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Determining differential preferences of two fluoride mitigation options: a behaviour change field study

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In the Ethiopian Rift Valley, 8.5 million people depend on water sources with excessive fluoride. In one rural village, a fluoride-removal community filter was implemented; a personalized reminder was distributed to change people's behavior and increase the usage of the in-village community filter. During this promotion phase, an alternative fluoride-removal option was installed in a neighboring village.
This study examines psychological factors that explain the differences in preference between the two options and their influence on the usage of the different sources. In addition, the effectiveness of the applied behavior change technique, a personalized reminder, was analyzed. The results showed that the better the taste, the lower the effort and the lower the costs for using the in-village community filter are perceived. Moreover, it was found that the personalized reminder also had a positive effect on the usage of the in-village mitigation option.

Introduction

The supply of safe water options is a great challenge, especially in developing countries. Worldwide, hundreds of millions of people rely on drinking water polluted by geogenic contaminants such as fluoride or arsenic. In Ethiopia, 8.5 Million people are at risk of developing fluorosis resulting from excessive fluoride uptake through water. Fluoride is a naturally occurring mineral that at excessive levels becomes a crucial contaminant of ground and surface water sources. Being exposed to high fluoride concentrations in water and having an excess fluoride intake leads to the development of dental and skeletal fluorosis. The symptoms of dental fluorosis are irregular brown patches on teeth, whereas for skeletal fluorosis the deformation of bones, limitation of joint movements, and even crippling in the last stage of the disease, are symptoms. Because medical treatement of fluorosis is very difficult and mostly ineffective, the prevention of fluoride uptake becomes crucial. People have to stop consuming as much fluoride-contaminated water as possible. For this reason fluoride-free mitigation options need to be implemented in highly affected areas. One possible option for defluoridation is filtering fluoride with the Nakuru technique. This technique compromises a filter material, which mixes bone char (charred animal bones) with calcium-phosphate pellets (Korir et al. 2009). Filtering fluoride with bone chare was found to be an efficient, and simple a comparatively low-cost technology, which is applicable at household and community level (Kloos and Tekle-Haimanot 1999).

However, just making fluoride-free water available - for example, by installing a community filter - is not enough. People might have difficulties to adapt the new behavior because of many different psychological, social or situational barriers. Therefore, it is crucial that technical solutions are accompanied by behavior change interventions, which facilitate the uptake of the new behavior and change people's different beliefs about the new behavior. Another important point is that people might have various alternative sources to choose from. If various safe water options are installed in one area it is important for implementers not only to know which safe water option is more sustainable but also which option is preferred for what reason.

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Preference factors

For identifying behavioral factors, which predict the preference of the two water options the RANAS behavior change model of Mosler was used (Mosler, 2012). The model describes five factor blocks: risk factors, attitude factors, norm factors, ability factors and self-regulation factors. All these factors are possible behavior determinants and therefore were analyzed.

Risk factors are divided into perceived vulnerability (a person's subjective perception of his or her risk of contracting a disease) and perceived severity (a person's perception of the seriousness of the consequences of contracting a disease). In addition, a person should have an understanding (knowledge) of how she or he could be affected by a disease through environmental conditions. As attitudinal factors, the taste of the water, perceived costs, and perceived distance are considered, as well as how effortful it is to collect the water from the option. Furthermore, the overall affect refers to feelings that arise when thinking about the behavior. Normative factors regard the descriptive norm (perceptions of which behaviors are typically performed) and the injunctive norm (perceptions of which behaviors are typically approved or disapproved by important others). The ability factors are represented by self-efficacy, which is the belief in one's capabilities to organize and execute the course of actions required to manage prospective situations. Finally, self-regulation factors put a behavior into practice and help to maintain it; planning is of use as the person plans how to cope with distractions and barriers. In addition, to perform a behavior continuously, the person has to be committed to doing so, and the behavior needs to be remembered at critical moments.

Methods

To assess the possible psychological factors that influenced the preference of the two fluoride mitigation options, a longitudinal survey was employed. In May 2010, a fluoride-removal community filter using the Nakuru technique was installed in one rural village, Weyo Gabriel, Oromia Region. The community filter was placed in the center of the village, next to the main public raw water source, a small piped water supply containing 3mg/l of fluoride. The water tariff was set by the local water committee at 0.50 ETB[1] per 20-liter jerrycan. The tariff for fluoride-treated water is twice as high as the tariff for raw water in this village. The community filter is filled with 600 liters of bone char and 900 liters of calcium phosphate pellets. After installation and testing of the filter, the project team organized an inauguration festival for all community members, where speeches were held and a local theater group performed a play to inform people about the fluoride problem. On inauguration day, everybody was allowed to collect water from the new community filter free of charge. Two panel surveys were undertaken (pre and post intervention) with an intervention (personalized reminder) in between. During the intervention phase, a private organization opened a business and installed another fluoride-removal option in the same project area, approximately three kilometers from the project community filter (CF). The new alternative option was a reverse osmosis (RO) treatment plant, from which the fluoride-free water is sold to the public at a tariff of 0.25 ETB per 20-liter jerrycan.

The study area is the village of Weyo Gabriel, a typical rural village in the Northern Rift Valley region. Most of its inhabitants are self-sustaining farmers, who live very basically, without running water, electricity, or proper sanitation facilities, in mud and stone houses. The main water sources are public boreholes and private hand-dug wells, which vary in their fluoride concentration between 2 mg/l and 18 mg/l. These levels of fluoride content are above the World Health Organization (2004) guideline value of 1.5 mg/l.

In this rural village, a fluoride-removal community filter was implemented. A personalized reminder was distributed to change people's behavior and increase the usage of that filter. During this promotion phase, an alternative fluoride removal plant was installed in a neighboring village. This study examines psychological factors explaining the change to the alternative source. Further, the effectiveness of the applied behavior change intervention on the use of the in-village community filter was analyzed. In a complete longitudinal survey, 180 households, who have access to both mitigation options, were interviewed through structured face-to-face interviews. Logistic regressions were carried out to reveal factors predicting the preference of the two mitigation options and the effect of the implemented behavior change intervention.

Intervention

One week before the intervention phase, the community facilitator of the village went to visit as many households as possible to announce the upcoming promotion. He informed the households that in the

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1 1 ETB (Ethiopian Birr) = 6 US cents (exchange rate on June 13, 2011).

coming week, a photographer could come to the CF to take photos of people fetching fluoride-free water. People who collected water at the CF the following week were asked if they wanted their photo to be taken. On the reminder the photos were printed and a slogan was added: "Always drink and cook with water from the community filter." The reminders were distributed by the caretaker of the filter. The goals of the intervention were 1) to gain new users by giving them an incentive and 2) to help people remember to collect and consume treated water. During the post-intervention survey, interviewers checked if households had a photo reminder displayed; 48 households had one or more photos hanging in their house.

Questionnaire and measures

The structured questionnaires for all panel surveys were designed in English and then translated into two locally spoken languages (Amharic and Oromic), back-translated by two assistants and, finally, revised by the interviewers during training. The questionnaires were pretested with 20 households to ensure applicability and understanding. The questionnaires were designed to cover water collection at different alternative sources, household water consumption, the psychological factors described above, and socio-demographics. Most of the questions were quantitatively measured with 9-point Likert scales for bipolar items and 5-point Likert scales for unipolar items. Factor analyses and reliability analyses (calculating Cronbach's alpha) were executed to scale multiple items.

Usage of treated water source: The dependent dichotomous variable covers two groups: Group 1 used water from the CF and Group 2 preferred collecting water at an alternative source, the new RO plant. Respondents who stated that their households consumed at least 50% more from the CF than the new alternative were allocated to Group 1, whereas households that consumed 50% or more from the alternative source compared to CF were allocated to Group 2. Household that showed no preference for either source (consumed 50% of each or 0% of each) were excluded from the analysis.

All independent variables, except perceived costs, perceived distance, and forgetting, were measured with multiple items, and therefore, included in the analyses as scales. All items surveying the psychological factors were measured in reference to the collection of water at the project community filter.

Results

The interviews were held with the person responsible for obtaining water; this person was female in 78.6% of the cases and mainly identified as a housewife (48.3%), working in agriculture (32.2%), or informally employed. The mean age of the respondents was 34.7 years (range, 9–80 years). In 57.8%, the interviews were held in Oromic, and 42.2% were held in Amharic. The majority of the interviewees stated that they were Ethiopian Orthodox (84.4%), and there were small groups of Muslims (10%) and Protestants (5.6%). On average, the highest completed school grade was two years (range, 0–12 years). However, 60.6% were unable to read or write. The mean family size of the questioned households was five people, ranging from one to 12 people living in one household.

To answer the first research question and evaluate the main influencing psychological factors that predict the use of either the in-village CF or the alternative source, a binary logistic regression was carried out (see Table 1). Because of the dichotomous dependent variable (use community filter or use alternative option), a logistic instead of linear regression was chosen. A forced entry method was used for the calculation of the regression, in order to include all factors from the behavior model. The results, displayed in Table 1, show which of the psychological factors determine the use of either one option or the other. After the calculation of the regression, an outlier analysis was undertaken, which resulted in the necessity to exclude four outliers. The eliminated cases showed residuals that exceeded more than two standard deviations and, therefore, would have been misclassified. The resulting regression model showed a high fit (Nagelkerke = 69.2%) and was able to classify 86.7% of all cases correctly.

Four psychological factors contributed significantly to the prediction of the preference groups: perceived vulnerability, perceived taste of treated water, costs of treated water, and effort to collect treated water. The less vulnerable that people felt to contracting fluorosis, the more probable it was that they preferred consuming water from the CF. A positive perceived taste of the water increased the possibility that they would collect more water at the CF. The less expensive that people perceived the price to be at the CF, the more likely it was that they would collect water there. Furthermore, the likelihood that they would collect more water at the CF increased if people perceived that collecting water there took less effort. None of the norm factors or the ability and self-regulation factors significantly contributed to the explanation of the preference groups.

Table 1. Logistic regression analysis for variables predicting preference of safe water option (1= uses in-village community filter more, 0= users alternative source more).

Factor block	Factor	B	SE B	Exp (B)	p
Risk factors	Vulnerability	-3.844	1.943	.021	.048
	Severity	-1.212	3.950	.298	.759
	Knowledge	-1.282	2.818	.278	.649
Attitude factors	Overall affect	3.614	2.970	37.132	.224
	Taste	5.049	2.018	155.889	.012
	Perceived costs	-2.757	1.211	.063	.023
	Perceived distance	2.218	2.181	9.188	.309
	Effort	- 7.008	2.967	.001	.018
Norm factors	Descriptive norm	3.986	3.051	53.841	.191
	Injunctive norm	-.525	2.157	.592	.808
Ability factor	Self-efficacy	-3.235	2.705	.039	.232
Self-regulation factors	Planning	4.173	3.058	64.94	.172
	Forgetting	-.173	1.245	.841	.890
	Commitment	3.021	3.15	20.520	.337
Constant		-8.304	4.514	---	.066

Note. Nagelkerke R^2 = .692, LR-χ^2 = 73.62 with df=14 (p=.000), n = 120. A forced entry method was used for the calculation.

To test the effectiveness of the implemented behavior change intervention (personalized reminder) and answer research question 2, a further logistic regression was calculated. The user group (option 1 or 2) was considered a dependent variable for calculation, and intervention (was a personalized reminder visible in the house or not) was considered an independent variable. The calculated model showed a model fit of 14.3% and successfully classified 77.4% of all cases. Furthermore, the regression revealed that having a personalized reminder at home significantly increased the probability of using the water at the in-village community filter (B = 2.56, $SE B$ = 1.04, $Exp (B)$ = 12.88, p = .014).

Discussion

With regard to research question 1, the two user groups were found to differ significantly in mainly four psychological factors. Regarding people's risk perception, both groups were aware of the severity of dental and skeletal fluorosis; however, those who preferred to collect water at the CF felt significantly less vulnerable to contracting fluorosis, which significantly predicted their preference. There might be two reasons for this result. One possible explanation is that people who collected water at the sustainable source, which had existed for nearly two years and was promoted with different campaigns, felt safe using that water and, therefore, felt less vulnerable to contracting fluorosis. People who consumed water from the new alternative, which was not promoted and about which they did not have any information, might not be one hundred percent certain about the effective prevention of fluorosis by consuming that water.

The two preference groups differed in attitudinal factors as well. People who preferred the CF liked collecting water there more and also enjoyed the taste of the water more than the other group. It has been found in many consumer research studies that positive attitudes towards a product relate positively to purchase intentions and behavior (e.g., Smith et al. 2008). In addition, the perception of the taste of the water was found to influence people's preference of different water types. Researchers found that most preferred water types have medium levels of mineralization and are perceived as tasteless and cooler (Teillet et al. 2009). Furthermore, people who collected water at the CF perceived the price of filtered water as a lot less than the other group did. This might be a result of the first intervention, when people's perception of price was successfully tackled with persuasion (see Huber, Tobias, and Mosler, 2011).

Not unexpectedly, the two preference groups showed significant differences in both norm factors as well. The descriptive and injunctive norms were significantly higher in the group of people who preferred the more sustainable water source. Consumer researchers also have focused on the role of injunctive and

descriptive norms influencing consumer preferences and have found a positive relationship between norms and product preference (e.g., Smith et al. 2008). The higher descriptive norm also can be explained by the fact that people who used the CF more often also more frequently catch sight of important others collecting water there. Although not significantly predicting the preference, the influence of descriptive norm on behavior should not be underestimated. Various studies, also in the development context of safe drinking water, have found the descriptive norm to predict health behavior (e.g., Mosler et al. 2010).

People's abilities and self-regulation factors were found to be significantly higher in the group preferring the CF, even though they were not found to be significant predictors in the regression. As Kiesler and Sakumura (1966) already pointed out, individuals who are bound or committed to a certain behavior avoid behaviors that contradict their commitment and, moreover, are willing to perform behaviors that are coherent with their commitment. Therefore, the high commitment (toward the community filter) in Group 1 is not surprising and supports former research. Consumer researchers have found that even if the purchase of a product evokes health risks (e.g., buying chicken during the chicken flu), a high commitment towards the product leads to an increase in consumption (Graffeo et al. 2009).

Finally, the implemented behavior change intervention, the personalized reminder, was found to influence people's preference positively (research question 3). People who took a photo during the promotion and hung up the reminder in their house preferred collecting water at the CF. The goal of the reminder was to bind people to a behavior that could be performed sustainably and not only for a short time. While taking people's pictures in front of the CF must be one reason for its effectiveness, research on how reminders or prompts operate psychologically is still rare. Mosler and Tobias (2007) however, postulate that the stronger a person feels committed to perform a certain behavior, the more probable it is that a situational cue, like a prompt, reminds the person of the behavior and, therefore, urges the person to act. This implies that a displayed reminder is able to induce commitment and, as soon the commitment is made, the reminder deploys a state of tension within the person if the behavior is not performed (Mosler and Tobias 2007).

Implications for practice

Gaining knowledge about what drives people to use an implemented mitigation option instead of using a newly implemented alternative is crucial for practitioners and implementers, especially if one of the options might be less sustainable than the other. If people change their behavior to collecting water at a possibly unsustainable source and later that source is not accessible anymore, it will be difficult to prevent people from relapsing to the consumption of unsafe, raw water. In the present study, the new alternative source, the RO plant, might be less sustainable than the implemented in-village CF. The raw material (e.g., animal bones) for producing bone char and calcium phosphate pellets used at the CF are locally available at low cost. Further, the income from the water sold at the CF can cover the salary of the caretaker, upcoming maintenance costs, and 50–75% of the cost of replacement of new filter media. The implementers and suppliers, a local NGO, are responsible for the sustainable operation of the filter. By contrast, the newly implemented RO plant bears the risk of not being sustained. One reason is that RO is a high-tech process that requires skilled operators and electricity for operation. Therefore, the capital and operational costs are very high, which makes it impossible to sustain by selling the treated water for the same price as raw water. That is why it was important to promote the more sustainable option for preventing people from contracting fluorosis over the long term.

With knowledge about decisive predictors of mitigation option preferences, specific interventions can be designed to bind a target group to a possibly more sustainable option. If the psychological factors identified as significant are known, then they can be positively influenced through health promotion campaigns.

Attitude factors, such as perceived taste, costs, and effort can be tackled with persuasive communication. As described in the Elaboration Likelihood Model of Petty and colleagues (2004), instrumental attitudes can be influenced with persuasion, using strong arguments, novel information, and positive outcome scenarios. For persuasion, not only the arguments are important, but also the peripheral cues. The messages should be delivered, for example, by health promoters who are perceived as competent, credible, and respected. In the case of perceived taste, one could increase their taste perception with arguments regarding health. Messages comparing the safe water to medicine might be helpful, by concluding that what is healthy does not always taste good (e.g., cod liver oil), or what tastes good is not always healthy (e.g., sweet soft drinks). Decreasing perceived price could be accomplished with messages saying that it is common that more expensive products also are of better quality, and vice versa (see the intervention study of Huber et al., 2011).

Last but not least, the study also shows that the implemented personalized reminder had a positive effect on the preference of the sustainable community filter. This result indicates that reminders or prompts are effective interventions to bind people to a certain behavior and help them not to forget it.

Conclusion

In conclusion, the present study reveals important insights in why people choose a certain safe water option and how this preference can be influenced by behavior change techniques. Future studies should focus on all different alternative behaviors so that practitioners and implementers can identify crucial social, situational and psychological factors and influence these with interventions to bind people to the most sustainable mitigation option.

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