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Evidence-Based Tailoring of Behavior-Change Campaigns: Increasing Fluoride-Free Water Consumption in Rural Ethiopia with Persuasion

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Two hundred million people worldwide are at risk of developing dental and skeletal fluorosis due to excessive fluoride uptake from their water. Since medical treatment of the disease is difficult and mostly ineffective, preventing fluoride uptake is crucial. In the Ethiopian Rift Valley, a fluoride-removal community filter was installed. Despite having access to a fluoride filter, the community used the filter sparingly. During a baseline assessment, 173 face-to-face interviews were conducted to identify psychological factors that influence fluoride-free water consumption. Based on the results, two behavior-change campaigns were implemented: a traditional information intervention targeting perceived vulnerability, and an evidence-based persuasion intervention regarding perceived costs. The interventions were tailored to household characteristics. The campaigns were evaluated with a survey and analyzed in terms of their effectiveness in changing behavior and targeted psychological factors. While the intervention targeting perceived vulnerability showed no desirable effects, cost persuasion decreased the perceived costs and increased the consumption of fluoride-free water. This showed that altering subjective perceptions can change behavior even without changing objective circumstances. Moreover, interventions are more effective if they are based on evidence and tailored to specific households.

Keywords: behavior-change campaigns, Ethiopia, fluoride-removal filter, intervention, perceived costs, perceived vulnerability, persuasion, tailored interventions

INTRODUCTION

Around 200 million people worldwide rely on drinking water that is contaminated with excess fluoride. In Ethiopia, 8.5 million people are at risk of

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developing fluorosis from their water due to excessive fluoride uptake. Fluoride is a naturally occurring mineral that at elevated levels becomes a geogenic contaminant in groundwater. Fluoride occurs at high levels in the East African Rift Valley (Tekle-Haimanot et al., 2006). Dissolved in water, fluoride develops a toxic effect on the human body by precipitating calcium needed mainly for bone formation (McDonagh et al., 2000). As a result, people who are exposed to high fluoride concentration in water and have an excessive fluoride uptake often develop dental and skeletal fluorosis. Symptoms of fluorosis include irregular brown patches on teeth, deformation of bones, limitation of joint movements, and even crippling in the last stage of the disease. People suffering from dental and skeletal fluorosis face psychosocial impacts as well, such as social exclusion and discrimination (Tekle-Haimanot et al., 2006). Due to the fact that there is no effective medical treatment for the disease, the prevention of fluoride uptake becomes crucial.

To prevent fluoride uptake, people must consume as little fluoride-contaminated water as possible. However, simply by making fluoride-free water available—for example, by installing a community filter—is not enough. Many people will not consume sufficient filtered water for several reasons, including water costs, a different water taste, difficult access to the water, or due to the habit of using water from a contaminated source (see, e.g. Tobias & Berg, 2011, for the use of arsenic-removing sand filters). Therefore, infrastructural intervention may need to be accompanied by additional behavior-change intervention in order to effectively prevent fluoride uptake.

Changing Health Behaviors with Behavior-Change Campaigns

In development cooperation, changing health-related behaviors is often attempted by simply providing information. Taking the mitigation of geogenic contamination in drinking water as an example, interventions such as mass-media campaigns (e.g. Caldwell et al., 2006) or public education programs (e.g. Hanchett, Nahar, Van Agthoven, Geers, & Rezvi, 2002) are reported in which health-risk related information was provided. Despite their popularity, however, these campaigns have tended to have a limited impact on changing targeted health behavior (see Caldwell et al., 2006; Hanchett et al., 2002).

In light of these reports, planning interventions based on health-risk related messages should be viewed critically. Every health behavior involves various aspects, and persuading people to use a new technology requires identifying the influential factors of a targeted behavior. Bartholomew, Parcel, Kok, and Gottlieb (2006), Michie, Johnston, Francis, Hardeman, and Eccles (2008), and Mosler (2012) have each discussed how systematically planning interventions based on data is essential. This implies that all psychological factors that potentially influence new behavior have to be investigated.

To cover all the potential factors of influence, we drew on Mosler's (2012) RANAS Model (risk, attitudes, norms, abilities, and self-regulation), a model derived from theories of social and health psychology, such as the Theory of Planned Behavior (Fishbein & Ajzen, 2010) and the Health Action Process Approach (Schwarzer, 2008). These theories have been shown to be successful in explaining and changing many types of health behavior (for the Theory of Planned Behavior, see Ajzen, Albarracín, & Hornik, 2007; for the Health Action Process Approach, see Schwarzer, 2008). The RANAS Model (Mosler, 2012) provides a conceptual integration of several theories that apply to water, sanitation, and hygiene-related behaviors.

In the proposed model, psychological factors are ordered in five different factor blocks: risk factors, attitude factors, norm factors, ability factors, and self-regulation factors. These factor blocks are assumed to comprise a comprehensive list of factors necessary to explain behavior change (see Albarracín et al., 2005). The factor blocks of the RANAS Model (Mosler, 2012) are briefly described in what follows.

Risk factors (health-risk awareness factors) comprise perceived vulnerability (a person's subjective perception of their risk of contracting a disease) and perceived severity (a person's perception of the seriousness of the consequences of contracting a disease) (Floyd, Prentice-Dunn, & Rogers, 2000); in addition, a person should have an understanding (factual knowledge) about how they could be affected by a disease through environmental conditions (Albarracín et al., 2005).

Attitudinal factors include instrumental beliefs and affective beliefs. Instrumental beliefs (outcome expectancies) include beliefs about costs in terms of money, time, and effort, and benefits in terms of savings or other advantages of a new behavior. Attitudes with affective components (Trafimow & Sheeran, 1998) are feelings that arise when performing or thinking about a behavior. This study surveys overall instrumental and affective beliefs, but considers three particularly relevant outcome expectancies separately: the perceived health impact of the behavior, the perceived costs of fluoride-free water, and the perceived taste of filtered water.

Normative factors consider the descriptive norm (perception of what behaviors are typically performed), the injunctive norm (perception of what behaviors are typically approved or disapproved by important others), and the personal norm (personal opinion about what one should do) (Cialdini et al., 2006; Schwartz, 1977). Due to specific characteristics of Ethiopian culture, such as frequent social gatherings, the guest norm has to be taken into account as well. The guest norm pertains to, for example, a household that is proud of their serving fluoride-free water to visiting guests.

Ability factors are represented by a person's confidence in their ability to perform a behavior (perceived behavioral control; Fishbein & Ajzen, 2010). In addition, self-efficacy is the belief in one's capabilities to organise and execute a course of action required to manage prospective situations (Bandura, 1997).

Finally, self-regulation factors come into play when a behavior is actually performed and maintained over time (Schwarzer, 2008). To perform a behavior continuously, the person has to be committed to doing so, and the behavior needs to be remembered at critical moments (Tobias, 2009). For a behavior to be consistently performed, it has to become habitual and automatic (Orbell, Blair, Sherlock, & Conner, 2001).

All factors of the model except for perceived costs and forgetting are here hypothesised to relate positively to the targeted health behavior. Based on evidence (i.e. data gathered on these psychological factors), the most promising factors for a behavior-change campaign can be determined.

In most cases, campaigns target a wide range of different persons or households, and it might be difficult to find one intervention that fits them all. Various authors have proposed tailoring interventions to the characteristics of targeted persons or households (e.g. Kreuter, Strecher, & Glassman, 1999; Mosler & Martens, 2008). This means that a number of possible interventions are prepared, and according to the characteristics of the person or household, the best-suited intervention is then applied. Various studies have shown that tailoring interventions to a target group can positively affect health behavior change (e.g. Wang et al., 2006). Moreover, some evidence suggests that interventions that do not fit the recipients' requirements might have undesired effects on behavior (e.g. a decrease in a behavior that should have been increased; Mosler & Martens, 2008). Therefore, tailoring persuasive messages to the recipients is not only a question of economic efficiency. Sometimes, it is a necessity to avoid unwanted effects.

The Present Study

The main research question of this study is whether evidence-based and tailored interventions are necessary to achieve successful behavior change. In investigating this question, two studies are required: a needs assessment to determine the interventions and how to tailor them to the target group; and an actual evaluation of intervention effects to test the hypotheses derived from the research question (Bartholomew et al., 2006). The first hypothesis tests whether evidence-based and tailored interventions actually have the desired effect on behavior.

> *H1*: An evidence-based tailored intervention changes the targeted psychological factor, and through this the target behavior.

To answer the question of whether evidence-based campaign design *and* tailoring is required for successful behavior change, any intervention different from the evidence-based and tailored one should have no desirable effect (i.e. no effect at all or even an undesired effect). The second hypothesis is as follows:

> *H2*: Interventions that do not fit the households' characteristics do not have desirable effects. The same holds for interventions that are not derived from data but are based on common sense.

In the case of Hypothesis 2 being falsified, we also investigated whether an evidence-based design or tailoring the interventions leads to an improvement regarding behavior change. Thus, Hypotheses 3 and 4 are formulated as follows:

> *H3*: An evidence-based intervention has a greater effect on changing behaviors than a campaign based on health-related messages, which might be the most obvious intervention for mitigating health problems.

> *H4*: An intervention that fits the households' characteristics has a greater effect on changing behaviors than an intervention that does not fit the characteristics of the households.

A special aspect of this study is that the effectiveness of the intervention is compared not only to a randomly selected control group, but also to cases that received inadequate intervention. The goal of this study is to investigate the consequences of the wrong selection of techniques, and of applying a technique to an entire population without distinguishing those for whom the intervention is relevant from those for whom it is not.

Next, we will explain some methodological aspects of the entire project and then present methods and results of both studies (needs assessment and evaluation of intervention effects) separately. The paper then closes with an overall discussion.

METHODS OF THE OVERALL PROJECT

Study Population and Sampling

The present study is part of larger project where a community filter was installed in May 2010 in a village in the northern Ethiopian Rift Valley. The project village, Weyo Gabriel, is a typical rural village with low-income families. All local water sources exceed the World Health

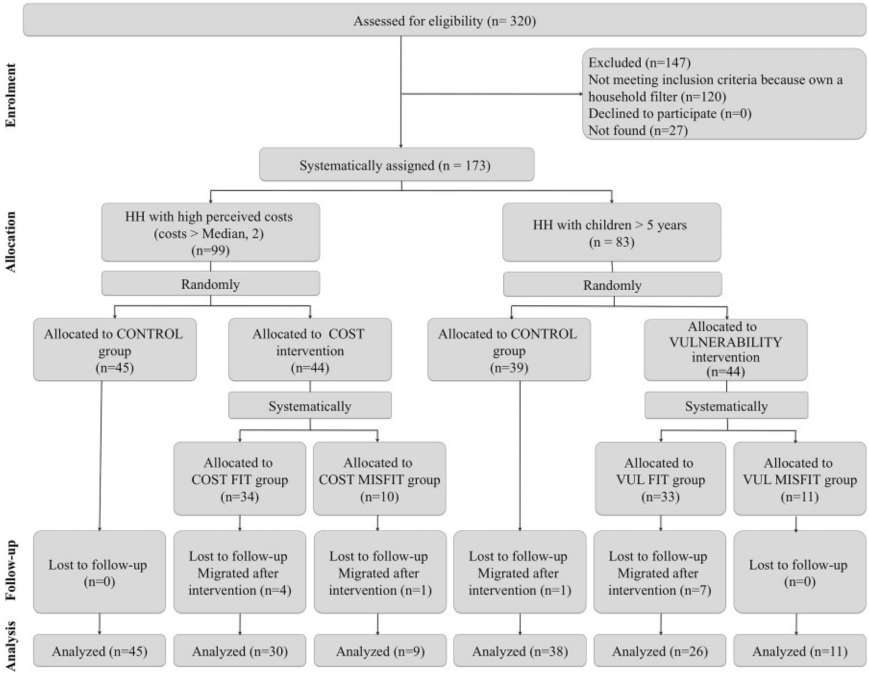

FIGURE 1. Flow diagram of the study design.

Organization (WHO) guideline of 1.5 mg/l fluoride concentration (World Health Organization, 2004).

According to village leaders and the regional office, approximately 320 households are counted in the project village, of which 120 own household filters. The exact number of inhabitants is not known due to a lack of census information and frequent migration. The household filter owners were excluded because they were part of another study (see Huber, Bhend, & Mosler, 2011). During the baseline assessment, 173 houses were found to be inhabited. These households were then recruited and interviewed by a research team that aimed for a complete survey. Of the 173 households, 160 took part in the post-intervention survey (see Figure 1). No household refused to participate after being fully informed about the study and giving their verbal consent, but some families migrated during the project. The interviews were held with persons responsible for drinking water in the respective household. In 65.9 per cent of the cases, the interviewed person was female. The mean age of respondents was 34.7 years (standard deviation $SD = 14.5$, ranging from 9 to 80 years, median $Md = 30$ years), and their average years of education was 1.9 ($SD = 2.9$, ranging from 0 to 12 years, $Md = 0$). The average number of persons living in a household was 4.5 ($SD = 2.1$, ranging from 1 to 12 people, $Md = 4$). Of the respondents, 48.8 per cent were housewives, 32.5 per cent worked in agriculture, and 18.7 per cent were engaged in other occupations. The interviewees were Ethiopian Orthodox (84.9%), Muslim (10.8%), or Protestant (4.2%).

Procedure and Interventions

The community filter provided is based on the *Nakuru technique* (Korir et al., 2009), an efficient, simple and low-cost method that can be applied at the household and community level. The *Nakuru technique* uses a mixture of bone char (charred animal bones) and calcium-phosphate pellets as filter media (Korir et al., 2009). The community filter is at a central location in the village next to a public raw-water source (borehole), where 20 liters of water can be purchased for US 1.5 cents. The local water committee, together with the village leaders and members of the non-governmental organisation (NGO) involved, set the price for treated water at the community filter to US 3 cents per 20 liters. The rather high price was set to ensure sustained maintenance of the filter (changing filter material, repairs, caretaker).

Data gathering for this study started with a baseline assessment in September 2010, followed by the intervention phase in October 2010, and a post-intervention survey in December 2010. The results presented in this paper are part of a 3-year behavior-change study including three different intervention phases. The first intervention phase is described in the present study. Each intervention phase was followed by an evaluation. After the evaluation presented here, a second intervention (a personalised photo reminder) was applied to further increase filter use (see Huber & Mosler, 2013). The third intervention included public commitment that introduced blue flags to households as markers for those who consumed fluoride-free water exclusively (article in preparation). The sequential technique delivery used in this study has the advantage that each intervention is adapted to new conditions prevailing in the target population.

Data Gathering and Measures

Data gathering was carried out in the same way in all panels. Due to high illiteracy among the villagers, data collection was carried out through structured face-to-face interviews by a team of 10 local college students who knew nothing about the interventions applied before. Before each survey, the interviewer team attended a four-day training course. Moreover, a scientist and a research assistant supervised the team during the surveys. Households were visited without pre-announcement. It was clearly stated to interviewees that participation was voluntary, and before the interview began, individuals were informed about the study and that the data would be treated confidentially by the research team. No visited household rejected the interview. The questionnaires were translated from English into Amharic and Oromic, and translated back to English by two assistants, and finally revised by the interviewers during a workshop. The applicability of the baseline and post-intervention questionnaires was verified in a pretest, and some items were improved. Details of the questionnaire items can be found in the Supporting Information pages (S8–S10).

Behavior. A behavior index for every household was calculated based on various questionnaire items. First, the person responsible for fetching water reported the weekly purchase of filtered water at the community filter. Second, the interviewee was asked to show the interviewer a regularly used cup and to assess how many of these cups the entire family drinks per day. With the interviewer's estimation of the capacity of the cup, the total liters consumed per day could be calculated. Afterwards, people were asked how many cups they drank from the filtered water and how many cups they drank from other water sources. The estimation of the percentage of cooking with filtered water followed the same procedure. The percentage of filtered water consumption (drinking and cooking) was calculated compared to the total water consumption.

Perceived Costs. People's perceived costs with regard to the community's filtered water were addressed with one item: "Do you think that 0.5 Birr[1] for one 20 liter jerry can of fluoride-free water is too cheap, too expensive, or right?" Answers were coded on a 9-point Likert scale (–4 = too cheap to +4 = too expensive).

STUDY 1: NEEDS ASSESSMENT

Evidence-Based Selection of Behavior-Change Techniques

To determine which psychological factors have the greatest intervention potential, first the baseline means of all psychological factors were computed. Second, a linear regression of the behavior on these factors was calculated to determine the factors that are significantly related to the consumption of fluoride-free water. For each factor, the sample's mean is subtracted from the factor's targeted value and then multiplied by the regression weight of the

[1] 1 Ethiopian Birr = 0.059 US dollars (exchange rate on 3 June 2011).

determinant B (the slope or strength of association between determinant and behavior). Formally, this can be written as: Intervention potential = (Target – M) * B. The higher the resulting value of the intervention potential for a determinant, the greater the potential impact on behavior for an intervention targeting this determinant.

Results: Selected Interventions and Criteria for Tailoring

Descriptive statistics are shown in Table 1. The mean of perceived vulnerability indicates that users estimate their likelihood of contracting fluorosis as lower than the chance of an average person in their community ($M = -.351$, $SD = 2.81$). The price of filtered water is, on average, perceived as too expensive ($M = 1.62$, $SD = 2.33$). In addition, low values are reported for the descriptive norm, the perceived behavior control, and the automaticity of performing the behavior. All the other factors reached a considerably high mean value (above 2.5).

The results of the regression analysis are presented in Table 2. Perceived vulnerability is negatively related to the consumption of fluoride-free water (B = –3.58); the perceived costs of filtered water (B = –2.62) and its taste (B = 5.93) also affected people's consumption. In addition, perceived behavioral control (B = 7.04) and commitment (B = 7.41) are significantly related to the consumption of safe water. The preconditions for performing a linear regression were fulfilled, the residuals were normally distributed, and no evidence of heteroscedasticity or high multicollinearity (VIF values between 1.07 and 1.91) was found.

To determine which psychological factors should be targeted by the campaign, the mean values (M) of the factors in Table 1 are subtracted from the maximum value (MaxV) this factor can reach, and this value is multiplied with the Bs of the regression analysis [(MaxV – M) * B = Intervention potential]. The highest intervention potential was reached for perceived costs (MaxV = –4; $M = 1.62$; B = –2.62) [((–4) – 1.62) * –2.62 = 14.72] and for perceived behavior control (MaxV = 4; $M = 2.05$; B = 7.04) [(4 – 2.05) * 7.04 = 13.73]). Note that even though the latter has a much higher weight in the regression analysis (7.04 compared to –2.62 for perceived costs), the intervention potential is somewhat smaller because there is not much room for improvement (4 – 2.05 = 1.95 compared to –4 – 1.62 = 5.62 for perceived costs). However, both intervention potentials are similar and could be the target for a campaign.

The selection of the critical factor to be targeted by the intervention was not only based on quantitative data. Of particular importance here are the problems mentioned in an open question on what made it more difficult to fetch filtered water instead of unfiltered. The main reason mentioned was the high cost of the filtered water. Thus, an intervention on perceived costs

TABLE 1
Descriptive Statistics of the Factors Used in the Analyses

	Factors		n	Range	T	M	SD	α	Items
Baseline T1	Behavior	Percentage of filtered water consumption	173	[0, 100]	100	71.49	32.17	—	
	Risk factors	Vulnerability	173	[–4, 4]	4	–.351	2.81	.921	3
		Severity	173	[0, 4]	4	3.84	.318	.720	6
		Knowledge	170	[0, 5]	5	2.88	1.045	—	
	Attitudinal factors	Overall affective belief	171	[–4, 4]	4	3.49	.791	.882	2
		Overall instrumental belief	173	[–4, 4]	4	3.51	.798	.836	2
		Health impact	172	[–4, 4]	4	3.53	.812	—	
		Taste	173	[–4, 4]	4	2.56	1.48	.831	4
		Perceived costs	173	[–4, 4]	–4	1.62	2.33	—	
	Normative factors	Subjective norm	173	[–4, 4]	4	2.92	1.48	.910	5
		Descriptive norm	173	[0, 4]	4	1.74	0.76	.825	3
		Personal norm	173	[–4, 4]	4	3.01	1.21	.893	3
		Guest norm	172	[0, 4]	4	3.78	0.46	—	
	Ability factors	Perceived behavior control	173	[0, 4]	4	2.05	1.43	—	
		Self-efficacy	173	[–4, 4]	4	2.45	1.64	.883	4
	Self-regulation factors	Commitment	173	[0, 4]	4	3.04	.901	.826	3
		Perceived habit	173	[0, 4]	4	2.96	1.12	—	
		Automaticity	173	[–4, 4]	4	.812	2.89	—	
		Forgetting	173	[0, 4]	0	.690	1.14	—	
Post-intervention T2	Behavior	Percentage of filtered water consumption	172	[0, 100]	100	65.02	33.77	—	
	Risk factor	Vulnerability	172	[–4, 4]	4	–.205	2.31	.872	3
	Attitudinal factor	Perceived costs	172	[–4, 4]	–4	.64	2.62	—	

Note: Targeted values after intervention (*T*), means (*M*), standard deviations (*SD*), and value range (*Range*) of all factors are provided. For factors with multiple items, Cronbach's alpha (α) for scale reliability and the number of items used are indicated. No Cronbach's alpha for knowledge is indicated because of the Kprim-styled multiple-choice measurement (Krebs, 2002).

TABLE 2
Linear Regression Analysis for Consumption of Fluoride-Free Water

Variable		B	SE B	β	95% CI LL	95% CI UL	p
Risk factors	Vulnerability	−1.79	.809	−.156	−3.38	−.193	.028
	Severity	−1.98	7.63	−.020	−17.06	13.09	.795
	Knowledge	−.192	2.31	−.006	−4.76	4.38	.934
Attitudinal factors	Overall affective belief	−5.93	6.29	−.146	−18.37	6.51	.348
	Overall instrumental belief	10.18	6.72	.255	−3.10	23.47	.132
	Health impact	.738	4.96	.019	−9.06	10.54	.882
	Taste	5.93	1.83	.276	2.31	9.55	.002
	Perceived costs	−2.62	1.02	.190	.61	4.63	.011
Normative factors	Subjective norm	2.81	2.88	.112	−4.53	10.61	.330
	Descriptive norm	3.04	3.83	.073	−2.88	8.51	.428
	Personal norm	−5.61	3.57	−.215	−12.68	1.45	.119
	Guest norm	4.57	5.04	.065	−5.381	14.53	.365
Ability factors	Perceived behavior control	7.04	1.93	.312	3.223	10.85	.000
	Self-efficacy	−2.17	2.51	−.112	−7.131	2.80	.390
Self-regulation factors	Commitment	7.41	3.67	.210	.161	14.66	.045
	Perceived habit	−2.28	3.54	−.080	−9.28	4.72	.520
	Automaticity	−.082	.871	−.007	−1.80	1.64	.925
	Forgetting	2.34	2.12	.084	−1.88	6.53	.271
Constant		9.64	39.18		−6.78	−.39	.806

Note: *B* = unstandardised regression coefficient; *SE B* = standard error of *B*; β = standardised coefficient; *CI* = confidence interval; *LL* = lower limit; *UL* = upper limit; *p* = significance level. Adjusted $R^2 = .292$; *N* = 166. A forced entry method was used for the calculation.

appears to improve not only perceived costs but also the perceived behavioral control. The behavior-change campaign targeting perceived costs was designed not only to lower people's price perception but also to show them that fetching filtered water for drinking and cooking only is not as expensive as expected.

The "common sense" intervention (i.e. the intervention proposed by the NGO) targeted vulnerability. The intervention potential for this intervention is −7.61 (MaxV = 4; *M* = −.35; B = −1.75) [((4) − −.35) * −1.75 = −7.61]). The intervention potential is only about half the size of the one for perceived costs or perceived behavior control. More importantly, it is negative. This means that this factor already pushes the people towards the desired behavior: persons who consume less filtered water perceive higher vulnerability than persons who consume more filtered water. Thus, an intervention on vulnerability is—following our approach, at least—not supported by evidence.

To conclude, the most promising factor to be targeted by a behavior-change campaign is perceived costs. The perceived costs in the baseline can be used as the criterion for the fit of this intervention to the households. The intervention should be effective only for households with high perceived costs.

STUDY 2: EVALUATION OF INTERVENTION EFFECTS

Experimental Design

From Study 1 we concluded that the most promising intervention would target perceived costs. To compare this evidence-based intervention with a non-evidence-based intervention, we needed to implement a technique that appears to be effective but should not be effective according to the evidence-based derivation. Such an intervention was already identified in Study 1 as an intervention on vulnerability. Our non-governmental organisation (NGO) partners expected such an intervention to be the most promising. However, according to our evidence-based approach, an intervention on vulnerability should not show favorable effects. Since the design of this intervention should not be evidence based (i.e. based on data gathered in the baseline assessment), the criterion for this intervention to be adequate for a household was based on the actual vulnerability as stated in the literature and not the perceived vulnerability. Children below 5 years of age are at higher risk of contracting fluorosis (e.g. Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food, Nutrition Board, Institute of Medicine [SCSEDRI], 1997). Thus, the vulnerability intervention was defined as fitting a household if at least one child under 5 years lived in the household.

With regard to a tailoring method, we applied tailoring on two different levels. On the one hand, we tailored selected interventions to persons, for example, by calculating the actual costs specifically for each household, or by expressing the effects of fluoride in terms of the future of the children in the household. On the other hand, we tailored the campaign to the target population by selecting techniques and the population segment targeted by the techniques. This second level of tailoring makes up the essence of this study. We investigated the consequences of wrong selections of techniques and of applying a technique to an entire population without distinguishing for whom the intervention is relevant or not.

To conclude, five groups are distinguished: (1) the control group (CTRL); (2) households with cost persuasion showing high perceived costs (COST_FIT); (3) households with cost persuasion but low perceived cost (COST_MISFIT); (4) households with persuasion on vulnerability and having a child younger than 5 years (VUL_FIT); and (5) households with persuasion on vulnerability and no child under 5 years (VUL_MISFIT).

All households in the sample ($N = 166$) were systematically assigned to groups based on their characteristics (i.e. having children at high risk or not, and showing concern about the price of filtered water or not) and then randomly allocated to control or intervention groups (Groups 1 to 4). Group 1 was further randomised into COST (Median higher than 2 = quite expensive) and VUL (having children under 5 years) groups. Participants assigned to either COST or VUL and the people assigned to the MISFIT group were further randomised into control or intervention groups (see Figure 1). The group that received health-related messages was set to approximately the same size as the group that received persuasion on costs, as the NGO was convinced that the former would be effective. However, it was quite probable that interventions which did not fit the households would fail. Thus, for the efficient use of resources and due to ethical concerns, we decided to keep these groups smaller. As explained in the section on the methods of the overall project, this campaign was followed by two more campaigns promoting the consumption of fluoride-free water. Thus, all villagers had the chance of being positively affected by an intervention.

Procedure

Before the intervention phase, 10 local health extension workers (promoters) attended three days of training held by the research team and the NGO's social worker. The training comprised an introduction to the fluoride problem, promotion materials, and persuasion techniques. On the last day of the workshop, promoters practiced the promotion situation. The promoters were not informed about which intervention was assumed to be more or less effective. During the intervention phase in the field, research assistants accompanied the promoters to ensure correct household assignment and to make random checks on promoter activities. The following activities took place (further details on the interventions, which were newly developed by the research team and the NGO's social worker, can be found in the Supporting Information pages S2–S7).

The *control group* received a short (15 minute) visit from a promoter giving them general information (basic knowledge without persuasion attempts) on fluoride, such as what it is and its occurrence in the village, fluorosis, including its symptoms, effects, and its prevention, and the community filter. Households assigned to the *cost intervention* group received a promoter visit that lasted approximately 30 minutes. As in the control group, the promoter first provided general information. In addition, the promoter emphasised the difference in quality between filtered and raw water. Further, the promoter calculated, together with the head of household, a water budget for that particular household. This way, the household received realistic estimates of how much filtered water was required and how much money the household would have to spend per week.

As in the other groups, households assigned to the *vulnerability intervention* received a promoter visit, including the general information part. Further, the promoters asked for the names and ages of all children living in the household. Then the promoter presented individualised risk information for every child. The promoters showed pictures of children and adults with dental and skeletal fluorosis and indicated on a visualised water scale how their risk could be reduced. The visit lasted approximately 30 minutes.

During the post-intervention survey a manipulation check was applied. People were asked to describe the information they had received during the promotion visit. It was planned that people who did not describe or recall the right information would be excluded. However, all the households interviewed were able to recall the content of the promotion.

Data Analysis

To test the hypotheses explained in the introduction, we cannot follow the common approach for subgroup analyses (e.g. Assmann, Pocock, Enos, & Kasten, 2000; Brookes et al., 2004) due to the fact that we have only one treatment group (tailored cost persuasion) and four groups where we do not expect any effects. A test of interaction over all five groups is thus not feasible. First, we are not looking for effects in any group but in one specific group. Second, the effects in this specific treatment group have to be different from the effects in all four non-treatment groups. Thus, to test the hypotheses, the differences of effects on all four non-treatment groups must be significant, and therefore, these differences must be tested separately. This multiple testing does not increase the risk of Type I errors. On the contrary, since the four tests are additive, Type I errors are greatly reduced by this design.

The only exception is the test of Hypothesis 2. Here it would be possible to carry out a test of interaction over the four non-treatment groups (i.e. excluding COST_FIT). However, only a clearly non-significant result (i.e. $p \geq .25$) would have a clear interpretation, as it would confirm the hypothesis. Because the hypothesis states that no *desirable* effect is expected and not no effect at all, a significant result does not necessarily mean that the hypothesis is not supported. The result should not be significant or then indicate a reduction of the behavior measure. Thus, in the case that $p < .25$, anyway, planned contrast of the interaction effect group $\times$ time have to be calculated. These are nothing other than the group comparisons carried out for testing the other hypotheses. Thus, for testing Hypothesis 2, we will also use single group comparisons. The fact that such a procedure increases the Type I error is no problem here, because we test for the absence of an effect. Thus, our procedure, if anything, might lead to somewhat more conservative results than a test of interaction.

To test H1, changes over time of the tailored cost intervention group are compared to changes in the control group. This is done for ΔCOST (testing H1a) and ΔBEH (testing H1b). H2 is tested by comparing the ΔBEH of the groups, including cost intervention not fitting the household, tailored vulnerability intervention, and vulnerability intervention not fitting the household to the control group. The test of H3 involves the comparisons of ΔBEH for the tailored cost and vulnerability intervention. To test H4, ΔBEH for the tailored cost intervention is compared to the cost intervention that does not fit the household.

Effect sizes of the mean comparisons have been labeled in accordance with Rosenthal (1991). An effect size r between 0 and ±0.3 is interpreted as a weak effect. Effect sizes between ±0.3 and ±0.4 are considered medium effects, whereas effect sizes between ±0.5 and ±1.0 are strong effects.

Results

Results: Intervention Effects. The group comparisons presented in Table 3 show that the mean change of behavior of the COST_FIT group is significantly different from the control group ($p = .01$, $r = .32$). Further, the change in perceived costs for the COST_FIT group differs significantly from that of the control group ($p = .047$, $r = .19$). These results clearly support Hypothesis 1. Remarkably, in the actual control group, a significant decay in the behavior was observed ($p = .009$, $r = .282$). One possible reason for this could be the lack of an intervention, apart from receiving information, so that people fell back into old habits of consuming raw water.

The group comparisons presented in Table 3 show no significant *positive* effects on behavior for groups that received an intervention without effect-expectation. (COST_MISFIT: $p = .590$; VUL_FIT: $p = .560$; VUL_MISFIT: $p = .066$). Since we test for the *absence* of an effect, p-values need to be greater than .25. This is not the case for VUL_MISFIT. Surprisingly, however, this group *reduced* consumption of fluoride-safe water, even though the opposite effect was intended with the intervention.

H3 and H4 are supported by the data: a significantly greater positive change was observed for the COST_FIT group than the VUL_FIT group ($p = .037$), and for the COST_FIT group than for the COST_MISFIT group ($p = .004$).

DISCUSSION

This study investigated two campaigns for promoting the consumption of fluoride-free water in the Ethiopian Rift Valley. Interventions were derived

TABLE 3
Results of Mann-Whitney U-tests. Comparisons of Means of Behavior Change over Time (ΔBEH) of the Intervention Groups with the Control Group and with Each Other and Comparisons of Means of Perceived Cost over Time (ΔCOST) of the Intervention Groups with the Control Group

Hypotheses tested	*Comparison*	*Compared groups*		M (SD)	M (SD)	U	p[a]	r[b]
		Group A	*Group B*	*Group A*	*Group B*			
1a	**ΔCOST**	COST_FIT	CTRL	−.267 (.31)	−.101 (.43)	953	.047	.19
1b	**ΔBEH**	COST_FIT	CTRL	.18 (.43)	−.14 (.46)	1782.5	.001	.32
2a		COST_MISFIT	CTRL	−.39 (.41)	−.14 (.46)	419.5	.590	.06
2b		VUL_FIT	CTRL	−.03 (.43)	−.14 (.46)	1174.5	.560	.06
2c		VUL_MISFIT	CTRL	−.003 (.41)	−.14 (.46)	304.5	.066	.02
3	**ΔBEH**	COST_FIT	VUL_FIT	.18 (.43)	−.03 (.48)	516.5	.037	.28
4	**ΔBEH**	COST_FIT	COST_MISFIT	.18 (.43)	−.39 (.41)	52	.004	.45

Note: [a] significance of p is two-tailed; [b] effect size (Rosenthal, 1991, p. 19).

based on evidence, and target groups were specified for which the interventions should be effective. The effects of these evidence-based and tailored interventions were compared to those of interventions not derived from evidence and that might not fit the households.

Data from the needs assessment (Study 1) suggested that the biggest effect on behavior change should be reached by targeting perceived costs for filtered water and perceived behavior control. Therefore, a behavior change campaign was applied with the goal of influencing perceived costs. However, other NGOs working in developing countries apply educational interventions on health issues (e.g. vulnerability). Although our regression analysis showed a negative relation between perceived vulnerability and target behavior, a behavior change intervention targeting perceived vulnerability was applied. This was done for two reasons. First, we wanted to integrate the desire of our partner NGO to have a health awareness campaign. Second, we wanted to compare our evidence-based approach with an intervention that seemed to make more sense to practitioners, even if the intervention was not supported by evidence. Following the same logic, even though groups were specified a priori that should be targeted by the campaign, the interventions were applied also to households for which the techniques might not be effective.

The first hypothesis test compared the effects of the evidence-based tailored intervention (tailored cost intervention) to the control group regarding changes in perceived costs and behavior. H1 was clearly supported by the data, since in this group perceived costs decreased and the consumption of community filter water increased. Thus, the persuasion on perceived costs was able to change people's consumption behavior positively without changing the actual circumstances (e.g. without changing the objective costs of filtered water). The results from the baseline showed that perceived price played an important role with regard to people's consumption behavior. This result is also often found in marketing research (e.g. Monroe, 1973; Lichtenstein et al., 1993). Even though persuasion studies show that instrumental beliefs, such as perceived costs, can be changed (e.g. Petty, Rucker, Bizer, & Cacioppo, 2004), few studies show that price perceptions can be changed through persuasion without changing the actual circumstances. We assume that the household's personal water budget contributed significantly to the positive change in price perception. Helping people calculate their actual weekly expenditure for filtered water might have led to eliminating false beliefs about the costs of consuming only filtered water.

The second hypothesis tested whether the interventions not supported by evidence and/or that did not fit the households had effects. No positive effects were found, but in the not-fitted vulnerability intervention group, a near significant *decrease* in fluoride-free water consumption was observed. One reason for this result might be that the intervention failed to change people's perceived vulnerability. Another reason for this might be that the persuasion part focused only on children's vulnerability to contracting fluorosis. Children up to 5 years are actually at the highest risk, but emphasising this might have decreased adults' behavior. After the promoter visit, people might have concluded that it is important only for their children to consume fluoride-free water. Due to the fact that untreated water is less expensive, adults might have reverted to consuming more raw water after the intervention. On a more general level, by not designing and tailoring interventions based on evidence, one might not only spend resources on ineffective campaigns, but also might provoke undesired effects.

Testing Hypotheses 3 and 4 involved a comparison of the effects of the evidence-based tailored intervention (tailored cost intervention) to the non-evidence-based intervention (tailored vulnerability intervention) and the non-tailored intervention (non-fitted cost intervention). The results of the study support our hypotheses. The intervention on perceived costs was significantly more effective in changing people's consumption of safe water than the vulnerability intervention. Identifying perceived costs as the factor with the highest intervention potential helped to design an effective intervention. Further, people who received an intervention on costs having high perceived costs at baseline increased consumption of fluoride-free water more than people who did not show high perceived costs. When an intervention is applied to a whole community without being tailored, the intervention might reach households that do not need an intervention or do not meet the requirements for that specific intervention. This can reduce the efficiency of a campaign or even lead to harmful effects, as was shown for the non-fitted vulnerability intervention group.

When NGOs design interventions to promote a health behavior, they often apply awareness-creation as a first step of promotion. The severity of a disease and vulnerability to it are the main components of awareness-creation. However, risk perceptions, such as perceived severity and perceived vulnerability, might not always be the main influencing factors of performing a new behavior, as shown in this study. Interventions should instead be designed based on the baseline data gathered to augment the effectiveness of a promotion campaign and to prevent undesired effects of inadequate interventions.

We would like to emphasise that we are not arguing against awareness-creation or health-related messages in general. In many cases, such interventions might be very effective (George, Inauen, Rahman, & Zheng, 2013). The point we want to make is that what interventions are applied in a campaign and which households are targeted by these interventions should be derived from current data gathered from the target population (Kok, Schaalma, Ruiter, Brug, & Van Empelen, 2004).

Limitations of the Study and Directions for Future Research

This study analyzed a real-world promotion campaign that gives results of high external validity and relevance for practitioners. However, such studies always bear the risk of shortcomings with regard to data quality. The following possible limitations should be kept in mind when, based on the results presented, conclusions are drawn for other settings.

First, the study was performed in a relatively small community because only one community filter was installed. Therefore, the number of cases was limited, and there was a risk of dependence with regard to households. Small group size increases the probability of pure chance findings, and thus, care must be taken when generalising the results of this study. Particularly unfortunate was the decision to reduce the size of groups for which we did not expect desired intervention effects. Further, the interventions applied to one group might have had effects on other groups. This is a problem for any field study. However, in the case investigated, no evidence of such spillover effects could be found. Since all persons received some form of intervention and no physical material was handed out that could have been distributed to others, a spillover effect is rather improbable. Nevertheless, it cannot be ruled out.

A second limitation of this study is the use of self-reports. With such data, there is always the risk of errors or biases due to misunderstanding, lack of knowledge or of an opinion by the interviewee, or desirability effects. However, in this study, these effects are largely controlled due to the use of differences over time. Nevertheless, there is the risk of overstating changes after receiving an intervention. Such effects can, however, be excluded, since in most groups the desired behavior is actually reduced. Finally, there might be biases due to training effects in estimation tasks, such as the estimation of water consumed. However, all households in this study had already participated in a previous panel, and thus, these training effects should have happened before this study. Further, the interviewers were extensively trained regarding sources of biases and errors. A particular emphasis was put on the estimation of the consumed water. Thus, we are confident in the quality of the data used in this study. Nevertheless, we recommend reconfirming the findings with data that are not based on self-reports.

Implications for Practice

Our main findings are that, (1) with behavior-change campaigns, behavior can be changed without changing objective barriers, (2) intervention campaigns should be designed based on evidence, and (3) campaigns should be tailored to the target group. A particular strength of this study is that it was conducted in a population that faces severe monetary constraints. The target behavior is objectively an expensive choice for this population. In the context of development aid, one faces the dilemma of offering safe water at a low but unsustainable price, or to price the water in a way that allows maintaining the service without external aid but having only few people use it. This study showed that by using psychological interventions it is possible to offer sustainable solutions even to low-income households.

Our second main finding emphasises the importance of basing intervention campaigns on sound quantitative evidence. For any campaign, one first has to investigate the factors that hinder and enhance the chances of people performing a new behavior instead of the old habitual behavior. This statement is nothing new, yet most campaigns in the context of development cooperation are still designed and implemented without any psychological investigation of the target population. What is new here is the explicit investigation of interventions that are not adequate according to an evidence-based approach. Studies mainly show only that an optimal intervention is effective. However, the critical question is whether an intervention qualified as ineffective by an approach actually has a lower or even undesired effect. Such studies are problematic and, thus, data on forecast failure will always be scarce. That the presented study considers such data increases its value.

A final point here concerns tailoring. Besides the tailoring of an intervention to each and every household, the selection of the right technique for the right household is critical. One should apply an intervention only to households for which the targeted factors are actually hindering the performance of the new behavior. In the case of interventions distributed by promoters, this can easily be done by letting the promoters ask the households a few questions and then using an intervention that fits the pattern of answers (see Mosler & Martens, 2008). The particular value of this study is, again, the investigation of interventions that were expected to fail. Without implementing interventions with forecast failure, it remains unknown whether an effective tailored intervention is effective due to tailoring or would have been effective for anyone in the population.

The problem of fluoride with regard to drinking water quality has only recently been recognised by a broader audience, and further research in this area is necessary. However, with our study, we have added knowledge to the body of research to deepen understanding of what factors influence the use of a new fluoride mitigation option. Elaborate, evidence-based interventions were developed to mitigate this serious health-threatening problem. Moreover, these interventions were evaluated, and therefore can now be improved and adapted for a further increase in safe water consumption.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Fig. S1. Instruction for promoters for cost persuasion.
Fig. S2. Personal water budget sheet for individual households.
Fig. S3. Instructions for promoters for vulnerability persuasion.
Fig. S4. Water sources fluoride chart indicating grade of contamination of each accessible source in the village.
Fig. S5. Pictures of people suffering from dental and skeletal fluorosis.
Fig. S6. Instructions for promoters for information about prevention of fluorosis.
Fig. S7. Risk graph showing the risk of getting fluorosis.
Table S1. Factors, items and response options with corresponding values.
Table S2. Means and standard deviations for each group during baseline.