufficiently and that additional assessments of handwashing practices after this period may be unnecessary. Previous evaluations of this study population suggested that handwashing behaviours improved markedly during the intervention and were at least partially sustained for more than two additional years in the handwashing promotion group (Luby *et al.* 2006, 2009a). During the present study, we also found evidence of increased handwashing with soap in this community 5 years after the intervention. A separate study in India reported improvements in handwashing indicators up to 9 years after community-based handwashing promotion (Cairncross *et al.* 2005). Other types of health habits also appear to be maintained once inculcated. Substantial improvements in physical activity, nutritional choices and seat belt use were measured after the first year of a workplace wellness campaign in the United States; these improvements were then maintained at similar levels for several additional years (Byrne *et al.* 2011). If this is also true for handwashing, the cost-effectiveness of handwashing interventions could be estimated more accurately and resources for measuring handwashing habituation could be conserved.

This analysis is constrained by several limitations. Some fieldworkers were not blinded to original group allocation, and study participants might have been inclined to provide answers they felt would please the investigators. While we measured sizable improvements in many handwashing indicators, we cannot be certain how these indicators correspond to handwashing behaviours. Most of the outcomes we report reflect handwashing knowledge, an important but frequently insufficient precursor to behaviour change (Cairncross *et al.* 2005; Curtis *et al.* 2009). Information about soap purchases was self-reported and therefore of unknown validity. We did not use other methods to assess handwashing behaviour because of resource limitations and because of challenges to the validity of measuring handwashing behaviour through self-report, direct observation, hand microbiology and other proxies (Biran *et al.* 2008; Danquah 2010; Ram *et al.* 2010a, 2011). Current efforts to validate and improve measurement of handwashing behaviour will be useful for future assessments (Ram *et al.* 2010b). Questions and observations differed somewhat across the three assessments; thus, we were unable to summarise handwashing infrastructure uniformly across time. Further, we did not investigate the level of motivation underlying handwashing behaviours and therefore cannot be certain that such behaviours had become automatic. Perhaps, most notably, the design of our evaluation did not permit us to explore which aspects of the original handwashing promotion programme were associated with changes to the household handwashing environment or with maintenance of handwashing knowledge and practices.

Nonetheless, greatly superior access to handwashing stations with soap and water in intervention households suggests that appropriate handwashing was habituated among at least some members of these households and that these habits persisted for more than 5

years. The prolonged persistence of handwashing behaviours in this study suggests that cost-benefit analyses of handwashing promotion could assume a long time horizon (the time horizon is long) for assessing benefit. Implementers of handwashing programmes and other stakeholders may wish to adopt and evaluate intensive but time-limited methods of handwashing promotion, as used in this trial, and to focus on improving access to functional handwashing facilities and soap.

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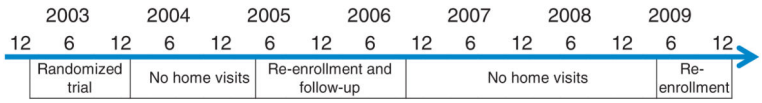

Figure 1.
Timeline of study activities.

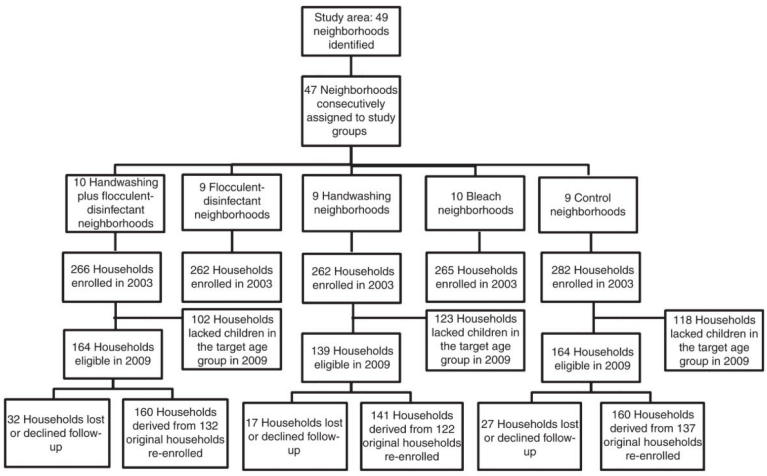

Figure 2.
Flow of participants through the study.

Table 1

Characteristics of re-enrolled households, by study group

	Control (9 clusters, 160 households)		Handwashing (9 clusters, 141 households)		Handwashing + water treatment (10 clusters, 160 households)		
Factor	***n***	**%**	***n***	**%**	***n***	**%**	***P***
Household size (mean, 95% CI)	8.5	(7.7, 9.4)	835	(7.9, 9.1)	834	(7.6, 9.2)	0.8
Mother in household literate	50	31	52	37	53	33	0.6
Father in household literate	88	55	84	60	103	64	0.6
Speak Urdu within home	153	96	134	95	153	96	0.9
Own radio	21	13	18	13	22	14	1
Own television	147	92	129	91	146	91	0.9
Own refrigerator	89	56	96	68	89	56	0.1
Home receives municipal water supply	55	35	50	35	50	31	0.9

Table 2

Water- and handwashing-related practices among households upon re-enrollment, by study group

	Control (9 clusters, 160 households)		Handwashing (9 clusters, 141 households)			Handwashing + water treatment (10 clusters, 160 households)			
Factor	***n***	**%**	***n***	**%**	***P****	***n***	**%**	***P****	**Overall *P*†**
Household water sources									
Municipal	104	65	91	65	0.9	110	69	0.8	0.9
Water tanker	83	52	72	51	0.9	96	60	0.5	0.7
Usual water treatment and handling									
None	120	75	73	52	0.005	87	54	0.005	0.002
Boil	32	20	52	37	0.01	59	37	0.02	0.005
Usually store water	157	99	137	97	0.3	150	94	0.0005	0.006
Typical hand cleansing materials									
Water alone	49	31	34	24	0.2	42	26	0.4	0.3
Hand soap (bars)	154	97	136	96	0.9	157	98	0.5	0.8
Laundry soap	16	10	4	3	0.003	9	6	0.1	0.03
Detergent	6	4	1	1	0.07	2	1	0.2	0.1
Dish soap	5	3	4	3	0.8	2	1	0.1	0.3
Most commonly reported hand cleansing material									
Water alone	17	11	7	5	0.05	4	3	0.005	0.02
Hand soap (bars)	140	88	134	95	0.02	152	95	0.02	0.02
Direct observation of handwashing technique									
Used soap	154	97	141	100	–	160	100	–	–
Rubbed hands together ≥ 3 times	11	7	136	96	<0.0001	155	97	<0.0001	<0.0001
Lathered hands ≥ 10 s	10	6	122	87	<0.0001	152	95	<0.0001	<0.0001
Dried hands with clean towel	112	70	107	76	0.4	127	79	0.2	0.2
Reported occasions for handwashing‡									
After toilet	150	94	132	94	0.8	154	96	0.3	0.7
Before cooking	109	69	120	85	0.006	129	81	0.03	0.01
After cooking	94	59	95	67	0.08	109	68	0.06	0.06
After handling trash	88	55	97	69	0.06	110	69	0.06	0.04
After feeding self or others	73	46	86	61	0.02	103	64	0.0006	0.005

	Control (9 clusters, 160 households)		Handwashing (9 clusters, 141 households)			Handwashing + water treatment (10 clusters, 160 households)			
Factor	***n***	**%**	***n***	**%**	***P****	***n***	**%**	***P****	**Overall *P*†**
Before feeding self or others	48	30	69	49	<0.0001	83	52	<0.0001	<0.0001
After diapering/toileting a child	37	23	48	34	0.1	51	32	0.2	0.08
No. occasions reported/household (mean, 95% CI)	3.9 (3.5, 4.2)		4.7 (4.5, 5.0)			4.8 (4.4, 5.1)			<0.0001

*Compared with control group.

†Combined intervention groups compared with control group.

‡Responses to an open-ended question about when hands should be washed with soap; multiple responses were possible.

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Table 3

Observed handwashing infrastructure and reported soap purchasing practices, by study group and year

	Control (9 clusters, 160 households)			Handwashing (9 clusters, 141 households)				Handwashing + water treatment (10 clusters, 160 households)			
Factor	***n***	***N***	**%**	***n***	***N***	**%**	***P****	***n***	***N***	**%**	***P****
Handwashing station observed											
2003	280	282	99	261	262	100	0.7	264	266	99	1
2005	na†	na	na	na	na	na	na	na	na	na	na
2009	154	159	97	141	141	100	—	158	160	99	0.5
Handwashing station with water observed											
2003	na	na	na	na	na	na	na	na	na	na	na
2005	na	na	na	na	na	na	na	na	na	na	na
2009	129	159	81	141	141	100	—	158	160	99	<0.0001
Handwashing station with soap observed											
2003	209	282	74	200	262	76	0.7	200	266	75	0.9
2005	na	na	na	na	na	na	na	na	na	na	na
2009	43	159	27	139	141	99	<0.0001	154	160	96	<0.0001
Handwashing station with soap and water observed											
2003	na	na	na	na	na	na	na	na	na	na	na
2005	104	195	53	154	195	79	0.0001	119	186	64	0.1
2009	41	159	26	139	141	99	<0.0001	154	160	96	<0.0001
Soap intended for handwashing stored at location other than handwashing station (observed)											
2003	na	na	na	na	na	na	na	na	na	na	na
2005	na	na	na	na	na	na	na	na	na	na	na
2009	114	159	72	2	141	1	<0.0001	6	160	4	<0.0001
Reported purchasing any hand soap in past month‡											
2003§	230	282	82	241	262	92	0.01	227	266	85	0.3
2005	191	195	98	193	195	99	0.4	184	186	99	0.4
2009	159	159	100	141	141	100	1	160	160	100	1
Reported # bars of hand soap purchased in past month (mean, 95% CI)‡											
2003¶	2.5 (1.9, 3.2)	282		2.7 (2.1, 3.2)	262		0.4	2.5 (2.2, 2.8)	266		1

	Control (9 clusters, 160 households)			Handwashing (9 clusters, 141 households)				Handwashing + water treatment (10 clusters, 160 households)			
Factor	***n***	***N***	**%**	***n***	***N***	**%**	***P****	***n***	***N***	**%**	***P****
2005	7.6 (5.5, 9.7)	195		8.6 (6.4, 10.7)	195		0.07	8.3 (7.4, 9.2)	186		0.2
2009	5.4 (4.9, 5.8)	159		7.33 (6.69, 7.96)	141		<0.0001	8.9 (8.3, 9.4)	160		<0.0001
Reported # bars of hand soap purchased per household member in past month (mean, 95% CI)‡											
2003¶	0.30 (0.23, 0.38)	282		0.32 (0.24, 0.39)	262		0.6	0.30 (0.26, 0.33)	266		0.7
2005	0.83 (0.59, 1.08)	195		0.93 (0.71, 1.15)	195		0.1	0.94 (0.84, 1.04)	186		0.1
2009	0.65 (0.63, 0.67)	159		0.91 (0.84, 0.98)	141		<0.0001	1.12 (1.02 1.21)	160		<0.0001

*Compared with control group.

†Not assessed at time of study.

‡Reported at the time of enrolment/re-enrolment.

§Question had been framed as purchases within the past 2 weeks.

¶Question had been framed as ‘bars of soap in past 2 weeks’; thus, we multiplied response by 2.17 to estimate monthly purchases.