Attitudinal and Relational Factors Predicting the Use of Solar Water Disinfection: A Field Study in Nicaragua

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Solar water disinfection (SODIS) is an uncomplicated and cheap technology providing individuals with safe drinking water by exposing water-filled plastic bottles to sunlight for 6 hours to kill waterborne pathogens. Two communities were visited, and 81 families (40 SODIS users and 41 nonusers) were interviewed. The relationship between several factors and the intention to use SODIS in the future and actual use were tested. The results showed that intention to use and actual use are mainly related to an overall positive attitude, intention to use is related to the use of SODIS by neighbors, and actual use is related to knowledge about SODIS; SODIS users reported a significantly lower incidence in diarrhea than SODIS nonusers. These results suggest that promotion activities should aim at creating a positive attitude, for example, by choosing a promoter that is able to inspire confidence in the new technology.

Keywords: *SODIS; water disinfection; health promotion; diarrhea*

Nicaragua is among the poorest countries of Central America (World Bank, 2004), and the lack of safe drinking water is one of its many problems. According to the Swiss agency for development and cooperation in Nicaragua (COSUDE, 2004), 60% of households outside of urban centers have no access to safe drinking water. Existing methods for water purification are often complicated or costly, and therefore they are rarely used.

Solar water disinfection (SODIS) provides individual households with a straightforward technology to disinfect their drinking water without the need for large investments. The exposure of water-filled transparent plastic bottles to sunlight for approximately 6 hours (or for 2 consecutive days when the sky is cloudy) produces safe drinking water. A combination of UV-A rays and the temperature of the water inside the bottles kills or incapacitates

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waterborne pathogens that can cause diseases such as diarrhea (McGuigan, Joyce, & Conroy, 1999). Any plastic bottle is suitable for this technique provided that the bottles are transparent, clean, and that the label on the bottle is removed (McGuigan, Joyce, Conroy, Gillespie, & Meegan, 1998). If the raw water is very murky, it has to be filtered, for example with a piece of cloth. SODIS has been developed and tested in Switzerland since 1991 and is being disseminated in many developing countries to improve the health situation of those without access to safe drinking water, especially because safe drinking water is essential for child survival (Anderson, Romani, Phillips, & van Zyl, 2002). In a controlled field trial, Conroy, Meegan, Joyce, McGuinan, and Barnes (1996, 1999) showed that the use of SODIS was related to a reduction of diarrhea in Maasai children and a certain degree of protection against cholera (Conroy, Meegan, Joyce, McGuinan, & Barnes, 2001). Other disinfection techniques have important disadvantages. Chlorination for example is refused by many people because of the taste. Filtration with ceramic filters (see Clasen, Brown, Collin, Suntura, & Cairncross, 2004; Clasen, Parra, Boisson, & Collin, 2005) is often too expensive for poor people. The use of flocculant-disinfectants requires certain skills for the treatment (see Reller et al., 2003). Boiling is resource and time-consuming, although in certain cold regions people are used to boiling water for soup and tea.

When promoting a change in behavior or a new technology, it is an advantage to understand the processes that lead to the behavior and the factors that influence it. Preexisting beliefs or the lack of resources can be factors that greatly influence the use of a new technology. In the case of SODIS, gathering information on such factors can help to identify the influences on the individual's current and future use of this technology. Promotion activities have encountered resistance in some SODIS projects, and therefore it is even more interesting to study the determinants of intention and behavior. To improve promotion efforts, the human behavior associated with the use of this technology needs to be better understood, especially from the point of view of the individual (Harkness, Wyon, & Super, 1988). The present article is the result of a field study carried out in particularly poor and inaccessible communities in Nicaragua.

The theory of planned behavior (TPB; Fishbein & Ajzen, 1975) proposes that the intention to carry out a certain behavior (say, water disinfection) is predicted by three main factors, namely, the attitude toward the object, the subjective norm (i.e., the perception that other people approve), and perceived behavioral control (i.e., the perception that one is able to carry out the behavior). This theory seems to be the most appropriate basis to predict behavioral intention and thereby behavior given the complexity of the situation in the field where this study was carried out. Its straightforwardness and the relatively small number of factors simplify the work in the field as well as the interviews that are carried out with people who have received very little or no formal education. The items developed for the questionnaire that we used for our study were derived from the factors of the TPB but adapted to the peculiarities of the targeted sample and extended for reasons of promotion activities. In the following paragraphs we describe the factors that we studied in the light of their being potentially related to intention and behavior for the use of a new water disinfection technology.

The factor attitude is conceptualized as the amount of affect for or against some object (Fishbein & Ajzen, 1975). This factor evaluates the overall emotional attitude toward the technology. In addition to the intellectual aspect of health behavior, as described in

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Rosenstock's (1990) health belief model, this factor is concerned with the emotional aspect of health behaviors. Even if knowledge about the technology and diarrhea exists and functions as a motivator, a negative attitude toward SODIS may impede its use. Attitude is independent of knowledge about SODIS because it can be affected by other factors such as for example the evaluation of promoters or of other users.

The factor subjective norms summarizes the behavior and the perceived influence of those surrounding the individual. This factor contains three different facets: The first is the behavior of neighbors regarding SODIS as perceived by the individual, and the second is the perceived social pressure, which may in some cases be sufficient to convince an individual to perform or not to perform a given behavior (Ajzen & Madden, 1986). The third is the perceived amount of neighbors who are SODIS users, which may have an effect as models favoring the establishment of an intention or the behavior itself, as described in Rogers's (2003) theory on the diffusion of innovations.

Perceived behavioral control consists of the subjective evaluation of the presence of external and internal elements essential to carry out the behavior. These elements are a necessary condition to develop an intention, in line with perceived behavioral control in the TPB (Ajzen & Madden, 1986; Schifter & Ajzen, 1985). Perceived behavioral control is likely to moderate the strength of the intention because such perceptions reflect the extent to which the person is in fact able to act on his or her intentions (Knussen, Yule, MacKenzie, & Mark, 2004). Especially when a behavior is not under a person's complete volitional control, it is necessary to take the extent to which the performance of the behavior is likely to be influenced by external factors into account (Terry & O'Leary, 1995).

In the case of SODIS, it is impossible to use the technology without the presence of a number of external elements. The behavioral control factor generally consists of two aspects: perceived control as an assessment of the presence of external constraints and the perceived internal ability to carry out the behavior, or self-efficacy, as Bandura (1982) called it in the theory on social learning. Given the simplicity of SODIS, only external factors are evaluated in this study, namely, the perceived availability of the resources necessary to use SODIS, such as enough sunny periods, sufficiently clear water, and most important, enough bottles.

The last factor can be called convictions and beliefs; it does not directly belong to the model proposed by the TPB, but it represents an important extension as this factor is often mentioned in studies inspecting promotion strategies (e.g., Mosler & Tobias, 2000; Pitts, McMaster, Hartman, & Maeusezahl, 1996). This factor represents the cognitive and rational information a person has about the SODIS technology and about issues surrounding its use, such as familiarity with causes of diarrhea. This factor also includes confidence in the technology and the subjective value of safe drinking water. Knowledge about the technology and waterborne diseases is important when studying the intention to use a water disinfection method as a deeper understanding of the processes at hand may provide a motivator to carry out this additional daily task. Pitts et al. (1996) showed that lay beliefs influence the use of preventive measures against and treatment of diarrhea by mothers in a very important way. Confidence also plays a very important role in this process as without confidence, SODIS may not be seen as a valid alternative to other disinfection methods or to drinking untreated water.

Due to difficulties reaching the participants (see following), only one visit could be carried out with the available resources. This led us to evaluate the current behavior and the intention regarding future behavior at the same point in time. Consequently, the intention does not affect the evaluated behavior. It was necessary to evaluate both intention and behavior to understand the continued use of a technology and to improve activities to promote it.

Finally, all behaviors have effects, and in the case of this study, the effect of behavior is the reported amount of diarrhea cases. The lack of clean drinking water contributes to the prevalence of waterborne diseases such as diarrheas, dysenteries, hepatitis A, cholera, and typhoid (Cosgrove & Rijsberman, 2000). Diarrhea remains a leading cause of death for children younger than the age of 5 (World Health Organization, 2004), and because the goal of the promotion of SODIS is to improve the access to safe drinking water in developing countries, its outcome is an important factor to be assessed. To assess the relative importance of SODIS in the reduction of the incidence of diarrhea, we calculated the difference in the reported number of diarrhea incidents for SODIS users and for nonusers.

The assumed sequence of influence is based on the consideration that certain factors need to be present before a behavior or an intention to perform a behavior is developed by an individual. Confidence could potentially be based on the realization that SODIS truly diminishes the incidence of diarrhea. However, this is fairly unlikely given that SODIS reduces the diarrhea incidence by 10% to 55% (Hobbins, Indergard, & Mäusezahl, 2004), and thus the decrease is not as easily observable in everyday life. Other causes such as contaminated foods and poor hygiene influence diarrhea illnesses in a significant way as well. Independent of these retroactions, at least certain knowledge about the behavior, some confidence, and a positive attitude need to be present before the first behavior or intention emerges. Therefore, a promotion campaign needs to a priori foster confidence, knowledge, and a positive attitude before the beneficiaries consider using the technology.

Thus, we predict that intention and behavior are related to confidence that SODIS works, knowledge about how it functions, establishing a connection between diarrhea and contaminated water, a positive attitude, favorable social norms, and the presence of the elements necessary to carry out the water disinfection.

METHOD

Sample

The promotion projects of two organizations were visited to collect the data. The organizations were chosen based on the amount of time they had been working with SODIS in the area: Centro de Educación y Promoción Social (CEPS), which works in La Paz Centro, and Programa Integral en Salud (PIS), which works in Waslala (this is the longest existing project in Nicaragua, having been in existence for 1.5 years). Based in the northeastern mountain range, PIS has been working in the area with the goal of improving the health condition of the inhabitants of the municipality. The area is very hilly, and most communities are only accessible on foot. The long rainy season has frequent cloud cover that makes the use of SODIS difficult during that time.

CEPS provides training and education in many regions of the country and had started a pilot project with SODIS in the municipality of La Paz Centro in the eastern lowlands only 2 months prior to the visit. The area is uncharacteristically dry for the tropics as clouds and rain are rare, even during the rainy season. The only water sources available to the population in La Paz Centro are wells, whereas in Waslala, rivers and creeks are abundant and provide an ample supply. Both municipalities are rural in their setting and are both fairly difficult to reach, although Waslala is much more isolated than La Paz Centro. The outcome of the projects has been quite different, with only 20% of the population being users in Waslala, whereas in La Paz Centro it seems that as many as 80% are using the technology.

La Paz Centro is much closer to city life and has a more "modern" feeling to it. Almost all houses have electricity and therefore all have at least a radio and some even have a television set. The proximity to the city and the existence of roads and of public transport mean that the farmers can relatively easily reach the city (either León, a state capital, or Managua, the national capital). On the other hand, Waslala and its communities are much further away from any city. The communities themselves are far away even from Waslala (approximately 10,000 inhabitants), and they do not have electricity. There is no form of communication between the communities and Waslala except messengers. Some families have a battery-driven radio, but the only radio station is the local one of Waslala. This radio station is used for a sort of one-way communication with the communities. The farmers have few opportunities to leave the communities and mostly have to do so on foot. The only place they go is Waslala, the next city being a 6-hour bus ride from Waslala. Most women have hardly ever left their community and lead a life of relative isolation.

Given to the geographical and structural differences, the two areas are different in their development. Education in a larger sense (i.e., school, radio programs, TV) is much more easily available in La Paz Centro than in Waslala. However, in La Paz Centro, it is much more of an effort to obtain water because there is hardly any surface water, as in rivers and creeks. The only sources of water are wells. In the mountains on the other hand, surface water is abundant. There are countless creeks and rivers, and it is not a big effort to obtain water. Under these circumstances, water is taken for granted and is not considered the valuable resource that it is in La Paz Centro where it is hard work to obtain water. In this surrounding, water is more a topic of conversation and reflection, and therefore the people may be more susceptible to forms of water treatment, whereas in the mountains of Waslala, water is taken for granted and its treatment seems unnecessary or maybe even absurd.

For this study 40 families in La Paz Centro and 40 families in Waslala were interviewed, half of which were using SODIS and half of which were not. For the purpose of this investigation, SODIS users were defined as a family owning suitable bottles and using them on an almost daily basis. Overall, 40 families using SODIS and 41 families not using SODIS completed the interview in August and September 2003. In each area, the families were selected at random by choosing every third family house along the path and avoiding a bias based on the accessibility of the households. This technique was applied until the number of 20 households using SODIS and 20 households not using it was reached. At the end of this procedure, the sample consisted of 20 households using SODIS and 20 households not using it from La Paz Centro and 20 households using SODIS and 20 households not using it from Waslala. No incentives had to be offered for the interviewing because the willingness to participate was very high. The purpose of the study was thoroughly explained to all participants.

Many households were only accessible on foot through dense jungle, and they were generally hours away from the dirt road. One community did not have any access road at all and could only be reached by hiking. Under favorable conditions, three to four families could be interviewed a day, with many hours walking in between the interviews. This meant of course that the interviewer had to stay in the communities under very basic conditions. The responses of a total of 163 participants were recorded (92 men and 71 women), and of these only those of the person responsible for the drinking water (81) were retained for further statistical analysis.

The sociodemographic data collected show that the mean age of the interviewees was 35.9 years old ($SD = 12.2$) and the average number of completed school years was 2.9 ($SD = 3.3$). Of the 163 people interviewed, 48.2% were SODIS users, 51.2% were

non-SODIS users, 51.5% were housewives, 39.3% were independent farmers, 7.4% indicated having some form of employment, and 1.8% stated not having an occupation. Those who mentioned employment were almost all sporadic day laborers earning approximately 25 Cordoba per day (roughly US$1.60). The number of adult family members present at the interview ranged from 1 to 4, on average it was 2 ($SD = 0.4$), whereas the actual number of family members was on average of 5.6 members ($SD = 2.4$). There were a few significant differences between the investigation areas La Paz Centro (PC) and Waslala (WS). They differed in the number of family members ($M_{PC} = 5.2$ and $M_{WS} = 6.2$) and in the average number of completed school years ($M_{PC} = 3.8$ and $M_{WS} = 1.3$), but there were no differences with regard to age ($M_{PC} = 39.5$ and $M_{WS} = 34.8$). In both areas, 50% of the people interviewed were housewives.

In each household there was one person who was particularly responsible for obtaining the drinking water for the rest of the family. To identify the responsible person, the family was asked to point to the adult in charge of providing the drinking water. Of the 81 persons carrying this responsibility, 97.5% were women and 2.5% were men.

Procedure

The interviews were all performed by the first author. The interviewer called on families in their homes during the day without an appointment or prior information about the impending visit. The interviews were carried out in Spanish, and all family members older than 15 years of age present at the time of the visit were invited to participate. After informing the participants of the anonymity of their answers and their right to terminate the interview at any time, the basic data regarding the household and its water consumption were recorded. The whole questionnaire (see following) was filled in by the interviewer on the basis of the family members' answers.

Every family that was visited by the interviewer agreed to participate. The person responsible for the drinking water in the family always completed the full interview, whereas not all other family members remained present for the entire duration. At the conclusion of the interview, the participants were encouraged to ask questions, and if they were interested, the functioning of SODIS was explained.

Questionnaire

The questionnaire was designed to obtain measures of the various factors to be inspected.

Convictions and Beliefs. To assess their knowledge about SODIS the interviewees were asked to explain its functioning. This answer was coded on a scale ranging from 4 (*detailed knowledge of SODIS*—including knowledge on the effect of the sunrays) to 0 (*no knowledge that SODIS disinfects water*). The second question asked the interviewees to explain the causes of diarrhea. A similar scale was used where 4 stood for *detailed medical knowledge* about bacteria and parasites as causes of diarrhea and 0 for *no knowledge* about the causes. The question regarding the confidence in the technology asked whether a person had confidence that the water treated by SODIS is disinfected or not (3 = *full confidence, SODIS is completely safe*; 0 = *no confidence, SODIS does not increase the safety of the water*). The final question for this factor regarded the value clean water and hygiene have for the interviewed person (3 = *very important, I would make a big effort and assume high costs to obtain it*, 0 = *it is not important*).

Attitude. To assess the attitude regarding SODIS, the question "After all we have talked about, do you think it is good to use SODIS or not?" was asked at the end of the interview (2 = *using SODIS is very good*, –2 = *using SODIS is very bad*). This is a very general question about an overall feeling toward the use of SODIS.

Subjective Norms. The factor subjective norms was evaluated by several questions. Perceived social pressure exuded by neighbors was assessed via the question "If all your neighbors were using SODIS and you were not, would you start using it as well or would you not do it precisely because all of them were using it?" (2 = *I would absolutely have to use it too*, –2 = *I would definitely not use it, I would do the opposite*). The second assessed the perceived opinion of neighbors regarding water disinfection by asking about what neighbors would think of them if they were not using any form of water disinfection (2 = *they would think I am a good, sensible person*, –2 = *they would think that I am a bad, unaware person*). Finally, the perceived percentage of neighbors using SODIS was recorded by first indicating the number of neighbors they have contact with on a daily basis. In a second step they were asked to estimate the number of SODIS users among these neighbors. This led to the calculation of the perceived percentage of neighbors using SODIS.

Perceived Behavioral Control. The perceived availability of bottles was evaluated for the perceived behavioral control. The interviewees were asked how easily they could get hold of suitable bottles for the use of SODIS. The answers ranged from 3 (*as many bottles as we want are available*) to 0 (*there are no bottles to use SODIS*).

Intention. To assess the intention to use SODIS, two slightly different versions of the question were asked of users and nonusers because the two types of respondents could not be asked the same question. SODIS users were asked how much water they intended to disinfect with SODIS in the future (3 = *as much as possible*, 0 = *I will not continue to use SODIS*). For nonusers the question was "Do you intend to start using SODIS in the future?" (3 = *I will definitely try it*, 0 = *I will not try it*).

Target Behavior. The first section of the questionnaire served to gather general information about the household, its members, their daily water consumption, and their use of water disinfection methods. This section provided data on the current behavior (SODIS user vs. nonuser) and the amount of water (treated or untreated) consumed.

Effect of Behavior. Finally, the effect of the behavior was evaluated by the reported number of diarrhea incidents in the family during the past month. The number of reported diarrhea cases was recorded independent of whether it had been a child or an adult suffering from the illness.

RESULTS

General Data on Water Consumption

Two measures were made regarding water consumption: On one hand, the amount of SODIS bottles per person in the household was noted, and on the other hand, the interviewees were asked to estimate their overall water consumption and the amount

Table 1. Regression Analysis on Intention to Use Solar Water Disinfection (SODIS)

Variables	*B*	*SE B*	*β*	*p*
Convictions and beliefs				
Connection diarrhea-water	.084	.115	.059	.468
Knowledge about SODIS	−.052	.064	−.073	.417
Confidence in SODIS	.217	.155	.182	.168
Value of clean water	.067	.167	.035	.689
Attitude				
Overall attitude	.935	.199	.629	.000
Subjective norm				
Perceived social pressure	.186	.147	.118	.212
Opinion of friends	.056	.087	.057	.519
SODIS use by neighbors	.005	.002	.214	.010
Perceived behavioral control				
Bottle availability	−.159	.114	−.125	.166
Constant	−.217	.536		.687

NOTE: Adjusted $R^2 = .617$, $N = 63$. $N = 63$ due to missing data. Constant indicates the value of the dependent variable if all independent variables are zero, the constant in the regression equation.

of water they consumed that had been treated by different water purification methods. Adequate bottles are scarce, and families on average own only 1.25 bottles per person ($SD = 0.91$). The bottles used for SODIS hold between 1.5 and 2 liters, which means that each person has access to between 1.88 and 2.5 liters of safe drinking water per day. The overall water consumption per person per day was 3 liters, as estimated by the families. The amount of water treated with SODIS, which was assessed independently of the number of bottles owned, was approximately 66% of the total water consumption. The correlation between the amount of bottles owned and the SODIS water consumption was significant ($r = .702$, $p < .001$, $N = 40$), which indicates that the number of bottles owned limited the amount of water that can be treated using SODIS.

Other disinfection techniques such as boiling and the use of chlorine are not very frequent. The use of chlorine depends on its distribution by the Ministry of Health, which is sporadic at best. Boiling water is complicated and requires extra firewood, a spot on the hearth, and an extra pot, all of which are rare commodities. Oftentimes, the pot used normally for either coffee or beans is used, which alters the taste and coloring of the boiled water. Of those not using SODIS, 46% apply chlorine when it is available and only 4.9% boil some of their water.

Factors Predicting the Intention to Use SODIS

A multiple linear regression was carried out to identify the main factors that predict the intention to use SODIS in the future (see Table 1). The results showed that none of the items of convictions and beliefs and perceived behavioral control were significant. The overall attitude had the highest weight. Among the subjective norm items, only SODIS use by neighbors was significant. Even though only two factors were significant, this regression still explained 61% of the variance.

Table 2. Logistic Regression Analysis on Behavior (Solar Water Disinfection [SODIS] Use)

Variable	*B*	*SE B*	Exp (*β*)	*p*
Convictions and beliefs				
Connection diarrhea-water	–0.543	0.988	0.581	.583
Knowledge about SODIS	1.885	0.931	6.587	.043
Confidence in SODIS	2.092	1.261	8.103	.097
Value of clean water	0.775	1.680	2.170	.645
Attitude				
Overall attitude	4.628	2.084	102.355	.026
Subjective norm				
Perceived social pressure	–0.839	1.424	0.432	.555
Opinion of friends	–0.439	0.856	0.645	.608
SODIS use by neighbors	0.016	0.016	1.017	.301
Perceived behavioral control				
Bottle availability	0.822	1.125	2.276	.465
Constant	–16.435	7.753	0.000	.034

NOTE: Pseudo-R^2 (Nagelkerke) = .863, LR-χ^2 = 66.647 with *df* 9 ($p < .000$), $N = 64$ (missing listwise). $N = 64$ due to missing data. Constant indicates the value of the dependent variable if all independent variables are zero, the constant in the regression equation.

Factors Predicting Behavior

To predict the behavior, a logistic regression needed to be calculated given that the variable was binomial (user vs. nonuser). The results from the analysis, as shown in Table 2, indicated that among the convictions and beliefs items, knowledge about SODIS was significant, and confidence in SODIS showed a tendency to be significant. Also, overall attitude was a significant predictor of behavior. No items belonging to the subjective norm or perceived behavioral control factors showed a significant relation. A very high portion of the variance (86%) could be explained with the included factors.

No differences between SODIS users (US) and nonusers (NU) could be found regarding demographic factors such as age ($M_{NU} = 35.8$ and $M_{US} = 36.1$), number of completed school years ($M_{NU} = 2.9$ and $M_{US} = 3.0$), and family members ($M_{NU} = 5.5$ and $M_{US} = 5.8$).

As discrepancies between the two investigation areas could have influenced the means of the variables included in the analysis, they were tested for significant differences. The areas differed with respect to two variables, namely, perceived social pressure ($M_{PC} = 1.75$ and $M_{WS} = 1.10$, $t = 4.462$, $p < .001$) and intention to use SODIS in the future ($M_{PC} = 2.33$ and $M_{WS} = 1.83$, $t = 2.108$, $p < .04$). This means that in La Paz Centro, people felt a slightly higher social pressure toward the use of SODIS and that they intended to use SODIS in the future more than the people in Waslala.

No significant differences between the two areas could be found for the perceived connection between diarrhea and water ($M_{PC} = 1.8$ and $M_{WS} = 1.6$), knowledge about SODIS ($M_{PC} = 1.2$ and $M_{WS} = 1.2$), confidence in SODIS ($M_{PC} = 2.4$ and $M_{WS} = 2.2$), the value of clean water ($M_{PC} = 2.6$ and $M_{WS} = 2.7$), overall attitude ($M_{PC} = 1.4$ and $M_{WS} = 1.2$), the opinion of friends ($M_{PC} = 0.7$ and $M_{WS} = 0.8$), the use of SODIS by neighbors ($M_{PC} = 1.7$ and $M_{WS} = 1.8$), bottle availability ($M_{PC} = 1.2$ and $M_{WS} = 1.1$), and the reported incidence of diarrhea ($M_{PC} = 0.9$ and $M_{WS} = 0.9$).

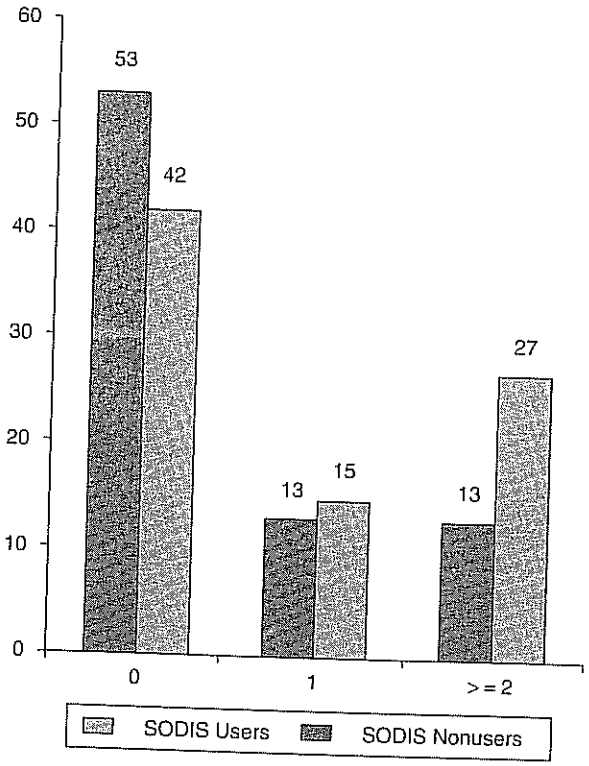

Figure 1. Frequencies of reported incidence of diarrhea ($N = 163$).

Reported Incidence of Diarrhea

Diarrhea can be one of the consequences of contaminated water, and the promotion of SODIS aims to reduce its incidence. Figure 1 shows the frequencies of reported incidence of diarrhea for users and nonusers of SODIS. It can be seen that more users reported no incidence of diarrhea in the last month than nonusers, whereas twice as many nonusers reported two or more incidences of diarrhea than users. A Pearson chi-square showed a significant difference between users and nonusers of SODIS, $\chi^2(2) = 6.169$, $p = .046$. Children are the most likely to suffer from diarrhea, and therefore it could be possible that families using SODIS have fewer children than nonusers, which could explain the lower incidence of diarrhea cases. However, no significant difference was found between users and nonusers regarding the number of children or their ages ($\lambda = -.086$, $p = .453$, $N = 79$).

DISCUSSION

The goal of this field study was to identify the factors related to the current and future use of SODIS to better understand what motivates a family to purify its drinking water with SODIS. Ajzen (1991) showed in an overview of 16 studies that perceived behavioral control is consistently linked to intention, but in this investigation, no such a relationship was found. In our study, only the attitude and subjective norms factors are

significant predictors of intention. The subjective norms factor may indicate a modeling effect of the neighbors' behavior. The lack of importance of perceived behavior control may be due to the fact that both users and nonusers concurred in their assessment of it. The availability of bottles, or the lack thereof, is for example assessed as equally low by users and nonusers. The evaluation that SODIS is easy to use, which is one of the advantages of the technology, is also similar in users and nonusers.

In the case of behavior, in other words putting SODIS into practice on a daily basis, the factors of convictions and beliefs and attitude are related. Understanding the functioning of SODIS, having confidence in this technique, and having a positive overall attitude are the most important variables when predicting the behavior. This indicates that SODIS users have a better knowledge of and confidence about the technology and that their attitude is more positive than that of nonusers. These results show that for any behavior to start, some knowledge about the technology, a certain confidence, and a positive attitude need to be present or else the person is unmotivated to initiate the new behavior. The predictive power of knowledge about SODIS may also be explained by the fact that users, by means of their experience with the technology, know more about it than nonusers, although some knowledge was most definitely present before the person became a user.

The data regarding the effects of the behavior are highly encouraging. It showed that families using SODIS reported fewer cases of diarrhea. This is even more positive as it was also established that most families still consume some contaminated water alongside that treated by SODIS. The results regarding the water consumption show clearly that more safe water would be produced if additional bottles were available. As the families rarely have enough resources to acquire bottles by themselves, the organizations promoting SODIS need to continue providing bottles. It can be expected that the effect of SODIS on the number of diarrhea cases would be stronger if no contaminated water was drunk in addition to the water treated with SODIS.

LIMITATIONS OF THE STUDY AND IMPLICATIONS FOR FUTURE INVESTIGATIONS

The practical assessment of some variables will need to be modified for future investigations. Attitude, confidence, and satisfaction appraise very similar concepts. It seems that these three questions measured some general positive attitude instead of three distinct concepts, and for future research these questions should be modified. Some other questions lacked adaptation in their form to the environment in which they were used. The question regarding perceived social pressure for example required users to imagine that they are not currently using SODIS. They then had to evaluate how much influence their neighbor's use of SODIS would have on them. The fact that they were already users may have influenced their answers, on top of the fact that this question was rather complicated.

In the present form, the factors taken into consideration explain a sizeable amount of the variance, although not all factors are significant predictors. It would certainly be interesting to obtain a larger and more varied sample to test the relationship between the different factors and intention and behavior. This would also make it possible to perform multilevel analyses, accounting for a structure in which individuals are nested in families, which are nested in communities.

Some of the factors also remain vague based on the data from only this study. In a future investigation it will be of great interest to determine what factors influence attitude

as it is the most important predictor of both intention and behavior. However, with regards to the question of influence, the cross-sectional nature of the present study only allows us to reflect on relationships between factors. To assess causal links, a longitudinal design of the same study would be necessary. A longitudinal approach would also be beneficial to obtain data on the sustainability of attitude as a motivator in the use of SODIS. A longitudinal approach would also make it possible to study how the social and cultural context on the family and community levels influences SODIS use, particularly with multilevel analyses. This would also enable us to take into account variability arising from the fact that different communities live in different areas and work with different organizations.

Finally, it should be noted that we have measured only the reported incidence of diarrhea and not the actual incidence. However, given the difficulties linked to this specific environment and the time at our disposal, these are the only data we could get. To obtain more accurate observational data would be very hard, but the quality of the survey data could be improved by interviewing individuals weekly or twice a week, provided that the interviewer was able to stay on site for quite a long period of time.

IMPLICATIONS FOR PRACTICE

This study leads to a number of interesting conclusions that could help improve future promotion activities of SODIS. Attitude has been shown to be the only common predictor for both intention and behavior. Knowledge about the functioning of SODIS in general is low, and the families often do not fully understand how SODIS works. They may therefore lack central processing of the information as described in the elaboration likelihood model by Petty and Cacioppo (1986) and are instead sensitive to peripheral stimuli when forming their attitude. In the case of SODIS, this might be a positive evaluation of those promoting it, and if this is so, special care should be taken when selecting a new promoter. Given that we only collected data on one occasion, it remains to be shown that attitude alone is a sufficient motivator for a sustainable use of SODIS. All the same, it will be beneficial for promotion activities to focus on forming a positive attitude as well as on choosing a promoter that will be well accepted in the community and who is able to create confidence in the new technology. According to applied behavior analysis (Graeff, Elder, & Booth, 1993), there are a number of ways to translate skills into action, and promoting a behavior with positive consequences is an important way. Given that the expected consequence of the use of SODIS, the reduction of diarrhea, is not easily observable by a user, other consequences and incentives—such as creating a sense of efficacy for the whole community—may also have to be considered in promotion activities.

CONCLUSIONS

In conclusion, SODIS is a technology that may have a positive effect on health, even if the measures used in the present study need improvement. By reducing the incidence of diarrhea in children, their chance of survival increases, and the standard of living is improved. Research based on social sciences can help to improve promotion efforts by explaining the underlying processes of decision making and information processing. A more effective promotion of a technology will then in turn also lead to fewer cases of diarrhea, which is after all, the goal of solar water disinfection.

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