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Difficulties in Maintaining Improved Handwashing Behavior, Karachi, Pakistan

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Abstract. In an earlier study in Karachi, Pakistan, households that received free soap and handwashing promotion for 9 months reported 53% less diarrhea than controls. Eighteen months after the intervention ended, these households were enrolled in a follow-up study to assess sustainability of handwashing behavior. Upon re-enrollment, mothers in households originally assigned to the intervention were 1.5 times more likely to have a place with soap and water to wash hands (79% versus 53%, $P = 0.001$) and when asked to wash hands were 2.2 times more likely to rub their hands together at least three times (50% versus 23%, $P = 0.002$) compared with controls. In the ensuing 14 months, former intervention households reported a similar proportion of person-days with diarrhea (1.59% versus 1.88%, $P = 0.66$) as controls. Although intervention households showed better handwashing technique after 2 years without intervention, their soap purchases and diarrhea experience was not significantly different from controls.

INTRODUCTION

In prospectively designed studies with appropriate control groups, interventions that promote regular handwashing with soap consistently reduce both diarrheal and respiratory disease.[1,2] In the community intervention studies that have shown a health benefit with handwashing promotion, handwashing was promoted primarily through interpersonal communication, which required frequent visits to the target population.[3–6] One challenge in translating these small-scale studies into effective large-scale interventions is that repeated household visits to encourage behavior change risk becoming prohibitively expensive if expanded to the hundreds of millions of households in need. An important determinant of the cost and feasibility of such interventions is the duration of changed behaviors; that is, once a household adopts improved handwashing practices, how long are these improved practices maintained? Few data are available on the long-term effectiveness of handwashing promotion interventions.[7–10]

In a trial conducted in 2003 in low-income squatter settlements in Karachi, Pakistan, households in 19 randomly selected neighborhoods that received free soap and weekly visits for 9 months encouraging handwashing with soap reported 53% less diarrhea than households in 9 control neighborhoods.[11] We revisited trial participants 18 months after the intervention ended to evaluate how much soap they purchased and to evaluate the prevalence of diarrhea in their households.

MATERIALS AND METHODS

Setting. This study was conducted in adjoining multi-ethnic squatter settlements in central Karachi, that typically received at least 1 hour of running water twice weekly. The field work was conducted by Health Oriented Preventive Education (HOPE), a local non-governmental organization that operates health clinics and undertakes community-based health and development initiatives in these communities.

Design. The 2003 study was a cluster randomized controlled trial. Field workers divided the study communities into 47 groups of households that were separated by commercial streets or industrial zones. Field workers visited households in these areas and enrolled households with at least one child under the age of 5 years who provided informed consent. These 47 clusters of households were randomly assigned to five intervention groups—10 clusters received dilute sodium hypochlorite and encouragement to use it to regularly treat their drinking water, 9 clusters received a regular supply of soap and encouragement to wash their hands regularly, 9 clusters received a flocculent-disinfectant and encouragement to use it to regularly treat their drinking water, 10 clusters received both soap and handwashing promotion plus the flocculent-disinfectant and encouragement to use it to regularly treat their drinking water, and 9 clusters were followed as a control group.

Field workers arranged neighborhood meetings in areas assigned to the soap and handwashing promotion intervention. Field workers used slide shows, videotapes, and pamphlets to illustrate health problems resulting from hand contamination and proper handwashing technique. Field workers encouraged participants to wet their hands, lather them completely with soap, and rub them together for 45 seconds. Hands were typically dried on the participants' clothing. Field workers visited each household that received the handwashing promotion intervention at least twice weekly from March through December 2003 to encourage regular handwashing with soap and resupply households with soap. Field workers encouraged all persons in intervention households old enough to understand (generally those > 30 months of age) to wash their hands after defecation, after cleaning an infant who had defecated, before preparing food, before eating, and before feeding infants.

The original study ended in December 2003, and there were no study activities, household visits, or other handwashing promotion activities in the intervention or control communities for 18 months (Figure 1). In July and August 2005, field workers attempted to revisit each of the households that were originally enrolled in the 2003 study that had been assigned to either of the interventions that included soap and handwashing promotion or to the control group. If households provided informed consent, field workers administered a re-enrollment survey and performed a spot check of facilities for handwashing. They asked the mother of the household to demonstrate how she usually washed her hands and noted her technique.

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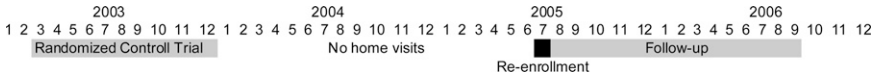

FIGURE 1. Study timeline.

Field workers were not formally blinded to the original intervention, because some of the field workers had worked on the earlier project.

From August 2005 through September 2006, field workers revisited each of the re-enrolled households weekly and asked the mother or other caregiver if the children had diarrhea (three or more loose stools within 24 hours) in the preceding week, and, if so, for how many days. Field workers also inquired about the caregiver's symptoms of diarrhea and how much hand soap was purchased by the household in the preceding week. During these weekly visits, no handwashing or water treatment supplies were provided, and no health promotion activities were conducted.

Statistics. We compared characteristics of re-enrolled households by originally assigned intervention groups. To test whether differences between each intervention and the control group were greater than would be expected by chance, we constructed a generalized estimating equation model with the household characteristic of interest as the dependent variable and the intervention group as an independent variable.[12]

For each study subject, we calculated his/her longitudinal prevalence of diarrhea[13]; that is, we summed the total number of person-days with diarrhea and divided it by the total number of person-days under observation. We calculated the coefficient of variation of the longitudinal prevalence of diarrhea by cluster by dividing the standard deviation of the cluster means of the longitudinal prevalence of diarrhea by the person-week weighted cluster means of longitudinal prevalences. To evaluate whether any difference between intervention groups was greater than would be expected by chance, we developed generalized estimating equation models with the longitudinal prevalence of diarrhea as the dependent variable and the intervention group as an independent variable.

Because of concern that averaging the diarrhea experience over the entire study period might attenuate genuine week to week differences between intervention groups, we constructed a linear mixed effect model. The outcome variable was the number of diarrheal days of each child in the previous week. We assumed treatment group had fixed effects. The neighborhood cluster effects were considered as random and the week intercept varied within each cluster.

To assess the relationship between soap consumption and diarrhea, we used the number of bars of soap purchased during the week divided by the number of persons in the households as the independent variable and the longitudinal prevalence of diarrhea in the subsequent week as a dependent variable in a generalized estimating equation model. For all of the generalized estimating equation models, we used an exchangeable correlation structure applied to neighborhoods to account for clustering derived from spatial proximity.

We used SAS 9.1 for Windows (SAS Institute, Cary, NC) for analysis of the generalized estimating equation models and STATA 10 (StataCorp LP, College Station, TX) for the linear mixed effect modeling.

Ethics. Heads of households provided informed consent. Ill children were assessed by field workers and referred to the appropriate level of health care. The study protocol was approved by the HOPE Human Research Review Board and an Institutional Review Board of the Centers for Disease Control and Prevention.

RESULTS

In March 2003, a total of 810 households were enrolled in the handwashing promotion, the water treatment plus handwashing promotion, and the control groups for the randomized controlled trial. In August 2005, 577 households were re-enrolled in the follow-up evaluation. These 577 households were derived from 560 households from the original 810 enrolled (69%). The additional 17 households were households that split and set up new households in the same neighborhood.

The 560 households that re-enrolled were similar to the 250 households that declined re-enrollment by household size, water supply, reported income, and amount spent on soap and water as measured in 2003 (Table 1). However, households that re-enrolled were more likely to have been assigned to the handwashing promotion with soap intervention during the randomized trial and were more likely to own a refrigerator and television (Table 1).

At re-enrollment, intervention and control households were just as likely to have soap in the house and reported similar spending on hand soap (Table 2). Households originally assigned to handwashing promotion but no water treatment were more likely to have a place in the household to wash hands that included soap and water (79%) than control households (53%, $P = 0.001$) or households that received both handwashing promotion and water treatment (64% $P = 0.05$). When asked to demonstrate handwashing, mothers from intervention households were significantly more likely to rub their hands together at least three times and to lather their hands for at least 10 seconds (Table 2). During the 63-week follow-up, intervention households purchased a similar quantity of soap and used a similar amount of soap per capita per week compared with control households (Table 2; Figure 2).

The average cluster included 8,433 ± 2,731 (SD) person-weeks of observation. The mean longitudinal prevalence of diarrhea for all children under observation was 1.68%, with an SD of 0.00735 and a coefficient of variation between clusters of 0.44. During the first 5 months of follow-up, households from the different intervention groups reported different prevalences of diarrhea. In the subsequent 8 months, the prevalence was quite similar across the groups (Figure 3).

Although the overall longitudinal prevalence of diarrhea was 15–16% lower in the intervention households, after accounting for clustering, neither the longitudinal prevalence among all ages, nor any of the age specific diarrhea prevalences were significantly different between intervention and control households (Table 3). When the two intervention groups were combined, the reduction in longitudinal prevalence of diarrhea in the intervention groups was still not significantly different from the controls ($P = 0.66$). Similarly, in the linear mixed effect model, the longitudinal prevalence of diarrhea in households that received soap and handwashing

Table 1
Comparison of persons re-enrolling vs. persons declining re-enrollment

Household characteristics measured in 2003	Re-enrolled (N = 560)	Declined (N = 250)
Mean		
Persons per household	9.3	9.0
Rooms in house	1.9	1.8
US$ spent on water in a normal week	0.53	0.59
Bars of hand soap purchased in preceding 2 weeks	1.2	1.2
Longitudinal prevalence of diarrhea April–December 2003	3.2%	3.4%
Percent of		
Households randomized to handwashing promotion wash soap	34	28
Households randomized to handwashing with soap plus water treatment	32	35
Control households	34	37
Mother of the youngest child is literate	35	30
Mother of the youngest child finished secondary school	11	8
Monthly household income < 54 US$	54	56
Father's occupation		
Salaried employee	52	50
Works for daily wages	40	41
Other	8	9
Owns		
Refrigerator	27	17
Television	62	52
Radio	25	21
Primary drinking water source		
Municipal supply within the house	31	25
Municipal supply at a community tap	39	39
Tanker truck	14	14
Water bearer	10	14
Tube well	6	8
Re-supply household drinking water less frequently than once a day	64	65
Toilet without flush tank in the home	96	96
Place to wash hands with soap seen by study workers	75	75
Feces visible where children have access	25	25
Kitchen judged by field worker to be dirty or very dirty	45	46

promotion (P = 0.67), and soap and handwashing promotion plus water treatment (P = 0.70) was not significantly different than control households.

There was no association between weekly per capita soap consumption and longitudinal prevalence of household diarrhea in the following week (P = 0.38).

DISCUSSION

In the original randomized controlled trial, neighborhoods that received soap free of cost and at least twice weekly home visits that encouraged regular handwashing reported 51–55% less diarrhea than non-intervention neighborhoods. On enrollment in a follow-up study 18 months later without any intervening handwashing promotion, households that had received soap and handwashing promotion as part of the original study reported purchasing similar quantities of soap compared with non-intervention households. During the 14 subsequent months of follow-up, the longitudinal prevalence of diarrhea in intervention households was not significantly different from control households. These findings illustrate important barriers to improving handwashing behaviors globally. Households that received the handwashing intervention knew how to wash hands properly. They had acquired a new habit and maintained that habit for several months. They had a better place to wash hands. They demonstrated better handwashing technique. They had experienced a substantial reduction in diarrhea. However, when soap was no longer provided for free, and regular encouragement to wash hands stopped, their behavior reverted to less soap consumption and a disease experience that was no different than communities that received no intervention. These results are similar to findings from the follow-up of a randomized controlled trial of household water treatment that also found that high levels of product use during a randomized controlled trial accompanied by a marked reduction in diarrhea longitudinal prevalence did not translate into regular use of the product after the trial ended.[14]

We identified only four other investigations that have evaluated the long-term sustainability of handwashing promotion.[7–10] A weakness of several of these studies is that they have depended primarily on self-reported handwashing behaviors to assess sustained handwashing practices.[8–10] Self-reported handwashing practices consistently over-report socially desirable behavior and are not a valid measure of handwashing practice.[15–17] Indeed a handwashing promotion intervention might increase the awareness of what a socially desirable answer is while having little impact on the actual behavior.

The most thorough evaluation of sustainability of improved handwashing was conducted by Hoque and others[7] in Mirzapur, Bangladesh. The original project was implemented in 880 households in five villages from 1984 to 1987. The intervention area received 148 improved hand pumps to provide access to less contaminated ground water, a twin pit latrine for almost every household, and extensive education on hygiene practice.[7] Local women were trained to maintain the facilities after the project ended. These intervention villages were compared with 750 households in nearby control villages with a similar level of socioeconomic status and baseline diarrhea morbidity. Five years later, an evaluation team returned to the area and noted that, although latrine use, exclusive consumption of tube well water, and the presence of ash for handwashing at the latrine was lower in the intervention communities than it had been at the end of the project in these communities, after 5 years, all of these indicators remained substantially higher in the intervention communities compared with the control communities. Women in intervention villages had less fecal bacteria contaminating their hands than women in control villages. Children under 5 years of age in intervention villages had a lower point prevalence of diarrhea than children in control villages, but this difference was not statistically significant.

Important differences between the Bangladesh study and the Karachi study included that the Bangladesh project integrated a number of interventions, not just handwashing, and in the Bangladesh project, there was an intentional effort to sustain behaviors after the end of the project. The intervention in Karachi, in contrast, was not designed to promote handwashing long term but to optimize handwashing practices during the 9-month efficacy study. The lack of a sustained improvement in handwashing behavior suggests that the specific methods used for the short-term efficacy study did not produce long-term behavior change. Importantly, soap was provided at no cost during the efficacy study. In other low-income communities, the cost of soap is frequently mentioned as a barrier to handwashing with soap.[18,19] Rather than working to motivate

TABLE 2

Soap use by group among households re-enrolled in August 2005, 20 months after active handwashing promotion and provision of supplies ended

	Handwashing promotion plus water treatment ($N = 186$) [N (%) P value]*	Handwashing promotion ($N = 195$) [N (%) P value]*	Control ($N = 195$)
Has soap in the house	180 (97) 0.25	191 (98) 0.21	183 (94)
Reported using hand soap to wash hands	181 (97) 0.84	193 (99) 0.16	189 (97)
Purchased hand soap within the last 1 month	184 (99) 0.43	193 (99) 0.40	191 (98)
Mean number of bars of hand soap purchased in the last 1 month [P value]*	8.3 [0.12]	8.6 [0.049]	7.6
Mean amount in US$ spent on hand soap in the last 1 month [P value]*	1.76 [0.53]	1.78 [0.50]	1.69
Showed a bar of hand soap to the interviewer	177 (95) 0.27	189 (97) 0.20	179 (92)
Showed a bar of hand soap that appeared recently used to the interviewer	163 (91) 0.65	183 (94) 0.32	167 (86)
Has a place in the household to wash hands that included soap and water	119 (64) 0.15	154 (79) 0.001	104 (53)
When mother asked to wash hands did she			
Use soap?	168 (90) 0.10	176 (90) 0.15	163 (84)
Rub hands together a least three times?	109 (59) < 0.001	98 (50) 0.002	44 (23)
Lather her hands for at least 10 seconds	82 (44) 0.001	81 (42) 0.006	31 (16)
Dry her hand with a clean towel	75 (40) 0.010	47 (24) 0.18	24 (12)
Soap purchase July 2005–September 2006			
Mean bars of soap purchased per household per week	2.35 0.12	2.32 0.31	2.20
Mean bars of soap purchased per person per week	0.26 0.46	0.25 0.87	0.25

* Compared with the control group using generalized estimating equations with an exchange correlation matrix to account for clustering.

households to overcome this barrier, for the efficacy study, we simply provided soap to participating households. Thus, the intervention did not build the value of soap and encourage its purchase. These results are consistent with insights from specialists working in behavior change for cardiovascular disease who note that maintaining a changed behavior is fundamentally different from acquiring a new behavior.[20] Maintenance has different determinants and requires different interventions.

The weekly pattern of diarrhea prevalence by group suggests that there was some difference in diarrhea experience in the first 6 months but that after that there was no difference in diarrheal experience. If this is not simply random fluctuation, this pattern is most consistent with a declining impact of the intervention over time. Perhaps an occasional visit to refresh and encourage handwashing might have been helpful. For a larger public health program, mass media messages may be an effective method to remind and encourage sustained regular handwashing with soap.[21]

This study also collected a novel indirect measure of handwashing frequency, the amount of soap purchased by study households. Difficulties in using this as an indicator of handwashing include that soap is used for many behaviors other than handwashing and that different soap from different manufacturers is sold in different sizes. Nevertheless, we would expect that if handwashing was markedly increased in households, soap purchases would increase. The lack of difference either in the number of bars of soap or in the spending on soap per capita reinforces the suggestion that there was not a sustained change in habitual handwashing by this intensive intervention.

This study had limited power to detect a difference in the longitudinal prevalence of diarrhea between the intervention and control arms. Although field workers collected data for over a year to ensure data collection during a full diarrhea season, the longitudinal prevalence of diarrhea was highly variable by neighborhood, illustrated by the coefficient of variation of 0.44. This high level of variability by neighborhood, also noted in the earlier intervention study,[11] reduced the power to distinguish the effect of the intervention from the large local neighborhood effects. The other two studies on sustainability of hygiene behaviors that compared diarrhea in the intervention group to a previously identified control group also noted a lower prevalence of diarrhea in the target age group among households that originally received the intervention, but these differences were also not statistically significant.[7,10] There are

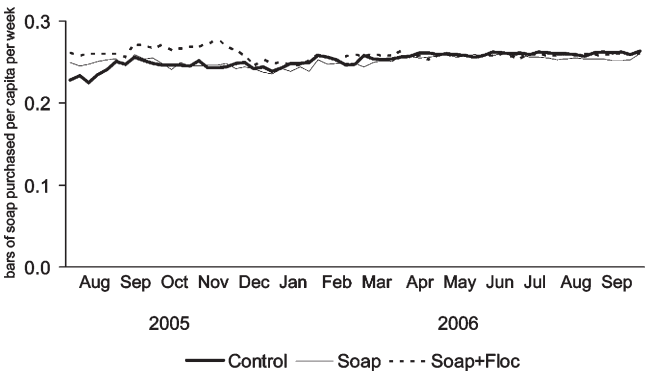

FIGURE 2. Bars of soap purchased per person by group and week.

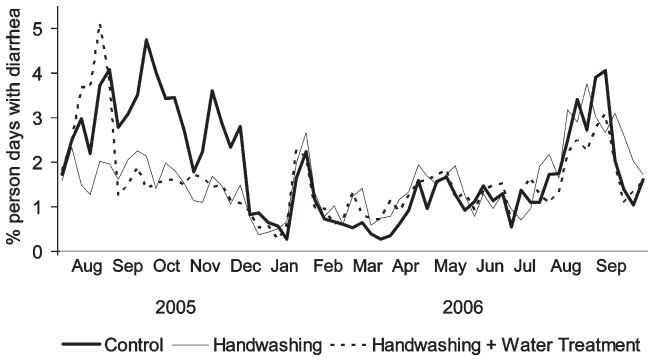

FIGURE 3. Longitudinal prevalence of diarrhea by intervention group.

TABLE 3
Mean longitudinal prevalence of diarrhea by age and intervention group

Age groups (person-weeks of observation)	Handwashing promotion		Handwashing promotion plus water treatment		Control
	Crude diarrhea longitudinal prevalence (%)*	Modeled risk difference (%) vs. control (95% CI)†	Crude diarrhea longitudinal prevalence (%)*	Modeled risk difference (%) vs. control (95% CI)†	Crude diarrhea longitudinal prevalence (%)*
< 1year (6,061)	8.3	−1.6 (−5.6, 2.4)	8.4	−0.97 (−5.6, 3.6)	9.2
≥ 1–2 years (8,124)	7.5	−0.6 (−3.8, 2.6)	7.9	1.0 (−1.9, 3.8)	7.3
≥ 2–5 years (28,584)	2.7	−0.5 (−2.3, 1.3)	3.0	−0.3 (−2.2, 1.7)	3.4
≥ 5–15 years (124,255)	1.2	−0.2 (−0.9, 0.5)	1.3	−0.2 (−0.9, 0.6)	1.6
> 15 years (69,086)	0.3	−0.1 (−0.3, 0.1)	0.5	−0.1 (−0.2, 0.1)	0.5
Total (236,110)	1.58	−0.16 (−0.92, 0.60)	1.59	−0.15 (−0.92, 0.61)	1.88

*Number of person-days with diarrhea divided by the number of person days under surveillance. Persons with less than six observations were not included in the analysis.
†Effect of the intervention modeled by averaging the longitudinal prevalence of each study subject who contributed at least 6 person-weeks of observation when they were in the age category under analysis and then using generalized estimating equations to account for clustering by neighborhood.

few data available on the variability of diarrhea prevalence by neighborhood, so it so it is unclear whether this marked variation is an unusual characteristic of the squatter settlements in Karachi or reflects a broader phenomenon. Additional studies on neighborhood level variation in diarrhea prevalence would assist in the design of future evaluations of diarrhea prevention with sufficient power to detect modest, but important, differences in diarrhea prevalence.

Another important limitation is that 31% of the originally enrolled households did not participate in the follow-up evaluation. They may have been different from their peers who agreed to re-enroll, and this may have changed the results. However, the measured characteristics of the re-enrollees versus those who declined or were unavailable were similar (Table 1), so the largest effect of these dropouts was probably loss of statistical power.

These data suggest that improved handwashing behavior is not guaranteed to be maintained when the activities promoting that behavior are withdrawn. This does not mean that improved handwashing practices cannot be maintained. Rather it suggests that, like other behavior change interventions, maintaining effective handwashing behavior requires focused efforts and research on optimal strategies.

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