

Promotion of Solar Water Disinfection: Comparing the Effectiveness of Different Strategies in a Longitudinal Field Study in Bolivia

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Solar water disinfection (SODIS) is a simple method designed to treat microbiologically contaminated drinking water at the household level. This study focused on the effective promotion of the SODIS method using various strategies. In a longitudinal field study, we compared 2 interpersonal strategies (promoters and opinion leaders) and a centralized strategy (health fair) with a control group. Indicators of effectiveness were SODIS knowledge, SODIS adoption rate, and potential reach. The results suggest that use of promoters is the most successful strategy in terms of reaching people and changing their behavior toward SODIS use. The opinion leaders—although less effective—show some potential to stimulate communication among people about SODIS. Only the health fair did not have a big impact on behavior. Further discussion includes the costs of the various promotional activities, limitations, and recommendations for future projects.

More than a billion people living in developing countries do not have access to safe drinking water. This causes 4 billion cases of diarrhea and 2.2 million deaths annually, most in children under the age of 5 (World Health Organization & UNICEF, 2000). The most commonly proposed methods to disinfect drinking water on a household basis are boiling (McLennan, 2000), chlorination, and filtration (Tayeh, Cairncross, & Maude, 1996). However, few scientific studies can be found assessing the effectiveness of different strategies for promoting these drinking water disinfection methods.

Another relatively new household water disinfection method is solar water disinfection (SODIS). The SODIS process is a simple technology designed to improve the microbiological quality of drinking water. Contaminated water is placed into transparent plastic bottles (the best are ordinary PET [polyethylenterephthalat] bottles from soft drinks or mineral water) and exposed to full sunlight for 6 hr (or for two successive days, if the sky is more than 50% cloudy; <http://www.sodis.ch>). SODIS is especially designed for use at the household level, as it relies only on locally

available resources such as plastic bottles and sunlight. The method has been shown to kill a large number of pathogens efficiently in the laboratory (e.g., Berney, Weilenmann, Simonetti, & Egli, 2006; McGuigan, Joyce, Conroy, Gillespie, & Elmore-Meegan, 1998) and in field settings (Sommer et al., 1997).

Because the SODIS method is quite recent (the first description can be found in Acra, Raffoul, & Karahagopian, 1984), and early investigations focused on determining its effectiveness and reliability, there has been almost no scientific research on its promotion. Nonetheless, SODIS has already been promoted in various countries since 1995 within the framework of general health promotion efforts. Although the method is inexpensive, and much effort has been put into its promotion, only moderate success has been achieved. Unfortunately, in the field, contextual factors that lead certain promotional strategies to be successful and others to be less so are often ignored. Partners from nongovernmental organizations (NGOs) such as the SODIS Foundation (in Latin America) regularly report that the method is not self-promoting after its initial introduction into a community (<http://www.sodis.ch>). An analysis of the few studies available on SODIS promotion shows that the success rates (percentage of SODIS users) reported in these studies varies greatly. Rainey and Harding (2005) report an

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adoption rate of only 9% in the course of a 4-month follow-up study, but the promotional effort there was very limited (one 2-hr training session). In contrast, other studies (Kabra, 2005; Moser, Heri, & Mosler, 2005) report adoption rates of between 40% and 70%. However, the promotional effort in these studies was comparably high, consisting of multiple strategies applied simultaneously.

The promotional strategies that were tested in this study will first be presented. They were derived on the basis of their applicability in the field, integrating what is known from theory and field experiences. Taking into account the experiences of our local partners, we found it useful to supplement the common classification of promotional strategies into mass media and interpersonal communication channels (e.g., Rogers, 1995) by adding a third category that we named centralized communication.

The classical mass media such as radio and TV are not studied here. First, many studies already exist on the effectiveness of classical mass media, showing that they often do not change the actual behavior of the majority of people (e.g. Alcalay, 1983; Griffin & Dunwoody, 2000) and only influence the early adopters of an innovation (Valente & Saba, 1998). Second, from field experiences we know that personal contact seems to be very important in the context of SODIS promotion. Therefore, we concentrated on interpersonal communication and centralized communication.

Interpersonal communication channels have great potential to change behavior because they allow effective persuasive communication (Rogers, 1995), can change contrary attitudes, and can encourage implementation intentions due to the process of social exchange (Gierl, 1987). The effectiveness of the social exchange process depends to a certain extent on the similarity of the exchange partners (homophily; Lazarsfeld & Merton, 1954). Similar social, economic, and educational levels among the interaction partners make interpersonal communications more effective (Petty & Wegener, 1998; Rogers, 1995). Several field studies have also shown that opinion leaders are successful in changing behaviors (Burn, 1991; Kelly et al., 1991; Levy-Storms & Wallace, 2003).

In the SODIS promotion context, interpersonal communication is typically realized by heterophilous agents (promoters making household visits). These promoters have the advantage of expertise, they can be easily trained to work continuously with their clients, and NGOs usually report high success rates with them. A disadvantage is the great effort needed to reach people. A way of realizing homophilous communication is to use opinion leaders (or block leaders; Katz & Lazarsfeld, 1955), but this approach has never been tested for SODIS promotion. Opinion leaders are persons from within a social system (community) with high social status and a high openness to innovations. Advantages of opinion leaders include, along with effective communication, better applicability in dispersed areas where employed promoters are impractical due to long

distances and lack of supervision. Drawbacks could be their "working" hours, the availability of targeted people (Passanisi, Prout, & Holm, 2001), and their lower motivation to promote the innovation because they are unpaid. In addition, their knowledge may not be as profound as that of the promoters, and they are difficult to control because they work on a voluntary basis. Nonetheless, the opinion leader approach poses the potential to be a very low-cost and low-effort promotional strategy. For these reasons, we introduced and tested the opinion leader approach in our project to compare it with traditional promoters. We expected the promoters to be very effective in disseminating knowledge and changing behavior. However, effects are expected to persist only as long as they were actively promoting SODIS. The opinion leaders may produce lower changes because they do not have such an expert status, and this may occur at a slower rate. But, in contrast to the promoters, SODIS should then be embedded more strongly in the social system and consequently be more sustainable over time.

Apart from classic mass media and classic interpersonal approaches, in the field context we found promotion strategies that could not clearly be classified into one or the other category; they share elements of both, along with some additional characteristics. These strategies can best be described as a centralized way of communication, and they comprise all types of fairs and community reunions. Due to the popularity of fairs, their frequent application (Moser & Mosler, 2008), and the fact that not much is known about the effects of fairs, we included a health fair as a third communication strategy. The main feature of this new category that we called *centralized communication* is the combination of different elements. Like mass communication, an individual can reach many people at once; in addition, the persuasive power of the social exchange process is used during the interpersonal communication between the exhibitors and the visitors of the fair. However, the interpersonal exchange is of rather limited depth and length; it may be disrupted, and it takes place in a public context (usually at a central spot in the community, therefore "centralized communication"). Moreover, fairs usually do not take place very frequently (approximately once every 6 months), so in contrast to the other promotion strategies, this is a one-time communication. We expected the health fair to have some influence on knowledge but a smaller effect on behavior. A lower effect on behavior is expected for two reasons: the briefness of the interpersonal communication and the one-time nature of the health fair. These factors lead us to expect that behavioral effects will weaken quickly with time. We also do not know how many households in a community can actually be reached with a fair.

Apart from the promotion strategy itself, relevant messages need persuasive elements through which people can be convinced in favor of the innovation. As a basis, we take the elaboration likelihood model of Petty and Cacioppo (1986) and use arguments and peripheral cues. Persuasion was not

varied in this study; all promotion strategies had the same persuasion strategy. However, the elaboration likelihood model reminds one to be aware of interactions between the type of promotion strategy and persuasion. For example, for the promoters, one has to expect a high peripheral cue, due to the competency people attribute to them.

For developing the details of the arguments, we reverted to Rogers' (1995) perceived attributes of the innovation. There are (a) the relative advantage of the innovation over the idea it supersedes ("SODIS is safe and good for your health"); (b) compatibility with the existing values, past experience and needs of the receivers ("SODIS is practical"); (c) complexity, or the degree to which the innovation is perceived as difficult to understand and use ("SODIS is easy to use"); (d) *trialability*, or the degree to which an innovation can be tested for effectiveness on a cost- or scope-limited basis ("SODIS is economical"); and (e) observability of the outcome of the innovation ("SODIS is good for your health"). In addition, descriptive norms (Ajzen, 1991; Rogers, 1995) were also addressed ("SODIS is already used in many other places").

Summarizing, we compared two interpersonal promotional strategies, the use of promoters and opinion leaders, and a centralized promotion strategy, health fair presentations, with each other and a control group. Dependent measures were the effects on SODIS knowledge, SODIS use, and the achieved coverage of the activities. The following hypotheses were tested:

- H1: Promoters have stronger short-term effects than opinion leaders on SODIS knowledge and use.
- H2: Opinion leaders have stronger long-term effects than promoters on SODIS use.
- H3: The health fair has lower effects on SODIS use than either interpersonal strategy, especially over the long term.

In addition, we address the question of whether the health fair has the same or a different range of coverage or reach than promoters and opinion leaders.

METHOD

The complete study design took the form of a longitudinal four-point panel lasting 9 months. Measurements took place at the beginning of the study (first panel, end of August 2005), after the first month (second panel, end of September 2005), the second month (third panel, end of October 2005) and then again 7 months later (fourth panel, June 2006). The first 2 months of the study were conceptualized as an active promotion phase, whereas no activities took place during the last 7 months. Consequently, the first three panel measurements reflect short-term effects, whereas the fourth panel reflects long-term effects after an inactive phase. During all three promotion strategies the same, previously

mentioned predefined set of persuasive arguments was used. In addition, reminders were distributed during the promotional campaigns with the instruction to hang them visibly at the place where SODIS water is usually prepared. Reminders have shown to be useful in stimulating habit formation (e.g., Cox, Cox, & Cox, 2005; Hill, Abraham, & Wright, 2007), which is especially important when people are in the process of adopting a new behavior. The reminder was a big, colorful A3-size poster containing brief information on how to do SODIS and a prominent question: "Have you already put your bottles into the sun today?"

The study area, promotional strategies, and measurements will be described in the following sections.

Study Area Selection

Our study area was located in Bolivia, one of Latin America's poorest countries. There is no piped water system in most of its periurban and rural areas. In our periurban study areas, water is delivered by trucks at intervals ranging from every 2 days up to only once a week. The origin and quality of the truck water vary unsystematically. It is not advisable to drink untreated water anywhere in Bolivia, no matter where it comes from. Even tap water in the cities can be contaminated.

We selected four investigation areas with the help of the local NGO, which indicated areas where SODIS was not yet used. Only rough estimations were available from the NGO about the percentage of people who were already familiar with SODIS, so before the study, unfortunately, we were unable to ensure that the areas would have similar percentages of people who were familiar with SODIS. The four areas we selected were located in the outskirts of the city of Cochabamba. In three of the four areas, one of the following promotional strategies was applied: health fair presentations, use of promoters, and use of opinion leaders; the fourth area served as a control. Strategies were randomly assigned to areas.

Description of Promotional Strategies

Area 1: health fair. Apart from SODIS, the health fair included other topics, such as hygiene, nutrition, and medication. The fair was preannounced with banner ads and a car with loudspeaker equipment driving through the area, ensuring many people would be able to participate. During the health fair, people got to taste SODIS water, and illustrated information on SODIS and the antibacterial effects of sunlight were presented. The persuasive arguments were used in conversations with the people who participated in the health fair, and reminders were distributed to those interested in SODIS. Later on during the study the reminders were also distributed by the interviewer because the health fair did not reach as many people as expected. The health fair was held only once, shortly before the second panel.

Area 2: promoters. The three promoters we selected were trained twice during the study period: shortly after the first panel and again after the second one. The training lasted about 2 hr each time, with the aim of familiarizing the promoters with the persuasive arguments on SODIS and the reminders. After each training session, their task was to visit all interested families in their areas (during 1 week after each training), to use the persuasive arguments in their conversations, and to distribute the reminders. They received a regular salary for these 2 weeks of work.

Area 3: opinion leaders. The opinion leaders were selected by a local NGO working on children's health and running a primary school in the area. The women we chose were described as being greatly involved in the problems of the community as well as in school activities. Some held positions as *dirigentes* (which means something like head of the quarter), and they were always the most interested in new ideas and respected in the community. Finally, we invited 15 of these women to the training workshop. There we informed them about water quality and diarrhea, and about the SODIS method, and trained them with the persuasive arguments. The dates and time frames of this training were similar to those for the promoters. After each training session, they were asked to talk about SODIS to their friends and neighbors using the arguments they had learned. They were not paid, and no presents were given. The opinion leaders did not work within a defined time frame like the promoters; they basically worked constantly. In this area, the reminders were distributed by the interviewers because it turned out to be impractical to leave them with the opinion leaders.

Area 4: control. Only four measurements were made in the control area.

Measurement

Measurements were made with questionnaires that were conducted in the form of interviews because there is a high illiteracy rate in Bolivia. Before the first panel took place, a car on which a loudspeaker was mounted drove through all the areas announcing the upcoming interviews, mentioning and describing SODIS in brief. The preannouncement was highly recommended by the local NGO because people in these communities are frequently wary of strangers. A second reason for using the car and loudspeaker was to create similar percentages of people familiar with SODIS in all areas. This allowed for the possibility of investigating knowledge dissemination depending only on the promotion strategy. Unfortunately, as can be seen later in the Results section, the car and loudspeaker did not have the desired effect.

The questionnaires were revised and validated by local experts and the interviewers to ensure identical understanding of the items. For reasons that will be made clear later, long and short versions of the questionnaire were used. The

short version measured only a few demographic variables, whether people had heard about SODIS at all, whether they used SODIS, and where they had heard about it (communication channels). The long questionnaire contained additional demographic characteristics and questions on the degree of knowledge of SODIS.

The operationalization read as follows (translated from Spanish):

Knowledge of SODIS: Do you know SODIS? 0 (*no*), 1 (*yes*)
Use of SODIS: Do you use SODIS at the moment? 0 (*no*), 1 (*yes*).

Communication channels:

First panel: Where did you hear about SODIS for the first time and when? open answer

Second and third panels: Where did you hear about SODIS during the last month? open answer

Fourth panel: Where did you hear about SODIS during the last 7 months? open answer

Multiple open answers were possible; all answers were then grouped into categories.

Depth of SODIS knowledge: Could you please explain SODIS to me?

This was an open-ended question that was instantly categorized by the interviewer into one of five categories, using the following criteria. These criteria were written on the questionnaire for the interviewers' own use.

0 = No knowledge; criteria: has never heard about SODIS.

0.1 = Very little knowledge; criteria: has heard about SODIS but does not know how to prepare it and that SODIS disinfects water.

0.33 = Some knowledge; criteria: knows in principle how to prepare SODIS and that it disinfects water but does not know why or gives some "magic" explanation.

0.67 = Good knowledge; criteria: knows how to prepare SODIS, and either the sun or the temperature as the cause of the disinfection process is mentioned.

1 = Very good knowledge; criteria: complete understanding of how to do SODIS and how it works.

Our knowledge measure may appear somewhat unusual, but there has not been much investigation into the issue of measuring SODIS knowledge. First steps into establishing a measure have already been taken by Altherr, Mosler, Tobias and Butera (2008), who have used a very similar measure. The use of only one open question, as opposed to classic multiple-choice (often used in education tests) or true-false items (e.g., on AIDS knowledge; Carey & Schroder, 2002), and the subsequent categorization by the interviewers were chosen for various reasons. One is that SODIS is basically too easy to allow for numerous questions to assess different knowledge facets. Moreover, many of our respondents are probably not used to multiple choice-questions or to judging true-false statements.

Interviewers were trained in the categorizations of knowledge in teams of two. Incorrect categorizations were corrected by an observing expert.

Design

Households were selected using a modified random-route procedure (Hoffmeyer-Zlotnik, 1997). In contrast to the technique described by Hoffmeyer-Zlotnik, we did not select random intersections because the areas were not very big. Instead we partitioned each area into four parts, and each interviewer started by selecting each second or third house from the center of each part, depending on how big the total area was. An equal spread of households across areas was ensured with the aid of maps on which all of the interviewed households were marked. The interviewed person had to be the one responsible for water in the household (in 90% of cases it was a woman). First we asked if the person was willing to participate in the long questionnaire. If he or she refused, we asked for participation at least in the short questionnaire. The interviewee was told that the study would consist of two additional measurements. Rejection rates were approximately 20% for the long questionnaires and almost 0 for the short ones. For the second and third panel, the same households were visited. Of the households that initially had only filled out a short questionnaire but were willing to also participate in a long one, a long questionnaire was applied (30 households changed from the short to the long questionnaire in the second panel; 26 in the third panel). In addition, new households were included (70 in the second panel, 9 in the third panel), ensuring that the interviewed persons knew about SODIS. The main reasons for the inclusions and questionnaire changes were to compensate for dropouts and to assure that the households used in the study had actually heard about SODIS, because an investigation of the effects of promotional strategies requires knowing where people had heard about SODIS. We will provide some insight into differences between households that were in the study from the beginning and those 70 households that were added during the second panel. After the third panel, the study was declared finished, and no more activities took place. The fourth panel then took place in June 2006. No prior warning was given to the households, and using the same interviewers as in 2005, about 70% of the households were identified and interviewed again. Dropout rates were 33 households after the first, 28 after the second, and 92 after the third panel.

RESULTS

First, we report some sample characteristics based on the gathered demographics to assure comparability of the areas. The main analysis then concentrates on a description of the effects of the different promotional strategies using the four indicators: percentage of people who knew about

SODIS, depth of SODIS knowledge, adoption rate of SODIS (% of users), and communication channels through which people heard about SODIS. The effects of the interviewer will be addressed separately in the last part of the Results section.

Sample Characteristics

The following demographic variables were collected; percentages or means are presented, as well as significant differences among the four areas. Lack of mention of a difference indicates that the areas do not differ significantly from each other.

The person responsible for water in the household (interviewed person) was female in 93% of cases ($N = 465$), the mean age was 39 years ($SD = 15$, $N = 462$), and the mean number of years of education was 6.9 ($SD = 4.7$, $N = 458$). For education, all areas differed significantly from each other, except health fair and control. The promoters area had the lowest education (4.8 years), followed by the control area (6.4 years), the health fair area (7.1 years), and the opinion leader area (9.7 years). The average employment rate was 37% (mostly vendors, few with formal employment; $N = 465$). Here the promoters area differed significantly from all other areas, having the lowest employment rate (15%). The other three areas had employment rates between 42% and 47%. The mean total number of people living in one household was 5 people ($SD = 2$, $N = 463$). Significant differences were found only between the health fair (5.3 persons) and the opinion leader area (4.5 persons); the other two areas had values in between these. Each household had on average 0.83 children below 5 years of age ($SD = 0.94$, $N = 462$), and the families lived on average in 3 rooms ($SD = 1.3$, $N = 234$). For rooms per household, the opinion leader area (3.46 rooms) differed significantly from the health fair (2.7 rooms) and the promoters area (2.8 rooms). In the control area one household lived in 3.3 rooms on average. The interviewed person had contact with an average of 2.1 persons outside his or her own house, but still living within the same community ($SD = 2.1$, $N = 245$), with significant differences between the promoters area (3.2 persons) and the health fair (2.0 persons) as well as the opinion leaders area (1.4 persons). The control area had a value in between (2.2 persons). The demographic variables with lower N s were only measured with the long questionnaire.

Overall, the demographics did not show any important differences among the areas. Particularly important, there was no area that consistently demonstrated the lowest or highest values. Therefore, we considered the areas to be comparable but also controlled for the demographic variables whenever possible.

SODIS Knowledge

Whether or not people had heard about SODIS was investigated by using only households included in the study from

the first panel on (consequently, N declined over time due to dropouts). This was done because the selection criterion for later inclusion was that people had to know about SODIS. Both types of questionnaires (short and long) contained this information and were included in the analysis. Within each panel (one point in time), the percentages of the different areas were compared with pairwise chi-square tests. For exact percentages, see Table 1.

Although the intention was to create similar percentages of people knowing SODIS before the study with the use of the loudspeaker car, percentages in fact varied quite a lot between the areas at the time of the first panel. The promoters area had the lowest percentage of people who knew SODIS, at only 7%, and differed significantly from all other areas (all $ps < .001$, $\chi^2 > 19.1$, $df = 1$). The other areas (health fair, opinion leaders, and control) had percentages of between 32% and 51%, with one significant difference between the health fair and opinion leaders area (32% vs. 51%; $p = .007$, $\chi^2 = 7.361$, $df = 1$). After testing for the relation to demographic variables, we found that the more years of education a person had, the more likely he or she was to have already heard about SODIS ($p < .001$, $F = 29.4$, $df = 1$). This relation is clearly reflected by the opinion leader area (most years of education and the highest percentage of people knowing SODIS) and the promoters area (vice versa).

At the time of the second panel a ceiling effect had already occurred, as all areas with promotional activities had very high percentages of people who knew about

SODIS, ranging from 86% (opinion leaders) to 99% (health fair). Only the control area had a significantly lower value (56%; all $ps < .001$, $\chi^2 > 19.1$, $df = 1$). At the end of the active phase at the time of the third panel, almost every household had heard about SODIS, and the percentages varied only between 95% and 100%.

In summary, all promotional strategies were clearly effective in informing people about SODIS faster, as compared to the control area.

Knowledge Depth

A more qualitative indicator of the depth of knowledge was analyzed with a general linear model for repeated measures. This method allows the simultaneous investigation of group, time, and interaction effects. A drawback is that a general linear model requires no missing data, so only cases with data from all four time points were used. The number of cases was therefore much lower, but a calculation with the complete data set (all information available, long questionnaires only) showed very similar mean values. The calculated general linear model contained a total of 75 cases and included all demographic variables as covariates (age, education, occupation, number of persons in the household, number of children below 5 years of age in the household, number of rooms in which the family lived, gender and number of people an interviewee knew within the same community but outside the household). The development of knowledge depth over time and for each promotional strategy can be viewed in Figure 1.

The promotional strategies had a strong direct group effect ($p < .001$, $F = 19.4$, $df = 3$) and time had a somewhat weaker ($p = .013$, $F = 3.9$, $df = 3$) direct effect on the depth of knowledge. Also, an interaction between promotional strategies and time could be observed ($p < .001$, $F = 7.9$, $df = 9$). Of the demographic variables, only the number of children below 5 years of age showed a slightly significant direct effect ($p = .025$, $F = 5.3$, $df = 1$). None of the demographic covariates showed an interaction effect with the time factor. Pairwise comparisons of promotional strategies (post hoc Bonferroni method based on estimated marginal means) confirmed what can be seen in Figure 1: The health fair and promoters areas form one group at a generally higher level and differ significantly ($p < .021$) from the opinion leader and control areas, which form a second group at a lower level. Pairwise analyses among the four time-points (post hoc Bonferroni method based on estimated marginal means) also confirmed the visual presumption: The overall increase of knowledge was highly significant until October 2005 ($p < .001$), and then the level stayed stable until June 2006.

In summary, a high level of knowledge depth was reached after the 2 months of promotional activities, and this level stayed stable until the fourth panel 7 months later. Although the final level was quite high, clear differences were evident between the promotional strategies. Whereas

TABLE 1
Percentages of People Knowing SODIS and Using It Over Time
for Each Promotional Strategy

Indicator/ Promotional Strategy	1st Panel		2nd Panel		3rd Panel		4th Panel	
	%	N	%	N	%	N	%	N
Knowledge^a								
1. Health fair	32 _a	98	99 _a	88	99 _a	78	100	50
2. Promoters	7 _b	99	91 _{ab}	74	100 _a	66	100	49
3. Opinion leader	51 _c	90	86 _b	85	99 _a	79	100	59
4. Control	37 _{ac}	104	56 _c	93	95 _a	83	100	74
Mean/total	31	391	82	340	98	306	100	232
Use^b								
1. Health fair	3 _a	98	14 _a	132	48 _a	125	39 _a	90
2. Promoters	3 _a	99	47 _b	88	73 _b	81	47 _a	74
3. Opinion leader	11 _a	90	33 _b	96	62 _{ab}	92	41 _a	70
4. Control	3 _a	104	13 _a	92	29 _c	85	20 _b	83
Mean/total	5	391	25	408	52	383	37	317

Note. Percentages in one column within knowledge and use, respectively, which do not share the same subscripts, differ from each other at least at $\alpha < .05$ in a pairwise chi-square test. Because it was necessary to calculate six chi-square tests to assess the differences between all four groups within one panel in a pairwise way, the corresponding threshold to define the significance (α) level was adjusted (Sachs, 1978). SODIS, solar water disinfection.

^aPercentage/number of households who knew about SODIS. ^bPercentage/number of households who used SODIS.

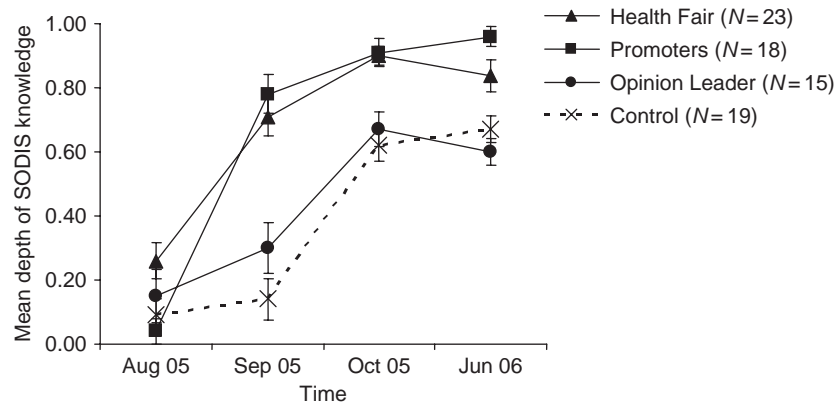


FIGURE 1 Mean knowledge depth over time and for each promotional strategy. SODIS, solar water disinfection.

knowledge in the health fair and the promoters areas nearly reached a “very deep” level, the opinion leader and control groups achieved only a “deep” level. The late “take-off” of the control and opinion leader groups—the knowledge depth started to increase remarkably only after the second panel—is especially noteworthy.

SODIS Use

The most important aim of the study was—aside from informing people about SODIS—to get people to use SODIS to treat their water. This information was gathered with the long and the short questionnaires. Table 1 lists the percentages of SODIS users across areas and time. At the beginning of the study, the opinion leader area had a slightly higher percentage of SODIS users than the other periurban areas (11% vs. 3% in all other areas), but pairwise chi-square tests showed no significant differences. As for the level of knowledge at the time of the first panel, a positive relation to the education level existed for SODIS use ($p < .001$, $F = 12.2$, $df = 1$).

After 1 month of activities, the user percentages of the areas with the various promotional strategies differed greatly from one other. Promoters showed a good increase (to 47% use), opinion leaders had a more moderate influence (33% use), and only the health fair stayed fairly low (at 14%). Except for the health fair area, the intervention areas differed significantly from the control area for SODIS use ($p < .01$, $\chi^2 > 10.8$, $df = 1$), which reached 13%. The same order of usage percentages as for the second panel was found for the third panel: the promoters area had the most users (73%), next came the opinion leaders area (62%), which was followed by the health fair area (48%) and the control area (29%). All of the promotional strategy areas, including the health fair area, now differed significantly from the control area (health fair $p = .007$, $\chi^2 = 7.256$, $df = 1$; the other $ps < .001$, $\chi^2 > 18.819$, $df = 1$). In addition, the high percentage found in the area assigned to the promoters

differed significantly from the health fair area ($p = .001$, $\chi^2 = 12.4$, $df = 1$). In summary, until October 2005 a clear order of the promotional strategies in terms of SODIS user percentages was visible: the promoters were more effective than the opinion leaders, who were more effective than the health fair in terms of getting people to start using SODIS. Of interesting, the control area, without any promotional activities, also showed a considerable number of users (29%). This finding will be discussed later.

When looking at usage percentages at the fourth panel in June 2006, it can be clearly seen that many people stopped using SODIS. The percentages went down to a range of 39% to 47% in the promotional activity areas and down to 20% in the control area. Only the differences between the areas of previous promotional activities and the control area remained significant (health fair $p = .008$, $\chi^2 = 7.0$, $df = 1$; promoters $p < .001$, $\chi^2 = 12.7$, $df = 1$; opinion leaders $p = .005$, $\chi^2 = 7.9$, $df = 1$). Overall, the promotional strategies showed a more positive effect on SODIS usage than did the control area, but there were no differential effects between the various activities. No relation of SODIS user percentages to the demographic variables was found for the second, third, or fourth panels.

Communication Channels

To compare the perceived communication channels with the applied promotional strategy, communication channels were assessed with an open-ended question. Table 2 presents percentages of the various communication channels separately for each promotional strategy area and time point. The communication channels that were named were the promotional strategies themselves (health fair; promoters; and friends/neighbors, to measure opinion leader influence), the loudspeaker car, the interviewers, and other sources (radio, TV, institutions, schools). Unsurprisingly, the interviewers were named as communicative channels by nearly everyone, but often other sources were also named. Therefore, the

TABLE 2
Percentages of Communication Channels Over Time and for Each Promotional Strategy

Time/Promotion Strategy	Communication Channel							N
	Loudspeaker Car	Health Fair	Promoter	Friend/Neighbor	Other Source	Interviewer Only	None	
1st Panel								
1. Health fair	5%	—	—	21%	22%	—	57%	98
2. Promoters	4%	—	—	7%	7%	—	84%	99
3. Opinion leader	16%	—	—	41%	34%	—	31%	90
4. Control	8%	—	—	20%	24%	—	54%	104
2nd Panel								
1. Health fair	—	20%	3%	2%	5%	45%	27%	132
2. Promoters	—	1%	81%	3%	16%	10%	8%	88
3. Opinion leader	—	2%	0%	46%	18%	27%	15%	96
4. Control	—	5%	0%	2%	2%	65%	26%	94
3rd Panel								
1. Health fair	—	—	0%	2%	7%	32%	60%	125
2. Promoters	—	—	73%	1%	6%	2%	23%	81
3. Opinion leader	—	—	0%	39%	24%	10%	38%	92
4. Control	—	—	0%	2%	1%	9%	88%	85
4th Panel								
1. Health fair	—	—	—	8%	3%	—	89%	90
2. Promoters	—	—	—	0%	0%	—	100%	74
3. Opinion leader	—	—	—	7%	3%	—	90%	70
4. Control	—	—	—	1%	1%	—	98%	83

Note. Calculation of percentages is based on the total number of interviewed households per area. Percentages are rounded off. An empty cells mean that this type of communication channel did not exist for that time point and promotional strategy area. Bold numbers mark the communication channels that were applied and therefore expected for the corresponding promotional strategy area and time point. Multiple answers were possible; row sums may therefore exceed 100%.

percentage of those who communicated *only* with the interviewers (and no other source) was included in Table 2. In addition, the percentages of households that had no SODIS-related communication at all were also included.

Asking where people had first heard about SODIS during the first panel was used to check if the loudspeaker car had an impact or not. The results show that people had heard about SODIS mainly from other people, from radio or TV, and a range of other sources. The loudspeaker car as the source of the first-time-knowledge was mentioned on average by only 8% ($n = 31$), although nearly 70% of participants had never heard about SODIS before the study (and theoretically would have been the target population for the loudspeaker car). Because the number of people who had heard about SODIS from the loudspeaker car was so small, we refrained from investigating the effects of the loudspeaker car on SODIS knowledge depth or SODIS use. Basically, the loudspeaker car did not have any remarkable influence. The other sources named during the first panel will not be further interpreted, because the time frame spanned the 10 years before the study, and this information therefore cannot be viewed as reliable.

To judge the effectiveness of the promotional strategies, it is of interest to know how many people heard about SODIS through the applied promotional strategies. The percentages after 1 month (second panel) showed relevant differences: whereas only 20% had heard of SODIS at the

health fair, in the promoters area 81% had contact with the promoters and heard about SODIS from them. In the opinion leaders area, 46% of the people heard about SODIS through friends or neighbors. Communications within the social network in this area were clearly the work of the opinion leaders because such communications were very low in the other areas (2–3%). Whereas 46% was a good result for the opinion leaders, as the least controllable promotional strategy, only 20% for the health fair was surprisingly low. One would expect such a big event to reach more people in the community. Therefore it is not surprising that of the areas with a promotion campaign, the health fair area had the highest percentage with no communication at all (27%), as well as the highest percentage of those who had heard about SODIS only from the interviewers (45%). After the 2nd month of promotional activities (third panel), the percentages relating to communication channels showed results similar to those after the 1st month: the promoters worked constantly and reached 73%, and the communications due to opinion leaders showed that 39% learned about SODIS within their social network. Almost no communication channels were named in the health fair area, because—as planned—the health fair was not repeated. So, once again we found the highest percentage of people without communication (60%) and only interviewer communication (32%) in the health fair area. Not much communication

took place in the control area: Most people mentioned no communication channel or mentioned only the interviewer.

When the fourth panel took place 7 months later, almost no communication channels were named in any area. As expected, no activities had taken place, and no communication had occurred within the social network either. For the opinion leader area, it was a rather disappointing fact to realize that although we had managed to trigger communication within the social network, nothing remained after 7 months.

Effects of the Interviewer

There are two reasons to separately investigate the effects of the interviewers: the first is the rather large number of households that joined our sample during the second panel, the second reason—and probably the more urgent matter to clarify—is that there were a considerable number of households who had heard about SODIS only from the interviewers. First, we compared the new households from the second panel to the households that were in the study since the beginning, to compare for sensitization due to interviewing. Second, we compared the households that had heard about SODIS from the interviewer only with those who mentioned additional sources.

First, we distinguish between first (*old* households) and second panel (*new* households) as entry points to the study. For knowledge depth at the second panel, an analysis of variance revealed a slightly but significantly higher knowledge depth of the old households as compared to the new households, $M_{old} = 0.54$ ($SD = 0.36$), $M_{new} = 0.35$ ($SD = 0.37$), $N = 192$, $p = .001$, $F = 11.97$, $df = 1$. This difference no longer existed at the time of the third panel, $M_{all} = 0.77$ ($SD = 0.22$), $N = 192$. In the case of SODIS use, chi-square tests were conducted, comparing percentages of SODIS users at each time point separately for the two groups, new and old households. By the time of the second panel, no significant difference could be found; the two groups had a similar percentages of SODIS users (~25%; $N = 408$).

The second analysis compared those households who heard about SODIS only from the interviewer (OnlyInt) with those who mentioned other sources as well (Other). Households that did not mention any communication channel were not included in this analysis. For the second panel, knowledge depth was clearly higher for those having heard about SODIS not only from the interviewer but from other sources as well, $M_{OnlyInt} = 0.40$ ($SD = 0.31$), $M_{Other} = 0.64$ ($SD = 0.37$), $N = 153$, $p < .001$, $F = 18.1$, $df = 1$). At the time of the third panel, knowledge depth was equally high for the two groups, $M_{All} = 0.79$ ($SD = 0.21$), $N = 136$. Looking at SODIS usage percentages, only 18% of the households that had heard only from the interviewer about SODIS also applied SODIS, in contrast to 42% of SODIS users in the other group, $N = 329$, $p < .001$, $\chi^2 > 21.7$, $df = 1$. Also for the third panel, the same relation was found: households that heard only from the interviewer were less likely to use

SODIS, $\%_{OnlyInt} = 56\%$, $\%_{Other} = 79\%$, $N = 179$, $p = .001$, $\chi^2 > 10.5$, $df = 1$.

Summarizing, the households that were in the study for 1 month longer showed a slight sensitization effect on SODIS knowledge but not on SODIS behavior. Furthermore, the interviewer did have an impact on SODIS knowledge and use (the effects found in the control area), but this effect was clearly lower than that of the promotional strategies as sources of information.

DISCUSSION

The following discussion compares the effectiveness of the different promotional strategies for knowledge and use of SODIS. Our conclusions obviously hold only for a setting similar to the one in which they were tested.

Interpersonal Communication

Until the end of the active phase of the study (third panel), both opinion leaders and promoters informed everyone in the sample about SODIS. The promoters reached people very well (81% during the 1st month, 73% during the 2nd month), and opinion leaders triggered communications with moderate success within the social network (46% during the 1st month, 39% during the 2nd month). As hypothesized (H1), a difference could be found when looking at short-term knowledge depth: promoters transferred information on SODIS better than opinion leaders. Also as hypothesized (H1), promoters were more effective in influencing SODIS use in the short term and attained a figure of 73% of SODIS usage compared to 62% in the opinion leader area. Looking at the long-term effects (fourth panel), percentages of SODIS users dropped to 47% for promoters and 41% for opinion leaders, and the difference became insignificant. Clearly, SODIS did not become better embedded in the social system with the opinion leaders than with the promoters over the long term as expected (H2). The main reason seemed to be a lack of communication within the social network; such communication was observed only during the active phase in the opinion leader area. The low connectedness within the social network (each person knew only two other people on average outside the household within the same community) probably explains both the poor communication and that the opinion leaders in general did not have a greater impact. Another reason for the lower impact of the opinion leaders compared to the promoters may be people's insecurity about the trustworthiness of the innovation. People seemed to find "official" information more convincing in regard to the innovation (in our case that SODIS really disinfects water). This was confirmed by the opinion leaders themselves, who reported that some people they talked to doubted that the SODIS method worked and sought confirmation when the interviewers walked around to distribute the reminders.

Thus, a part of the effect in the opinion leader area is certainly due to the interviewers serving as “confirming experts” for the people and as distributors of the reminders. Without the distribution of these reminders that serve as situational cues in the households, a lower effect on behavior probably would have been found.

Centralized Communication

A comparison of the health fair with the interpersonal communication strategies reveals large differences between the two approaches. Whereas at least 39% of the participants heard about SODIS as a result of an interpersonal communication strategy, only 20% of our sample participated in the health fair. So, clearly, the coverage range of the health fair is lower than that of the interpersonal strategies. Nevertheless, the percentages of informed people and knowledge depth were very high, at the same level as in the promoters area. This high knowledge was probably caused by the additional, unplanned impact of the interviewers in the health fair area. However, because it is impossible to disentangle the effects of the health fair and interviewers in the health fair area, we cannot clearly state whether the health fair really would have achieved lower knowledge than the interpersonal strategies, as hypothesized. When looking at the usage percentage after 1 month, a clear difference among the interpersonal communication strategies can be seen. The health fair area did not have more users than the control area (14%, which represents the interviewer effect), whereas in the interpersonal areas at least 33% of the people used SODIS. Only later did user percentages in the health fair area also increase more than in the control area, but the interviewers were actively involved at that time (distributing reminders). The decision to involve the interviewers was made with the goal of helping people with their water treatment. Although we cannot exclude delayed effects of the health fair, the fair most likely affected only those 20% who actually participated in it. Confirming H3, the health fair area showed the lowest percentages of SODIS users of all promotional strategy areas at the end of the active phase. An explanation for the low participation rate (which was also unexpectedly low) may be the fact that people on average only knew two other people outside their households. It is possible that motivation to go to a primarily social event where a person will meet other people is low.

As already observed for the interpersonal communication strategies, the health fair area user percentage also dropped in the fourth panel, down to a level (39%) slightly lower than in the areas with interpersonal strategies, but insignificantly different.

In summary, interpersonal strategies were more effective than the centralized strategy. The centralized strategy did not reach as many people and did not change behavior well, whereas the interpersonal strategies were successful in both respects. Moreover, the applied centralized strategy (health fair) was the most expensive promotional strategy (music,

animator, food for staff, advertising, prizes for competitions), whereas the opinion leaders were very inexpensive and the 2 weeks of employing the promoters cost about half of the health fair. To us, the strategy of using a health fair as a method to reach people, as was suggested by our local partners, seems to be questionable, at least the way it was organized in this study (which is the way the local NGOs do it) and in this periurban setting. Perhaps a more participatory approach in organizing such an event would have had the power to get more people attracted and involved, but here further research is needed.

For the interpersonal strategies, promoters are more effective than opinion leaders in the short term, but there is no difference between these two interpersonal communication strategies in the long run. The strengths of the opinion leaders are their ability to trigger social network communication and their low costs, whereas the strengths of the promoters are that they inform people more adequately, have higher perceived expertise, and have stronger practical skills in distributing additional materials. A clear drawback is the higher cost of their salaries. In our view, it would be worth further investigating the opinion leader approach and developing strategies that would give them a more “official” appearance. A combination of promoters and opinion leaders may show interesting synergistic effects and save costs. This combined approach could start with promoters and opinion leaders working together and only later would the latter take over full responsibility. Alternatively, the expert promoters could be chosen directly from within the community. This combination would also be very practical for field application because the training does not require much effort and should be applied for a longer time period to have real long-term effects on behavior. The strength of interpersonal contact is in fact also reflected by the impact the interviewers had in the control area (and later in the health fair area) because conducting interviews is nothing more than having interpersonal contact with the people. Therefore, we would like to emphasize the importance of further studies on how these interpersonal strategies could be improved in terms of optimizing costs and effects.

Limitations

A clear limitation of our study are the shortcomings due to its realization as a field project. For this reason, the community sizes were different and we also had to deal with the almost unavoidable irregularities of the sample size due to dropouts and the enlargement of the sample in the second panel. The percentages of people who knew about SODIS before the study were also quite different. Only when we were in the field did we realize that the opinion leaders were not very effective in distributing the reminders. Therefore we had to take advantage of the interviewers because the reminders were an important part of the promotional strategies. The interviewers had to be involved again when we realized that

the health fair had very little impact. There was also a strong general interviewer effect—in the control area a maximum of 29% of households used SODIS—but it would be ethically questionable to forbid an interviewer to tell the interviewed person more about SODIS (a method that could possibly save their children's lives) if the person was interested in knowing more. Furthermore, we used an open question to measure knowledge, which was not explicitly tested for interrater reliability beforehand. However, we addressed the reliability issue during the interviewers' training, and due to the rather simple nature of an explanation of SODIS, consistent categorization during the training session was easily achieved.

Even if the list of limitations appears to be long, the results shed some interesting light on the advantages and disadvantages of the different strategies. In addition, it was our intention to investigate these strategies in the field as close to NGO reality as possible because that is where we hope the results will be used. Although the absolute level of SODIS use is probably not correct, the relation between the promotional strategies should be. We think that interviewer effects in all areas were similar or even lower in the areas where the promotional strategies worked well (opinion leader and promoters), so one should discount the effects of the control area on SODIS knowledge and behavior from those of the promotional strategies. This should reveal realistic results in terms of absolute level of SODIS knowledge and user percentages that can be achieved with the promotional strategies alone (without interviewers). We hope to have shown that although the promoters may not reach 73% of users on another occasion, they will probably be more successful than opinion leaders, and opinion leaders will be more successful than a health fair, all applied in a similar setting. However, to overcome some of these limitations and gain more insight into the promotional strategies presented here, more field studies in different contexts are needed on this topic.

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