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Factors Affecting the Diffusion of Solar Water Disinfection: A Field Study in Bolivia

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This study examines a broad array of theory-based factors derived from diffusion research that affect the current and intended use of solar water disinfection (SODIS), a simple, low-cost technology for treating drinking water at the household level. The perceived attributes of an innovation, the nature of the social system in which it is diffused, the extent of change agents' promotional efforts in diffusing it, and the nature of the communication channels used were operationalized by 16 variables. The aim of the study is to determine the influence of each factor and its predictive power. Eight areas in Bolivia were visited, and 644 families were interviewed on the basis of a structured questionnaire. Simultaneous multiple regression analysis showed that 9 of the 16 factors derived from diffusion research contributed significantly to predicting the current use of SODIS. The implications of the findings for customizing future SODIS diffusion activities are outlined.

Keywords: *diffusion of innovations; dissemination; solar water disinfection; safe drinking water; adoption; health behavior*

The World Health Organization (2005) estimates that 1.1 billion people, representing 17% of the global population, currently lack access to improved water sources. The dramatic consequences are that 1.8 million die every year from diarrheal diseases, 90% of them children under 5 years of age, mostly in developing countries (Kosek, Bern, & Guerrant, 2003). Eighty-eight percent of diarrheal disease is attributed to unsafe water supplies, inadequate sanitation, and hygiene. Universal access to safe water and sanitation is an essential step in reducing this burden of preventable disease.

Solar water disinfection (SODIS) is a simple, low-cost technology designed to improve the microbiological quality of drinking water through solar radiation and thermal treatment. Contaminated water is filled into transparent polyethylene terephthalate (PET) bottles and exposed to full sunlight for 6 hr (or for 2 consecutive days if the sky is more than 50% cloudy). Sunlight inactivates and destroys pathogenic micro-organisms that cause waterborne diseases through two synergetic mechanisms, namely, radiation

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in the UV-A spectrum (wavelength 320-400 nm) and increased water temperature (Meierhofer & Wegelin, 2002). Several studies under laboratory and field conditions demonstrated the effectiveness of the SODIS method (e.g., Rose et al., 2006).

The theory of the diffusion of innovations (E. M. Rogers, 2003) has been used to study the spread of new ideas and practices in a wide variety of settings, among them various health promotion programs (e.g., Ferrence, 2001; Finney, Nelson, & Meissner, 2004). As preventive health innovations such as SODIS tend to diffuse relatively slowly (E. M. Rogers, 2002), we believe that SODIS is a good example to advance research on the diffusion of preventive innovations.

THEORY OF DIFFUSION OF INNOVATIONS AND ITS APPLICATION TO SODIS

E. M. Rogers (2003) posits that the adoption of an innovation is affected by (a) the perceived attributes of the innovation, (b) the type of innovation decision, (c) the nature of the social system in which the innovation is diffused, (d) the extent of change agents' promotional efforts in diffusing the innovation, and (e) the nature of the communication channels used. Theses five types of variables that determine the adoption of an innovation have not received equal attention from diffusion scholars. The perceived attributes of an innovation have been most extensively investigated (e.g., Moore & Benbasat, 1991). However, as Rogers notes, little research (e.g., Völlink, Meertens, & Midden, 2002) has been conducted to determine the relative contribution of each of the five types of variables. With the exception of the type of innovation decision, which is inapplicable to this study because SODIS is a household water-treatment technology and therefore its adoption is defined to occur at the household level, we now describe the factors we derived as possible determinants of the current and intended use of SODIS.

Attributes of the Innovation

The first factor, namely, the attributes of the innovation, is the most widely studied. Five attributes have been found to explain between 49% and 87% of the variance in the rate of adoption of innovations. These are (a) the relative advantage of the innovation over the idea it supersedes; (b) compatibility with the existing values, past experience, and needs of the receivers; (c) complexity, or the degree to which the innovation is perceived as difficult to understand and use; (d) trialability, or the degree to which an innovation can be tested for effectiveness on a cost or scope-limited basis; and (e) observability of the outcome of the innovation (E. M. Rogers, 2003).

The relative advantage is the degree to which an innovation is perceived to be better than the idea that it supersedes. With regard to SODIS, the greater safety of the drinking water is the most obvious relative advantage that may be perceived by potential adopters. Furthermore, cost savings (e.g., compared to the costs of boiling water) and the better taste of the SODIS-treated water sometimes reported may also be perceived as relative advantages. The latter is due to the unchanged level of oxygen dissolved in the water compared to its decrease during the boiling process. Therefore, the more a person perceives the relative advantages of SODIS as measured in (a) cost savings, (b) better taste, and (c) greater safety of the drinking water, the more he or she may be inclined to use or intend to use SODIS in the future.

Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters. Compatibility was conceptualized on four dimensions: (a) the compatibility of the application of SODIS with daily tasks and habits, (b) cognitive beliefs regarding SODIS, (c) affective beliefs regarding SODIS, and (d) the perceived threat of diarrhea. In accordance with the findings of Trafimow and Sheeran (1998) indicating that items measuring affective and cognitive beliefs regarding behaviors loaded on separate dimensions, we drew a distinction between cognitive and affective beliefs about SODIS. The cognitive dimension evaluated the confidence that is placed in the SODIS technology as a safe drinking-water treatment, whereas the affective belief evaluated whether the use of SODIS is perceived as pleasant or unpleasant. To assess to what degree diarrhea is perceived as a health threat in the cultural context of our sample, two variables forming the perceived threat of diarrhea from the protection motivation theory (R. W. Rogers, 1983) were recorded. These were estimates of the chance of contracting diarrhea (i.e., perceived vulnerability) and estimates of the seriousness of diarrhea (i.e., perceived severity). Hence, it is hypothesized that the more a person perceives the compatibility of SODIS as measured in (a) compatibility with daily tasks and habits, (b) confidence in the technology (i.e., cognitive beliefs), (c) the degree to which the application of SODIS is perceived as pleasurable (i.e., affective beliefs), and (d) the perceived threat of diarrhea, the more he or she may be inclined to use or intend to use SODIS in the future.

Complexity is the degree to which an innovation is perceived as being relatively difficult to understand and use. Any new idea is classified by its potential adopters on a complexity–simplicity continuum (E. M. Rogers, 2003). Given the simplicity of SODIS, complexity may not be as important as the other attributes, although perceived difficulty can be a strong barrier to the adoption of an innovation. Therefore, it is hypothesized that the more a person perceives SODIS as difficult to understand and use, the less that person may be inclined to use or intend to use SODIS in the future.

Trialability is the degree to which an innovation may be experimented with on a limited basis. The personal trial of an innovation is one way for an individual to give it meaning and find out how it works under his or her own conditions. Minimal resources are needed for the correct application of SODIS. To experience a reduction in the diarrhea rate, however, it is crucial for the trial phase to be sustained for an extended time period. We therefore measured the trialability by means of the perceived availability of the resources necessary to apply SODIS on a regular basis. These are essentially the sufficient availability of sunny surfaces to place the bottles, sufficiently clear water, and an adequate supply of transparent PET bottles to treat as much water with SODIS as needed. Thus, it is hypothesized that the more a person perceives the sufficient availability of the resources essential to try SODIS for an extended period as measured in (a) sunny surfaces, (b) clear water, and (c) PET bottles, the more that person may be inclined to use or intend to use SODIS in the future.

Observability is the degree to which the results of an innovation are easily observed by and communicated to other people. Preventive innovations (such as SODIS), defined as new ideas that an individual adopts now in order to reduce the probability of some unwanted future event, sometimes have a particularly slow rate of adoption because individuals have difficulties in perceiving their observability (E. M. Rogers, 2002, 2003). Adoption by an individual now may prevent getting diarrhea at some future time. But the individual might not have contracted diarrhea even without adopting SODIS. Hence, not only are the rewards of adoption delayed in time, but it is uncertain as to whether they are really essential. An unwanted event that is avoided by adopting a preventive innovation is difficult to perceive because it is a nonevent—the absence of something that might otherwise have happened (cf. Singhal & Rogers, 2003). Hence, it is hypothesized that the more a person perceives the observability of the results of SODIS as measured in a subjective reduction of diarrhea episodes, the more that person may be inclined to use or intend to use SODIS in the future.

Social System

Diffusion occurs within a social system. A system's norms can facilitate or impede the diffusion of innovations. When considering the normative influence from the social system on behavior, it is crucial to differentiate between injunctive norms that specify what ought to be done and descriptive norms that specify what is actually done (Cialdini, Reno, & Kallgren, 1990). The injunctive meaning of norms refers to rules or beliefs about what constitutes morally approved and disapproved conduct. A descriptive norm describes what is typical or normal. It is what most people do, and it motivates people by providing evidence as to what is likely to be effective and adaptive action. Thus, it is hypothesized that the more strongly a person perceives the injunctive and descriptive norms to be in favor of SODIS, the more that person may be inclined to use or intend to use SODIS in the future.

Extent of Change Agents' Promotion Efforts and Communication Channels

The adoption of an innovation is also affected by the extent of the promotional efforts by change agents. A change agent is an individual who influences clients' innovation decisions in a direction deemed desirable by a change agency (E. M. Rogers, 2003). Three different types of communication channels for the promotional strategies of change agents were used in our investigation areas. The first of these were household visits performed by staff of the SODIS Foundation, staff of partner nongovernmental organizations (NGOs), local authorities, or volunteers of the local health center. A second group consisted of official events such as health fairs, presentations in community assemblies, women's groups or mothers' centers, and activities in schools. The third approach was the use of mass media such as radio or television transmissions, advertisements in newspapers or posters, and the distribution of promotional materials such as stickers and calendars. We hypothesized a positive relationship between the number of strategies in which people actively participated and the current use and intended use of SODIS.

Percentage of Safe Drinking Water in Total Consumption of Liquids Not Treated With SODIS

The main criterion for judging the relative success of the diffusion of an innovation is the rate of its adoption actually achieved. As regards the effectiveness of the change agency and its measurement, it is important to note that SODIS is introduced as a complementary water purification technology replacing raw water consumption. Thus, the aim of its implementation is defined as creating a large number of SODIS users without rejecting existing water disinfection habits (Soto, 2004). To take this implementation message into consideration, it was essential to introduce a factor that monitored the percentage of safe drinking water in the total consumption of liquids not treated with SODIS but with another water treatment method or bought bottled in a store and thus regarded as safe. Therefore, it is hypothesized that the higher a person's percentage of consumption of safe drinking water not treated with SODIS (e.g., by boiling, buying drinks), the less that person may be inclined to use SODIS or intend to use it in the future.

Current Use of SODIS and the Intention to Use It in the Future

The adoption of SODIS as an innovation is conceptualized as the current use of SODIS-treated drinking water. Moreover, the intention to use SODIS in the future was taken as a discrete variable with the aim of exploring the determinants of its continued use. Behavioral intentions are seen as a key element in many health behavior models. Several of these theories—for example, the theory of planned behavior (Ajzen, 1991)—postulate a strong relationship between intention and behavior, such that intention is the strongest predictor of behavior. Most empirical studies based on these theories therefore measure the intention of behavior, but not both factors (e.g., Armitage & Conner, 2001). Instead, intentions often serve as a proxy for behavior. Although intentions do correlate highly with behaviors (Ajzen, 1991), the fundamental point remains that intentions do not always translate into health behaviors (e.g., Johnston & White, 2003).

Because only one visit to each of the 644 households was scheduled in this project, we had to evaluate current behavior and intentions regarding future behavior at the same point in time. Consequently, the intention did not affect the evaluated behavior. However, the intention to use SODIS in the future was judged to be the best measure available to understand the acceptability of its long-term use and to improve ways of promoting it.

The aim of this study is to determine the predictive power of each of these variables derived from diffusion research in a large and varied sample from eight areas of Bolivia. This theory-guided approach could provide a framework for developing theory-based SODIS-diffusion programs that address relevant predictors.

METHOD

Participants and Procedures

Participants (N = 644) were from eight areas of Bolivia selected for this study because of their diversity. Criteria were different geographical conditions (highlands, valley, and lowlands), different levels of urbanization (peri-urban, rural), the duration of the projects, and different implementing agencies (NGOs, government entities). The areas finally selected according to these criteria were Alto Sebastian Pagador, Tiraque, Yapacaní, Potosí (San Pedro), Potosí (San Gerardo), Uncía/Llallagua, Caripuyo, and Villa Tunari.

A team of Bolivian interviewers collected the data through structured interviews in July and August of 2004. The team was trained and supervised by the first author of this study, Moser (2005), and a Bolivian master's student together with professionals from Fundación SODIS. To exclude cultural and linguistic misunderstandings, the questionnaire was revised by professionals of Fundación SODIS, a Bolivian master's student, and the interview team, who also jointly translated the questionnaire from Spanish into Quechua. The applicability of the questionnaire as well as the interviewers' performance after a 1-week training course were tested in a pretest. In examining possible indigenous health concepts and beliefs that might pose a barrier for the incorporation of the technology, we found that 88% of the participants believed water to be a cause of diarrhea. Hence, the acceptance and understanding of biomedical concepts appeared not to be a key obstacle to the diffusion of SODIS, and we therefore focused on the diffusion of innovation factors to explain the adoption of SODIS.

In rural communities, all households willing to participate were interviewed. In peri-urban and urban areas, participants were selected by the random-route method (Hoffmeyer-Zlotnik, 1997). Streets within neighborhoods were randomly sampled, and every third house on the sampled streets was approached. The arrival of the interviewer team in the respective investigation areas was preceded by arrangements with the local partner organizations and authorities to facilitate the first contact with the households and to provide local guidance to reach the communities, which were often in remote areas. This cooperation proved very useful in gaining the confidence and willingness to participate of the households, resulting in a response rate of more than 90% of those approached. Consent was obtained before starting the interview. After the conclusion of the interview, each participating household was offered a small gift pack consisting of cooking oil, rice, and soap.

Interviews were held with the person responsible for drinking water in the respective household; this person was female in 80% of the interviews. According to the participants' preferences, interviews were conducted in Spanish (53%) or Quechua (47%). The mean age of the adult persons living in the interviewed households was 35.9 years (*SD* = 11.2), and the mean number of years of education was 5.3 (*SD* = 3.5), with a higher average in the urban and peri-urban areas (*M* = 7.2, *SD* = 3.7) than in the rural ones (*M* = 4.1, *SD* = 2.8). The average household size was 5.1 (*SD* = 2.5) persons, and the mean number of children under the age of 5 per household was 0.9 (*SD* = 1.2). The water source was piped water into the dwelling, yard, or plot in 61% of the households interviewed, whereas 23% obtained their drinking water from wells, 4% obtained their drinking water from rivers or streams, and 12% had water delivered to them by tanker trucks.

Questionnaire

The questionnaire was designed to measure the various factors to be examined. Except for three variables calculated in percentages, all variables used Likert-type formats (e.g., *very safe* to *very unsafe*). The interviewer had to ask the questions openly and mark the answer category that best fitted the given response. In cases of ambiguity in assigning the answer to the respective Likert-type scale, the interviewers were trained to clarify their questions and ask them again to get the most accurate answer possible. As Likert-type scales with different numbers of categories had been applied, all items were *z* transformed.

E. M. Rogers (2003) emphasized that the specific ways in which the five attributes of the innovation are expressed differ in each study and that these attributes should therefore be uniquely created afresh in each investigation in preference to utilizing existing scales borrowed from previous investigations. The relative advantage of SODIS was measured on the three dimensions of cost savings, taste of the water, and greater water safety. Participants had to assess untreated, SODIS-treated, and boiled water on a scale from 1 (*not cost-saving/safe/tasty*) to 3 (*very cost-saving/safe/tasty*).

To measure the compatibility of the application of SODIS with daily tasks and habits, participants were asked to what extent the application of SODIS fits smoothly into their usual day-to-day habits, and their answers were categorized ranging from 1 (*lowest compatibility*) to 7 (*highest compatibility*). Cognitive beliefs about SODIS were recorded by asking to what extent participants were confident that the SODIS-treated water is safe to drink. Answers were marked on a scale from 1 (*no confidence, completely unsafe*) to 4 (*full confidence, completely safe*). Affective beliefs were operationalized by inquiring whether the application of SODIS is perceived as enjoyable or disturbing; answers were marked from 1 (*not enjoyable at all*) to 7 (*very enjoyable*). The perceived health threat of diarrhea is an additive combination (R. W. Rogers, 1983) formed by perceived vulnerability and perceived severity. The vulnerability to diarrhea was assessed by asking about the participants' perceived likelihood of contracting diarrhea when drinking untreated water, and the answers were categorized from 1 (*very unlikely*) to 7 (*very likely*). To assess the perceived severity of diarrhea, participants were asked to what extent they perceived their health to be affected when they suffered from diarrhea, and their answers were ranged from 1 (*not severe at all*) to 5 (*very severe*). Items were *z* transformed before being combined additively into the perceived threat of diarrhea as described in the theory section.

The complexity was measured by asking whether participants perceived the correct application of SODIS as difficult. The answers were categorized from 1 (*not difficult at all*) to 4 (*very difficult*). To assess the trialability, the perceived availability of the resources necessary to use SODIS for a sustained period of time was recorded. The participants were asked whether they felt that they had sufficient sunny surfaces, clear water, and transparent PET bottles at their disposal to prepare as much SODIS-treated water as they needed or whether the availability of resources was a barrier to the application of SODIS. The availability of sunny surfaces, sufficiently clear water, and enough transparent PET bottles was ranged from 1 (*not available at all*) to 4 (*abundantly available*) in each case. The subjective observability of the results of SODIS was measured with the question as to whether the participants had noticed a reduction in diarrhea episodes when consuming SODIS-treated water. The answers were marked from 1 (*no reduction at all*) to 4 (*very considerable reduction*).

The injunctive norm was operationalized following Ajzen's (1991) expectancy-value structure. The expectance of what a person's social network wants a particular person to do is multiplied by that person's motivation to comply with that expectation. The perceived expectations of the participants' social network were recorded by asking whether and, if yes, how often participants were told to treat their drinking water. The answers were marked from 1 (*had never been told to do so*) to 5 (*are told to do so all the time*). The motivation to comply was assessed by the participants' estimation of the degree to which they felt motivated to comply when their social network requested them to use SODIS. The answer categories ranged from 1 (*decision not at all influenced*) to 5 (*decision very much influenced*).

To assess the descriptive norm, the perception of whether the participants' social network used SODIS was recorded. First, participants had to list the names of all the people with whom they had talked in the week preceding the interview. Then, it was asked for each of the listed names whether the participants could recognize the respective person to be a SODIS user. The descriptive norm was calculated as the percentage of people known to be SODIS users from the total number of names listed.

The factor of the extent of change agents' promotional efforts was quantified by recording the number of times the interviewed person had received household visits, attended official events, and followed mass-media broadcasts. The number of promotional activities attended for each of these three communication channels then were added up to obtain a measure for the extent of the diffusion efforts undertaken by change agents.

To calculate the percentage of safe drinking water in the total liquids consumed that were not treated with SODIS, the amount of untreated, boiled, SODIS-treated, filtered, or chlorinated water as well as the amount of bought bottled drinks consumed throughout an average day were recorded. Except for the untreated water, all of these were considered to be safe drinking water. The percentage was then formed by deducting the amount of SODIS-treated and untreated water from the total amount of liquids consumed in an average day.

To assess the intention to use SODIS in the future, participants were asked how much water they intended to treat with SODIS in the future. The answers ranged from 1 (*no water at all*) to 5 (*as much water as possible*).

The dependent variable for the current use of SODIS was quantified in terms of the percentage of SODIS-treated water in the total liquids consumed. The consumption patterns of liquids consumed throughout an average day were recorded in detail in the first section of the questionnaire. This section provided data on current SODIS-related behavior, including the percentage of SODIS-treated water in the total liquids consumed.

RESULTS

General Data on Water Consumption

Sixty percent of the interviewed households stated that they used SODIS, and 13% of them knew about the technology but had not yet used it, whereas 17% of them had never heard about the technology. Ten percent stated that they had used SODIS but had since abandoned it.

For the complete sample ($N = 644$), the amount of water treated with SODIS averaged 33% of the total liquids consumed. Boiled water accounted for 45%, on average, making it the most widely consumed liquid. Bought drinks made up only a small fraction, 3%, of the total liquids consumed, with 19% of all consumed liquids being untreated water. Most of the boiled water is consumed in the morning hours when people like to prepare a hot tea, coffee, or soup. In contrast, SODIS-treated water is mainly consumed in the afternoons, when people like to carry a bottle of SODIS-treated water with them, as it is easy to transport.

Households that reported being SODIS users had an average of 2.5 bottles placed outside for SODIS treatment at the time of the interview, corresponding to 0.6 bottles per person. Apart from counting the bottles put outside for SODIS treatment, their correct condition was assessed. Nine percent of the bottles and their caps were found to be dirty and 12% not fully transparent. The water used for SODIS was judged to be cloudy in 2% of the bottles, and 8% of the bottles were placed in the shade. Moreover, 30% of the households used bottles larger than 3 L, at least to some extent. These large bottles were widespread because bottled water is usually sold in large units such as 5 or 10 L. However, their use is not recommended because the intensity of UV radiation is reduced at increasing water depth. The containers used for SODIS should be as flat as possible, with a water depth of less than 10 cm (Wegelin et al., 1994).

Descriptive Statistics

The means and standard deviations of the variables derived from the theory of diffusion of innovations are shown in Table 1. The part of the questionnaire where these variables were recorded was applicable only to participants who had already heard about SODIS ($n = 536$), irrespective of whether they had never used it, were current SODIS users, or had abandoned its use.

Table 1. Means and Standard Deviations for Independent and Dependent Variables (n = 536)

Variable	*M*	*SD*
I. Attributes of the innovation		
1. Relative advantage		
Cost savings (1 = *not cost-saving*; 3 = *very cost-saving*)	2.45	0.61
Taste of water (1 = *not tasty*; 3 = *very tasty*)	2.69	0.63
Safety of water (1 = *not safe*; 3 = *very safe*)	2.75	0.57
2. Compatibility		
Daily tasks and habits (1 = *lowest compatibility*; 7 = *highest compatibility*)	5.73	1.73
Threat of diarrhea		
Vulnerability (1 = *very low*; 7 = *very high*)	5.39	1.48
Severity of diarrhea (1 = *not severe at all*; 5 = *very severe*)	3.91	1.28
Affective beliefs (1 = *not enjoyable at all*; 7 = *very enjoyable*)	6.12	1.28
Cognitive beliefs (1 = *no confidence in SODIS*; 4 = *full confidence in SODIS*)	3.55	0.80
3. Complexity		
Perceived difficulty (1 = *not difficult at all*; 4 = *very difficult*)	1.13	0.51
4. Trialability		
Sunny surfaces (1 = *not available at all*; 4 = *abundantly available*)	3.81	0.47
Clear water (1 = *not available at all*; 4 = *abundantly available*)	3.89	0.38
Transparent bottles (1 = *not available at all*; 4 = *abundantly available*)	3.25	0.89
5. Observability		
Experience of reduction in diarrhea episodes (1 = *no reduction at all*; 4 = *very considerable reduction*)	3.48	0.72
II. Social system		
Injunctive norm		
Perceived expectations of social network (1 = *were never told to treat drinking water*; 5 = *are told to do so all the time*)	3.28	1.03
Motivation to comply with social network (1 = *very low*; 5 = *very high*)	2.03	0.94
Descriptive norm (percentage of SODIS users in personal communication network)	49	43
III. Extent of promotion efforts		
Number of strategies in which participated	0.95	0.47
IV. Total consumption of safe water		
Percentage of safe drinking water in total liquids consumed without SODIS	47	30
V. Percentage of SODIS water in total liquids consumed	39	33
VI. Intention to use SODIS in the future (1 = *no water*; 5 = *as much as possible*)	4.63	0.77

NOTE: SODIS = solar water disinfection.

The relative advantage of SODIS in terms of cost savings (*M* = 2.45, *SD* = .61), taste of water (*M* = 2.69, *SD* = .63), and greater safety of the drinking water (*M* = 2.75, *SD* = .57) reached quite high means on a 3-point Likert-type scale, indicating that all three measured dimensions were indeed considered to be advantageous by our sample.

Compatibility with daily tasks and habits reached a mean of 5.73 (*SD* = 1.73) on a 7-point Likert-type scale, indicating that the application of SODIS is perceived to be highly compatible with the day-to-day routine of our sample. A mean of 5.39 (*SD* = 1.48) was obtained for the perceived vulnerability to contracting diarrhea, which reflects that the likelihood of getting diarrhea is perceived as quite severe but not very high. Likewise, the severity of diarrhea with a mean of 3.91 (*SD* = 1.28) on a 5-point scale indicates that this illness is perceived as being quite severe but not very severe.

Affective beliefs reached a mean of 6.12 (*SD* = 1.28) on a 7-point Likert-type scale, indicating that the technology of treating drinking water with SODIS is regarded as enjoyable. Cognitive beliefs about SODIS reached a mean of 3.55 (*SD* = .80) on a 4-point Likert-type scale, reflecting that people in our sample have high confidence in the technology. The perceived difficulty reached a mean of 1.13 (*SD* = .51) on a 4-point Likert-type scale, showing that the correct application of SODIS is perceived to be not at all difficult. The availability of enough sunny surfaces (*M* = 3.81, *SD* = .47) and clear water (*M* = 3.89, *SD* = .38) did not impose serious constraints on the maximum possible amount of water treatable with SODIS. However, the availability of transparent PET bottles, with a mean of 3.25 (*SD* = .89) on a 4-point Likert-type scale, indicates that they were a more scarce resource. The self-reported perceived reduction in diarrhea episodes while using SODIS reached a mean of 3.48 (*SD* = .72) on a 4-point Likert-type scale, indicating that a considerable reduction of diarrhea was perceived by our sample.

With a mean of 3.28 (*SD* = 1.03) on a 5-point Likert scale, the perceived expectations of the social network scored rather low, indicating that the people in our sample were not told frequently to purify their drinking water. The motivation to comply with the perceived expectations of the social network scored even lower (*M* = 2.03, *SD* = .94), reflecting a low motivation to comply with the perceived expectations of the respective social network. The descriptive norm indicated that, on average, 49% of the personal communication network were known to be SODIS users (*SD* = .43); that is almost half the network.

The mean of the total number of strategies used was .95 (*SD* = .47), which means that the people in our sample participated in an average of one diffusion strategy. For the segment of the total sample that had already heard about SODIS (*n* = 536), the mean percentage of SODIS-treated water in the total amount of liquids consumed was 39% (*SD* = .33). In addition, the participants consumed an average of 47% (*SD* = .30) of water rendered safe by other means (e.g., boiled water, bought drinks). The intention to use SODIS in the future reached a mean of 4.63 (*SD* = .77) on a 5-point Likert scale, indicating that participants intend to treat a high average percentage of their drinking water with SODIS in the future.

Descriptive Statistics for Different SODIS User Groups

Factors Predicting the Percentage of SODIS-Treated Water in the Total Liquids Consumed. A simultaneous multiple regression analysis was performed on the percentage of SODIS-treated water in the total amount of liquids consumed as the dependent variable and the independent variables (IVs) derived from diffusion research.

Table 2 shows the correlations between the IVs and the dependent variable (*r*), the unstandardized regression coefficients (*B*), the standardized regression coefficients (β), and the variance explained by all predictors adjusted for their number ($R^2_{adjusted}$). The regression *R* was significantly different from 0, $F(16, 519) = 74.54$, $p < .001$. The assumptions of normality, linearity, and homoscedasticity of residuals as well as independence of errors were deemed to be justified.

Of the 16 IVs, 9 contributed significantly to predicting the percentage of SODIS-treated water in the total amount of consumed liquids. The highest standardized regression coefficient (β = –.547, $p < .001$) was reached by the percentage of safe drinking

Table 2. Correlations and Summary of Simultaneous Multiple Regression Analysis for Variables Predicting the Percentage of SODIS-Treated Water in the Total Amount of Consumed Liquids (n = 536)

Variable	*R*	*B*	*SE B*	β
I. Attributes of the innovation				
1. Relative advantage				
Cost savings	.322***	.084	.032	.083**
Taste of water	.451***	.100	.041	.098*
Safety of water	.407***	.039	.040	.038
2. Compatibility				
Daily tasks and habits	.551***	.167	.039	.165***
Threat of diarrhea	.255***	.100	.026	.101***
Affective beliefs	.470***	–.042	.041	–.042
Cognitive beliefs	.452***	.035	.040	.035
3. Complexity				
Perceived difficulty	–.055	–.023	.030	–.019
4. Trialability				
Sunny surfaces	.148***	.036	.029	.033
Clear water	.072*	.065	.026	.062*
Transparent PET bottles	.235***	.099	.027	.101***
5. Observability				
Experience of reduction in diarrhea episodes	.248***	–.021	.031	–.020
II. Social system				
Injunctive norm	.155***	.033	.026	.032
Descriptive norm	.471***	.122	.029	.123***
III. Extent of promotional efforts				
Number of strategies in which participated	.355***	.068	.028	.067*
IV. Total consumption of safe water				
Percentage of safe drinking water without SODIS	–.697***	–.540	.027	–.547***
Constant (p = .000)		.144	.025	

NOTE: SODIS = solar water disinfection. $R^2_{\text{adjusted}} = .69$, $p < .001$.
*$p < .05$. **$p < .01$. ***$p < .001$.

water not treated with SODIS in the total liquids consumed, confirming the inverse relationship hypothesized. This result indicates that the share of SODIS-treated water drops by about half a percent ($B = –0.54$) for each percentage of safe water already consumed without SODIS.

A beta weight of .165 ($p < .001$) resulted for the compatibility with daily tasks and habits, thus confirming the hypothesized relationship. Further variables that contributed significantly to the regression were (a) the descriptive norm, (b) the perceived threat of diarrhea, (c) the sufficient availability of PET bottles, (d) the cost savings, (e) the better taste of SODIS-treated water, (f) the total number of strategies participated in, and (g) the availability of sufficiently clear water, all of which confirmed the respective hypothesized relationship.

Although there were significant correlations between the dependent variable and (a) the greater safety of SODIS-treated water, (b) the affective beliefs about SODIS, (c) the cognitive beliefs about SODIS, (d) the availability of sunny surfaces, (e) the perceived experience of reduction in diarrhea episodes, and (f) the injunctive norm, these variables

Table 3. Correlations and Summary of Simultaneous Multiple Regression Analysis for Variables Predicting the Intention to Use SODIS in the Future (n = 536)

Variable	r	B	$SE\ B$	β
I. Attributes of the innovation				
1. Relative advantage				
Cost savings	.378***	.082	.040	.081*
Taste of water	.468***	.103	.050	.102*
Safety of water	.435***	.014	.050	.014
2. Compatibility				
Daily tasks and habits	.610***	.179	.048	.177***
Threat of diarrhea	.176***	.016	.033	.016
Affective beliefs	.635***	.211	.050	.211***
Cognitive beliefs	.605***	.132	.050	.132**
3. Complexity				
Perceived difficulty	–.056	–.060	.037	–.050
4. Trialability				
Sunny surfaces	.252***	.098	.036	.090**
Clear water	.041	–.026	.032	–.025
Transparent PET bottles	.332***	.077	.033	.079*
5. Observability				
Experience of reduction in diarrhea episodes	.400***	.079	.038	.075*
II. Social system				
Injunctive norm	.230***	.087	.032	.087**
Descriptive norm	.294***	–.040	.036	–.040
III. Extent of promotion efforts				
Number of strategies in which participated	.196***	.021	.034	.021
IV. Total consumption of safe water				
Percentage of safe drinking water without SODIS	–.292***	–.097	.033	–.099**
Constant (p = .720)		–.011	0.31	

NOTE: SODIS = solar water disinfection. $R^2_{adjusted}$ = .52, p < .001.
*p < .05. **p < .01. ***p < .001.

did not contribute significantly to the regression. The relationship between those 6 IVs and the dependent variable is apparently mediated by the other IVs in the regression. The perceived difficulty of the technology was the only variable that neither correlated significantly with the dependent variable nor contributed significantly to the regression. Altogether, 69% of the variability in the percentage of SODIS-treated water in the total amount of liquids consumed was predicted by these 16 IVs.

Factors Predicting the Intention to Use SODIS in the Future. A simultaneous multiple regression analysis was conducted to identify the variables that predict the intention to use SODIS in the future. Table 3 shows the correlations between the IVs and the dependent variable (r), the unstandardized regression coefficients (B), the standardized regression coefficients (β), and the variance explained by all predictors adjusted for their number ($R^2_{adjusted}$). The regression R was significantly different from 0, $F(16, 519)$ = 36.73, p < .001. The assumptions of normality, linearity, and homoscedasticity of residuals as well as independence of errors were deemed to be justified.

Of the 16 IVs, 10 contributed significantly to predicting the intention to use SODIS in the future. The highest standardized partial regression coefficient (β = .211, p < .001) was reached by the affective beliefs toward SODIS, confirming the hypothesized relationship. A beta weight of .177 ($p < .001$) was found for the compatibility with daily tasks and habits, whereas that for the cognitive beliefs was .132 ($p < .01$), both confirming the hypothesized relationships.

Further variables that contributed significantly to the regression were (a) the better taste of SODIS, (b) the percentage of safe drinking water except the SODIS-treated water in the total liquids consumed, (c) the availability of sunny surfaces, (d) the injunctive norm toward SODIS, (e) the cost savings, (f) the availability of transparent PET bottles, and (g) the perceived reduction in diarrhea episodes, all confirming their respective hypothesized relationships.

In total, 52% of the variability in the intention to use SODIS in the future was predicted by these 16 IVs. Although there were significant correlations between the intention to use SODIS in the future and the better safety of SODIS-treated water as well as the perceived threat of diarrhea, neither of these contributed significantly to the regression. The relationship between these two variables may be mediated by the other IVs in the regression. The perceived difficulty of the technology was the only variable that neither correlated significantly with the dependent variable nor contributed significantly to the regression.

DISCUSSION

Results and Implications for Intervention

The main purpose of this study was to assess the capability of the variables derived from E. M. Rogers's (2003) theory of diffusion of innovations to predict the current and intended use of SODIS. The results of the simultaneous multiple regression models predicting its current and intended use generally confirmed the hypothesized relationships between dependent variables and IVs. By clarifying the most critical theory-based determinants of the current and intended use of SODIS, the results may guide the development of more effective diffusion strategies.

With respect to the role of the perceived relative advantage over the superseded method, it is noteworthy that the current and intended use of SODIS was predicted mainly not by the perceived better safety of the drinking water but by the reduced costs and perceived better taste of the water. This suggests the assumption that the relationship between the perceived better safety and the dependent variables is mediated by other variables in the regression.

To increase the perceived relative advantage of a preventive innovation, we need to stress any aspect possibly constituting a relative advantage (E. M. Rogers, 2003). With regard to SODIS, we anticipated such aspects to be the lower costs compared to boiling water and the occasionally reported better taste of the SODIS-treated water. In particular, complex relative advantages need to be elaborated. With regard to SODIS, several financial advantages could be meaningful for users, not only the more obvious ones such as lower expenses for traditional energy sources used for boiling water but also the resulting higher productivity and lower expenditure for medical care as a result of improved health.

The importance of the perceived compatibility with daily tasks and habits is highlighted by the fact that for both dependent variables this predictor proved to be the second largest standardized partial regression coefficient. We therefore recommend that careful attention be paid to the full incorporation of SODIS in the daily household routine. Teaching about SODIS and delivering bottles is not sufficient; the reorganization of water preparation and consumption also needs to be addressed. Other factors that can seriously hinder the full incorporation of SODIS in the daily household routine are a lack of resources or unfavorable climatic conditions (Moser, Heri, & Mosler, 2005). For instance, insufficiently clear water or a lack of transparent PET bottles can hinder people from using SODIS on a daily basis. Solutions are available, however, such as the filtration of water that is too turbid for SODIS and setting up a supply scheme for transparent PET bottles. Other factors are harder to overcome, such as climatic conditions like the rainy season in the inter-Andean valleys that limits the possibility of using SODIS continuously throughout the year. Under these climatic conditions, SODIS should be introduced alongside the collection of rain water from a clean area (e.g., from a corrugated or tiled roof) and/or by using an alternative method of water treatment. Even though SODIS is a simple water-treatment method, changing ingrained habits can prove to be a difficult and prolonged task. Some kind of regular follow-up action is therefore indispensable for any SODIS diffusion program.

The perceived threat of diarrhea contributed significantly to the current use of SODIS but not to the intention to use it in the future. One explanation of this difference in line with R. W. Rogers's (1983) protection motivation theory is that higher threat appraisals combined with a message that contains reassuring behavioral advice will increase the likelihood of following the advised behavior. Therefore, after the appraisal process in which the behavioral options to diminish the threat are evaluated, higher levels of threat appraisal can eventually result in higher percentages of SODIS-treated water in the total liquids consumed. For the intention to use SODIS in the future, the standardized partial regression coefficient of the threat of diarrhea is near zero and insignificant. However, as Paz, Soto, and Zevallos (2003) stress, the local epidemiological profile does not recognize diarrheal diseases as a major health priority. Thus, this result might not reflect the unimportance of the perceived threat of diarrhea on forming intentions but rather the unawareness of the current vulnerability to contract diarrhea as well as its severity, especially for children under the age of 5 years. Hence, one diffusion strategy would be to raise awareness of the ways in which diarrhea is contracted and of the sometimes tragic consequences of diarrheal diseases.

The affective beliefs about SODIS were shown to represent the highest standardized partial regression coefficient that significantly predicted the intention to use SODIS in the future. This means that the more an individual perceives the application of SODIS to be pleasurable, the more will that person intend to treat water with SODIS in the future. For the current use of SODIS in contrast, the standardized partial regression coefficient for affective beliefs is near zero, even indicating a slight inverse relationship, and thus insignificant. The latter result conflicts with the findings of Altherr, Mosler, Tobias, and Butera (2008), who found attitude to be the only common predictor for both the current and intended use of SODIS. Our results suggest that even though promotional activities that focus on developing positive affective beliefs toward SODIS may to a great extent influence the intention to use SODIS in the future, the encouragement of positive affective beliefs is not sufficient for its sustained use on a daily basis. Positive affective beliefs may be sufficient to give SODIS a try. However, Table 2 shows that a positive affective belief is negligible for the current percentage of SODIS-treated water in the total liquids consumed. Therefore, if diffusion activities focus solely on fostering positive affective beliefs and do not build on the variables that influence the current percentage of SODIS-treated water illustrated in Table 2, the use of SODIS may not be sustainable.

Regarding the intention to use SODIS in the future, cognitive beliefs were shown to be the third-largest standardized partial regression weight. The fact that cognitive beliefs did not appear to be relevant for actual behavior may be attributed to the end users lacking any means of verifying the efficacy of the SODIS treatment process. As demonstrations of the effectiveness of SODIS at field level reduce skepticism and thereby enhance the confidence placed in the technology, we recommend that initial promotional activities in a new area should always be accompanied by the performance and demonstration of microbiological tests.

The hypothesized inverse relationship between perceived difficulty and the dependent variables was not confirmed in the regression analyses: The standardized partial regression coefficients were not significant for either the current or intended use of SODIS in the future. However, with regard to our observations of incorrect SODIS application—such as not fully transparent, dirty, and heavily scratched bottles; overly turbid water; bottles left in the shade; and recontamination after the treatment process—we conclude that even though SODIS is perceived as a simple technology by the target population, its correct application nevertheless requires adequate initial training of users.

Trialability in terms of the perceived availability of sunny surfaces necessary to use SODIS was a significant predictor only for the intention to use SODIS but not for its current use. As the mean calculation of the corresponding item suggests, sunny surfaces are generally abundantly available and do not present a constraint to the application of SODIS. However, we suggest that the topic of suitable locations for exposing SODIS bottles to the sun, such as roofs, latrines, corrugated iron sheets, or any other appropriate place where bottles are fully exposed to the sun and protected from wind cooling, should be addressed during the promotional activities, as they significantly influence the intention to use SODIS in the future.

In contrast to the perceived availability of sunny surfaces, the perceived availability of sufficiently clear water was shown to be a significant predictor for the current use of SODIS but not for its intended use in the future. To encourage people who experience difficulty in using clear water, we recommend that the simple turbidity test based on the readability of the SODIS logo should be demonstrated and if the water is judged too turbid for SODIS, people should be advised on how to filter or decant the solids.

The sufficient availability of transparent PET bottles significantly predicts both the current use of SODIS and the intention to use it in the future, although it is more pronounced for its current use. The latter result suggests that the availability of PET bottles may determine the amount of water that can be treated with SODIS. Thus, the lack of sufficient PET bottles is a constraint for the widespread use of SODIS not only, but especially, in remote areas. We found that promoters were supplying bottles to users in the majority of our investigated areas. Although the supply of bottles can help people start using SODIS immediately after instruction, it creates a dependency and makes it uncertain whether they will continue using SODIS after the program has ended. Moreover, we found that, bottles were distributed only sporadically and in insufficient numbers, thus making it more difficult for users to establish a habit of regular SODIS use. We conclude that, in the long run, bottles should either be supplied on a regular and sufficient basis by an organization that will continue unlimited operations in the respective area, or a local scheme should be initiated for the purchase and transport of used PET bottles from the city to the villages and peri-urban areas. This supply scheme should preferably be combined with a collection scheme for the correct disposal of old bottles so as to minimize the amount of waste produced by SODIS.

The observability in terms of the experience of reduced diarrhea episodes significantly predicted the intention to use SODIS in the future but not its current use, indicating that the latter is influenced by factors other than the self-perceived reduction in diarrhea episodes. This is not surprising given the fact that even a statistically significant reduction of diarrhea incidence by 10% to 55% (Hobbins, Indergard, & Mäusezahl, 2004) may not be easily observable in everyday life, particularly under the public health conditions prevailing in our investigation areas where diarrheal diseases are not recognized to be a major health priority and where several incidences of diarrhea per year are regarded as normal (Paz et al., 2003). However, the intention to use SODIS in the future was significantly predicted by the perceived reduction in diarrhea episodes, reflecting the fact that people who perceived such a reduction are also more likely to treat as much water as possible with SODIS.

With regard to the influence of the social system, the injunctive norm significantly predicted the intention to use SODIS in the future, indicating that greater use of SODIS would be approved by the participants' social network. Also, the higher the motivation of the participants to comply with these normative beliefs, the greater would be their intention to use SODIS in the future. Consequently, one way to strengthen the intention to use SODIS in the future is to change the system norms with regard to SODIS and other innovations that encourage diarrhea prevention through peer support. According to E. M. Rogers (2002), preventive norms can be changed only gradually, but such change can nevertheless be accomplished by using champions, for example. A champion is an individual who devotes his or her personal influence to encourage adoption of an innovation. Goodman and Stekler (1989) found that champions for health ideas were often middle-level officials in an organization.

The descriptive norm proved to be the third largest standardized partial regression coefficient for the current use of SODIS. Thus, the more people in the participants' network who are known to be SODIS users, the higher is the current use of SODIS. Although the correlation between a descriptive norm and the intention to use SODIS was .29 ($p <$ .001), the descriptive norm did not contribute significantly to the regression. These findings suggest that for the everyday use of SODIS the perception as to whether the members of the participants' social network actually use SODIS themselves is much more important than any injunctive norms. This is in line with E. M. Rogers's (2002) findings that diffusion is essentially a social process in that most individuals evaluate an innovation not on the basis of scientific research by experts but by the subjective evaluation of near peers who have already adopted the innovation. The fact that certain innovations are adopted by clusters of individuals (E. M. Rogers, 2003) suggests that interpersonal networks among neighbors are powerful influences on individual decisions to adopt them. We therefore recommend activating peer networks as a means of diffusing preventive innovations. Anything that can be done to encourage peer communication about a preventive idea, such as exposing SODIS bottles on highly frequented places and offering workshops for community-based organizations, thus encourages its adoption.

The number of promotional strategies with active participation significantly predicted the current use of SODIS, indicating that the more strategies in which people have participated, the higher is their percentage of SODIS-treated water in the total liquids consumed. Although the correlation between the number of strategies in which people participated and their intention to use SODIS in the future was .20 ($p < .001$), the number of these strategies did not contribute significantly to the regression.

These results suggest that as many different promotional strategies should be applied as possible in order to take advantage of their respective strengths. Thus, mass-media channels are more effective in disseminating initial knowledge of an innovation, whereas interpersonal channels are more effective in forming and changing attitudes to a new idea, and therefore in influencing the decision to adopt or reject it (E. M. Rogers, 2002). The advantages of the mass media were clearly not fully exploited in our investigation areas. Singhal and Rogers (1999) explicitly recommend using entertainment-style education to promote preventive innovations. This describes the process of placing educational ideas, such as those concerning prevention, in entertainment messages in order to achieve behavior changes.

In comparison to the underused communication channel of the mass media, household visits were frequently made. However, as further elaboration of the data (Moser et al., 2005) indicates, there are considerable differences as to how household visits by SODIS promoters were perceived by the households and thus facilitated the process of incorporating SODIS in household life. As the ability of the SODIS promoters to address the potential initial reluctance and doubts of the families as well as their specific technical and social problems is decisive for the effectiveness of household visits, there is potential for improvement. Emphasis should consequently be placed on the careful selection, training, and supervision of SODIS promoters.

The hypothesized inverse relationship between the percentage of safe drinking water in the total liquids consumed without any contribution from SODIS and the dependent variables was confirmed by the regression analyses. The percentage of safe drinking water without any contribution from SODIS was by far the largest standardized partial regression coefficient predicting the current use of SODIS. This indicated that the greater the consumption of drinking water rendered safe by other means, the lower the percentage of SODIS-treated water in the total liquids consumed. Considering that the aim of the SODIS implementation was to create a large number of SODIS users without rejecting existing water disinfection habits, these results confirm adherence to the implementation message. Another interpretation would be that people are less likely to adopt SODIS when another technique is already in use. We therefore recommend to households who already boil part of their drinking water that they implement SODIS as a complementary water treatment method, thus making the goal of 100% clean drinking water possible.

Limitations of the Study

A caveat is that the major part our data is self-reported, containing the danger that the respondents tried to answer so as to satisfy the interviewer. To reduce the possibility that interviewers were perceived as authority figures who need to be answered in a socially desirable way (e.g., Katz, 1942), we chose interviewers who themselves (except one) were not university educated and lived in a peri-urban area. Although the selection process of interviewers was clearly guided by the utmost reduction of possible social desirability bias, a balance had to be struck between the professional requirements of the interviewer task and the status homophily: All interviewers had to be literate and Quechua speaking. Additionally, both too much and too little social distance can produce biasing effects (Dohrenwend, Colombotos, & Dohrenwend, 1968); thus we tried to achieve an optimal middle social distance between interviewer and respondent.

Furthermore, care was taken at the outset of the interviews to ensure as far as possible that the purpose of the study was not evident to the participants in an attempt to minimize social desirability bias. The interviewers introduced themselves as seeking to conduct an interview on water purification methods; the SODIS-specific questions were raised only after general data about water consumption and illnesses suffered. Furthermore, the language used in the questionnaire was designed and tested to be as simple and appropriate as possible. However, as several methods of reducing or preventing social desirability bias are only partially effective (Nederhof, 1985), it cannot be excluded that some answers might have been biased in a socially desirable way. Yet with all the precautionary measures taken, we do not believe this to be a severe limitation to the interpretation of our results. In addition, the fact that we found significant correlations between several variables indicates that there is variance in the respondents' answers, which means that a significant amount did not answer in a biased way.

The results reported must be seen against the fact that the cross-sectional nature of the data made it imperative for the multiple regression models that we had developed and tested to be guided by theory. Thus, the directions of the effects described in this study are based solely on theory, and the efficacy of our entire set of predictors could be better tested with prospective data. The cross-sectional design of our study does not take into consideration the process dimension of the innovation–decision sequence as described by E. M. Rogers (2003). However, this process provides a theoretical basis for designing programs with interventions timed and targeted to the various stages of the diffusion process, the types of people expected to adopt them at each stage, and the sources of influence to which they are expected to respond. Future research may well operationalize and test the whole innovation–decision process in a longitudinal design so as to provide empirical findings on the scarcity of the research conducted into the innovation–decision process.

Implications for Practice

SODIS is a low-cost and simple point-of-use water treatment method that can be adopted immediately in advance of centralized water treatment and distribution systems, thus accelerating health gains and paving the way for universal access to safe drinking water. SODIS should best be introduced together with other sanitary measures such as washing hands and access to improved sanitation to reduce diarrhea episodes as much as possible.

To increase the relative advantage of SODIS, it is recommended to stress not only the better safety of the water but also less obvious advantages such as the better taste of the water and the lower costs compared to boiling water.

To ensure the full incorporation of SODIS in the daily household routine and to change ingrained habits, regular follow-up action is recommended. Furthermore, a supply scheme for PET bottles should be initiated before the end of the intervention. To ensure the sustainability of the SODIS application, it is important to include in the trainings how to overcome difficulties other than lack of bottles, such as turbid water, cloudy skies, or raining periods.

With respect to the promotional strategies of change agents, the advantages of mass media should be considered, using entertainment-style education to promote preventive innovations. A recurring successful pattern was that after mass media had spread the information, diffusion interventions were targeted at peer networks to influence the individual's adoption decision.

Finally, with regard to the worldwide diffusion of SODIS, it is important to remember that preventive innovations generally diffuse relatively slowly even when promising diffusion strategies are used (E. M. Rogers, 2002). Nevertheless, the diffusion of viable innovations from those who have them to those who need them is a key factor in worldwide health-promotion efforts. Without successful diffusion strategies to facilitate the widespread diffusion of health-related innovations, the latter will realize only a fraction of their potential in preventing avoidable disease and premature death.

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