Use of Certeza point-of-use water treatment product in Mozambique

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ABSTRACT

Certeza, a branded and socially marketed point-of-use water treatment product consisting of diluted sodium hypochlorite solution, was launched in Mozambique by Population Services International (PSI) in 2004. Certeza is sold in 150-mL bottles at subsidized prices through the private sector and distributed for free during emergency situations. PSI also implements behavior change communication (BCC) activities to promote healthy behaviors related to water treatment. In 2007 and 2012, two large-scale, population-based surveys were conducted in selected districts to collect information from caregivers of children under the age of five on knowledge and use of water treatment products. This study presents changes in water treatment indicators between 2007 and 2012 and an assessment of the effects of exposure to BCC interventions on water treatment behaviors in 2012. The findings show improvement in most water treatment behaviors, after controlling for differences in the two surveys. Notably, ever-use of Certeza increased from 17 to 30% and current use increased from 10 to 25%. These improvements were accompanied by improved social norms, knowledge, and self-efficacy relating to water treatment. Moreover, exposure to PSI interventions was associated with practicing water treatment behaviors (those specific to Certeza use and also general water treatment behaviors).

Key words | behavior change interventions, point-of-use water treatment, sodium hypochlorite

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INTRODUCTION

Diarrheal disease, alongside malaria and acute respiratory infections, is the leading cause of morbidity and mortality in Mozambique. Environment, sanitation, rapid urbanization, and hygiene factors combined create conditions that place many Mozambicans at risk of diarrheal disease, including cholera (Aragon *et al.* 1994). Many Mozambicans, particularly those living in rural areas, do not have access to safe drinking water. Nearly half (48%) of households in Mozambique have an unprotected water source as their primary source of drinking water. This statistic is much higher in rural areas (59%) as compared to urban areas (21%) (UNICEF 2011).

A large proportion (68%) of Mozambican households also lack adequate sanitation facilities. Over half of rural households lack facilities altogether (50%) and 24% use unprotected latrines (UNICEF 2011). Heavy flooding during the rainy season (typically December to March) brings increases in malaria cases, increases in diarrheal disease, and declines in water quality. An epidemiological study in Gaza province found that diarrheal disease incidence increased two- to four-fold during large floods (Kondo *et al.* 2002) and cholera epidemics become widespread (WHO 2004). Lack of adequate sanitation and poor hygiene practices facilitate the spread of cholera during times of epidemics.

A recent evaluation of a water supply and hygiene promotion campaign in Mozambique found that water is often contaminated between the source and the point-of-use. In locations where the intervention took place, 19% of the samples taken from the improved water source and up to 33% of water samples at point-of-use were microbiologically contaminated (Ministry of Foreign

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Affairs-Netherlands and UNICEF 2012). While cholera and other water-borne diseases cannot be completely eliminated from the environment, experts agree that improving access to safe water supplies is the only strategy to lessen their spread (Sack *et al.* 2006). Ensuring access to piped, treated water is a critical long-term strategy to reduce the devastating effects of diarrheal disease in Mozambique. In the interim, however, practical and inexpensive approaches, such as treatment of household water prior to consumption, can greatly reduce the burden of cholera and other water-borne diarrheal diseases (Fretwell *et al.* 2005; Gaffga *et al.* 2007).

In late 2004, PSI introduced Certeza in Mozambique. Certeza is a simple, robust, water quality intervention developed by the CDC, WHO, and Pan American Health Organization (PAHO) for diarrheal disease prevention. Certeza consists of a point-of-use chemical disinfectant consisting of diluted sodium hypochlorite solution and has been manufactured locally in Mozambique since 2007 from deionized water and sodium hypochlorite powder. The solution eliminates water-borne pathogens, such as *Escherichia coli*, *Shigella dysenteriae*, *Vibrio cholerae*, and rotavirus. Certeza is designed for point-of-use treatment of contaminated water at the household level. Sodium hypochlorite has long been considered a safe, effective, and inexpensive point-of-use water treatment option (Crump *et al.* 2005). A newer product for chemical disinfection, flocculant-disinfectant, has shown some advantages over sodium hypochlorite as it has not only been shown to be effective in removing suspended organic matter, bacteria, viruses, parasites, and heavy metals, but, unlike sodium hypochlorite, it also reduces turbidity of water (Mintz *et al.* 2001). Other treatment strategies, such as boiling and use of filters, are less ideal in developing world settings. Boiling is considered economically and environmentally unsustainable in low-resource settings (Gillman & Skillicorn 1985), and may be of limited effectiveness since water can become easily re-contaminated. Ceramic water filters have shown promise as a viable and cost-effective solution in some settings; however, their long-term effectiveness under real-world conditions must still be determined (Bielefeldt *et al.* 2009; Brown & Sobsey 2010).

PSI first began distributing Certeza in Maputo, Gaza, Sofala, Manica, Nampula, and Zambezia provinces and then, in 2007, PSI expanded to Cabo Delgado, Inhambane, Niassa, and Tete. Between April 2006 and May 2012, PSI distributed 4.4 million bottles of Certeza in Mozambique. PSI uses two channels to distribute Certeza: (1) free distribution and (2) sale through the private sector at subsidized prices. PSI uses interpersonal communication (IPC) activities, advertising, distribution of print materials, and mass media (TV, radio, and billboards) as means to increase knowledge and use of water treatment. In 2007 and 2012, PSI/Mozambique conducted population-based behavioral surveys to track key behavioral indicators over time and to assess the effectiveness of Certeza interventions.

METHODS

Objectives

The first objective of this study is to determine if there are any significant differences in key behavioral or intermediate programmatic indicators over the project period. A second objective of this study is to determine if there are any associations between exposure to Certeza interventions and behaviors (or other key indicators) relating to water treatment and Certeza knowledge and uptake.

Study design

The study used two multi-stage, cross-sectional quantitative surveys to collect and track key indicators among caregivers of children under the age of five. Conducted in 2007 and 2012, the surveys collected data from selected districts in four provinces that were chosen to represent PSI intervention areas. The strata were defined as: (1) urban Maputo/Beira; (2) urban Nampula; (3) rural Nampula/Zambezia (no intervention); (4) rural Zambezia (intervention). Within each district neighborhoods or villages were chosen with probability proportional to size as the primary sampling unit (PSU). Within each PSU, households were selected at random and respondents were selected from the household using a kisch grid. A total of 1,988 caregivers of children under the age of five were interviewed in the 2007 survey, and 2,071 were interviewed in the 2012 survey. The questionnaire collected information relating to

the knowledge of diarrheal diseases and associated behaviors, such as primary sources of water, means of transportation and conservation, hygienic practices, methods of water treatment, and Certeza knowledge and use. The indicators collected as part of this study are categorized into four outcome categories: (1) behaviors associated with water treatment; (2) community norms and social support for water treatment; (3) self-efficacy to treat water; and (4) knowledge of diarrheal disease prevention. The results of this study are presented using the four. The questionnaire also contained a section that collected information regarding exposure to Certeza interventions and advertisements. This exposure information is used in the evaluation analysis discussed below.

Analysis

Given differences in key socio-demographic characteristics between the two survey years, adjusted percentages are presented that account for differences in the respondents' residence, age, marital status, socio-economic status (SES), ethnicity, schooling, household ownership of key commodities, and access to media. Adjusted percentages are estimated by means of a margins command. The margins command provides predictions of the probit model at fixed values for each survey year, averaging or otherwise integrating over the remaining socio-demographic covariates. Three key exposure measures are created to assess the existence of associations between exposure to interventions and behaviors, using the 2012 survey. The three exposure measures are defined as:

1. Exposure to a water treatment television advertisement. PSI/Mozambique aired a national Certeza advertisement campaign to raise awareness and increase correct use of the product. This dichotomous exposure measure determines whether the respondent recalled seeing a TV advertisement for water treatment.
2. Exposure to IPC about Certeza. A key component of PSI/Mozambique's safe water program is training and promoting Certeza through peer educators and community groups. This dichotomous variable measures whether anyone in the respondent's community has ever spoken to them about how to use Certeza.
3. Exposure to single/multiple interventions. This exposure measure captures whether the respondent has been exposed to no intervention, one intervention (IPC or Mass Media) or two interventions (IPC and Mass Media). This exposure measure is used to assess whether a combination of interventions is more beneficial than a single intervention. Ideally, the variable will include a category for no intervention, IPC-only, mass media-only, and IPC/mass media combined. However, most of the respondents that were exposed to IPC interventions were also exposed to mass media intervention, so creation of an additional category was not possible.

The evaluation analysis uses a probit model and margins command to: (1) test the association between exposure to the interventions and key outcomes after controlling for other measured factors that may account for these differences; and (2) present adjusted percentages for each level of exposure. For exposure measures with more than one level, *p*-values for the tests of differences between each level and the null category (no exposure) and with the preceding categories of exposure (medium vs. low, high vs. medium) are presented in the tables. Measures of water treatment are dichotomous variables (yes/no). To measure intermediate outcomes (community norms, self-efficacy, availability, knowledge, and risk perception), respondents were asked whether they strongly agreed, agreed, disagreed, or strongly disagreed with a series of statements. For the purposes of this analysis, the categories of strongly agree/agree and strongly disagree/disagree are combined to create dichotomous variables.

RESULTS

2007–2012 Time trend analysis

Behaviors: water treatment

Between 2007 and 2012 there was significant improvement in the treatment of water for household consumption (Table 1). The percentage of respondents who reported that someone in the household treats the water to make it safe to drink increased by over ten percentage points, from

Table 1 | Behaviors relating to water treatment by year

Behaviors: water treatment	% 2007	% 2012	*p*-value	*N*
Someone in household (HH) treats water to make it safe to drink	26.7	38.2	0.000	4,058
Boils water at home	15.8	23.4	0.000	4,058
Treats water at home with any chlorine product	14.1	25.1	0.000	4,058
Treats water at home with Certeza	11.3	22.2	0.000	4,058
Has ever used Certeza	16.9	30.4	0.000	4,058
HH drinking water was treated with Certeza last week	9.9	25.1	0.000	3,389

27 to 38% in 2007 and 2012, respectively. This is reflected in significant increases between the two survey years, in all the recommended forms of water treatment: boiling (8 percentage point increase); use of chlorine (11 percentage point increase); use of Certeza (11 percentage point increase). The percentage of respondents who have ever used Certeza increased from 17 to 34%, and those who used Certeza within the past week increased from 10 to 25%.

Community norms and social support: water treatment

Table 2 below summarizes key indicators relating to community norms and social support regarding water treatment. The percentage of respondents who believe that doing something to make drinking water safe is normative within their communities increased from 23 to 43% between the two survey years. A greater percentage of women in 2012 also agreed that they had received advice from friends about water treatment (41% vs. 27%), or had someone in their community teach them how to treat water (36% vs. 19%). Respondents in 2012 were significantly more likely to report that they taught friends (39% vs. 22%) or family members (50% vs. 36%) how to treat water.

Self-efficacy: water treatment

Three key variables measuring self-efficacy to treat water were significantly different between the two survey years (Table 3). Respondents in 2012 were more likely than respondents in 2007 to feel that it is easy to treat water using chlorine (48% vs. 38%), a difference of ten percentage points. It is also evident that there were increases in women's sense of agency regarding water treatment between the two years: a lower percentage of women in 2012 than in 2007 agreed with the statements 'It is not up

Table 2 | Community norms and social support related to water treatment by year

Community norms and social support: water treatment	% 2007	% 2012	*p*-value	*N*
Agree that in community most people do something to make drinking water safe	23.4	43.0	0.000	4,058
Agree that most people do something to make drinking water safe	25.5	43.1	0.000	4,058
Agree that her friends advised to treat drinking water	27.1	41.5	0.000	4,058
Agree that people in the neighborhood taught her how to treat water	19.1	35.6	0.000	4,058
Agree that her friends sometimes bring water treatment products	9.7	28.2	0.000	4,058
Agree that she has taught friends how to treat water	22.2	39.3	0.000	4,058
Agree that she has given advice to family on how to treat water	35.8	50.2	0.000	4,058

Table 3 | Self-efficacy related to water treatment by year

Self-Efficacy: water treatment	% 2007	% 2012	*p*-value	*N*
Agree that it is easy to treat water using chlorine	38.0	48.4	0.000	4,058
Agree that there is nothing she can do to prevent her children from getting diarrhea	23.2	20.8	0.088	4,058
Agree that there is nothing she can do to protect her children from cholera	22.7	20.5	0.112	4,058
Agree that it is not up to her if household (HH) water is safe to drink	26.7	21.5	0.000	4,058
Agree that partner makes decisions on whether to buy products for water treatment	21.4	22.8	0.335	4,058
Agree that in absence of piped water, there is nothing to do about the quality of our drinking water in the HH	29.5	21.4	0.000	4,058

to me if HH water is safe to drink' (21% vs. 27%) and 'In the absence of piped water, there is nothing to do about the quality of our drinking water in the HH' (21% vs. 29%). There were no significant changes between the two survey years on indicators measuring women's confidence in being able to prevent their children from getting diarrheal disease or cholera.

Knowledge: prevention of diarrheal disease

Though values of the indicators were quite high in 2007, there were significant increases in indicators relating to causes and prevention of diarrheal disease between 2007 and 2012 (Table 4). Agreement from respondents that diarrhea can be prevented increased from 82 to 89% between the two years. Agreement that diarrhea is caused by lack of hygiene increased from about 82% to nearly 88% and that diarrhea is caused by contaminated water increased from 80 to 89%. Knowledge that water that may look clean can still be contaminated also increased. This is demonstrated by changes in the values of two indicators: knowledge that water that looks clean may still be contaminated increased from 64 to 79%; the same concept in the inverse – that clean-looking water is safe to drink–declined from 63 to 59%. Both of these indicators show significant changes in the hypothesized directions.

There was little change, however, in indicators that measure knowledge of the severity of contaminated water. All of these indicators, presented below, show no significant changes, but most show high values at baseline.

Table 4 | Knowledge related to prevention and causes of diarrheal disease, by year

Community norms and social support: water treatment	% 2007	% 2012	*p*-value	*N*
Agree that diarrhea can be prevented	81.7	88.6	0.000	4,058
Agree that diarrhea is caused by lack of hygiene	82.1	87.6	0.000	4,058
Agree that diarrhea is caused by contaminated water	80.4	88.7	0.000	4,058
Agree that diarrhea can be caused by drinking dirty water	81.1	90.9	0.000	4,058
Agree that diarrhea can be caused by drinking water that looks clean	67.3	82.0	0.000	4,058
Agree that water that may look clean may still be contaminated	63.9	78.7	0.000	4,058
Agree that if water looks clean it is safe to drink	63.0	58.6	0.008	4,058
Agree that adding chlorine to water makes it safe to drink	53.8	65.6	0.000	4,058
Agree that if it is piped water it should be safe to drink	71.1	67.3	0.014	4,058
Agree that it is dangerous to drink untreated water	88.4	88.9	0.657	4,058
Agree that contaminated water can cause serious health problems	93.1	92.7	0.599	4,058
Agree that treating the water with chlorine is the safest way to protect the family from contaminated water	69.1	71.2	0.178	4,058
Agree that treating water with chlorine takes out infectious substances that may be harmful	71.4	71.9	0.719	4,058

Effects of exposure to Certeza interventions

To determine whether PSI communication interventions have an effect on key indicators, a separate analysis is conducted using the data collected in 2012. Three exposure measures are created to examine the association of exposure to the activities and key outcome variables. Adjusted percentages for outcomes indicators are then compared between those exposed and those not exposed, after controlling for all key socio-demographic factors.

Behaviors: water treatment

Exposure to water treatment television advertisement (*Table 5*): After controlling for other factors, respondents who were exposed to the water treatment television advertisement were more likely to report making drinking water safe at home (45% vs. 34%) and to treat water at least once daily at home (19% vs. 14%). Respondents who saw the advertisement were more likely to use any of the recommended water treatment methods at home (boiling, use of chlorine, and use of Certeza). Habitual water treatment with Certeza was higher among those exposed to the advertisement (28% among exposed as compared to 17% among unexposed). Ever use of Certeza was 24 percentage points higher among exposed compared to unexposed respondents.

Table 5 | Effects of exposure to water treatment television advertisements on water treatment behaviors

Behaviors: water treatment	% Unexposed	% Exposed	*p*-value	*N*
Someone in household (HH) treats water to make it safe to drink	34.5	45.4	0.000	2,040
Boils water at home	22.5	27.6	0.020	2,040
Treats water at home with any chlorine	19.3	30.5	0.000	2,040
Treats water at home with Certeza	17.4	27.6	0.000	2,040
Treats water at least once daily	13.6	18.8	0.007	2,040
Has ever used Certeza	28.9	52.8	0.000	2,040
HH drinking water was treated with Certeza last week	15.1	35.3	0.000	1,384

Exposure to Certeza through IPC (Table 6): Exposure to IPC about Certeza (i.e., if someone in the respondent's community has spoken to her about Certeza) is significantly associated with all water treatment behaviors measured as part of this study. Exposure to IPC was highly associated with ever-use of Certeza (68% vs. 35%), habitual use of Certeza (39% vs. 18%) and also with other forms of water treatment. Those exposed to IPC were more likely to treat water at least one per day (23%) as compared to those who were unexposed (15%).

Table 6 | Effects of exposure to community IPC on water treatment behaviors

Behaviors: water treatment	% Unexposed	% Exposed	*p*-value	*N*
Someone in household (HH) treats water to make it safe to drink	35.3	59.5	0.000	2,071
Boils water at home	21.9	37.0	0.000	2,071
Treats water at home with any chlorine	20.6	43.2	0.000	2,071
Treats water at home with Certeza	18.5	39.3	0.000	2,071
Treats water at least once daily	15.0	22.8	0.000	2,071
Has ever used Certeza	35.3	68.1	0.000	2,071
HH drinking water was treated with Certeza last week	19.8	45.0	0.000	1,402

Exposure to single/multiple interventions: To determine the added value of interventions for water treatment, a three-level exposure measure was created to identify: (1) respondents who were unexposed to any Certeza intervention; (2) respondents who were exposed to one intervention (mass media or IPC); and (3) respondents who were exposed to two interventions (mass media and IPC). As can be seen by the results below (Table 7), exposure to one intervention presents significant effects for almost all key water treatment indicators measured as part of this study (comparison of columns 1 and 2). With the exception of whether the respondent treated her water at least once daily, the effects of exposure are significant and in the hypothesized direction – the largest being for ever-use of Certeza (41% vs. 13%) and whether the respondent treats her water habitually with Certeza (21% vs. 5%).

Exposure to both types of interventions (mass media and IPC) is associated with significant differences for all the indicators under study. For most indicators, those exposed to both types of interventions are more than two times as likely to be practicing water treatment. These effects are significant, not only when comparing to the null unexposed category (*p*-value presented in column 5), but also when comparing to the adjusted values of exposure to a single intervention (*p*-values presented in column 6). Notably, the percentage of respondents who treat water at home with Certeza increases from 5% among unexposed, to 21% among those exposed to a single intervention, and to 40% among those exposed to both interventions. These trends show the hypothesized dose–response effects of exposure to multiple types of interventions.

LIMITATIONS

This study uses an observational design to determine the effects of exposure to PSI Certeza interventions on key outcome variables. Observational studies such as this one are limited because they do not use randomization and equivalent control groups to determine effects of exposure on behavior. These studies estimate the effect of a program by comparing individuals who have self-selected to be exposed to a program against those who remained unexposed. Exposure is, therefore, not assigned by the investigator.

Table 7 | Effects of exposure to single/multiple Certeza interventions on water treatment behaviors

	% Unexposed (1)	% Exposed MM or IPC (2)	*p*-value (2 vs. 1) (3)	% Exposed to both (4)	*p*-value (4 vs. 1) (5)	*p*-value (4 vs. 2) (6)	*N* (7)
Someone in household (HH) treats water to make it safe to drink	25.2	37.9	0.000	60.0	0.000	0.000	2,071
Boils water at home	17.2	23.1	0.049	37.0	0.000	0.000	2,071
Treats water at home with any chlorine	8.8	23.2	0.000	44.0	0.000	0.000	2,071
Treats water at home with Certeza	5.5	21.1	0.000	39.9	0.000	0.000	2,071
Treats water at least once daily	12.4	15.6	0.198	23.1	0.001	0.001	2,071
Has ever used Certeza	13.1	41.0	0.000	69.2	0.000	0.000	2,071
HH drinking water was treated with Certeza last week	4.1	23.9	0.000	46.5	0.000	0.000	1,402

Multivariate regression analysis is used to overcome this problem. However, the design cannot account for two critical threats: (1) uncertainty about whether the exposure preceded the outcome; and (2) effects of unmeasured variables that cannot be accounted for in the regression models.

CONCLUSIONS

This study examined changes in water treatment behaviors, perceived norms about water treatment, perceived social support, self-efficacy, and perceived risk of diarrheal disease among caregivers of children under five in Mozambique. Between 2007 and 2012, perceived norms related to water treatment, perceived social support and self-efficacy in being able to treat water improved substantially. These changes were consistent with large improvements across multiple indicators reflecting increased treatment of water with Certeza, a chlorine-based solution.

The study also examined the impact of demand generation activities conducted by PSI during this period. Both exposure to a television advertisement and exposure to IPC activities had a large positive association with multiple indicators measuring water treatment, including daily treatment of water, ever-use of Certeza, and treatment of water with Certeza the week before the survey. Both exposure to television advertising and exposure to IPC were strongly associated with increased water treatment with Certeza. However, the largest impact of demand generation activities was among individuals who had been exposed both to IPC and to a television advertisement on the use of Certeza.

This is the first study that has evaluated the impact of a safe water solution in Mozambique. The findings of this study are consistent with findings from numerous studies across a range of health areas that have shown how social marketing can have a significant impact on the adoption of healthy behaviors (Stead *et al.* 2007). The findings from this study are promising and indicate that marketing a safe water solution can have substantial impact on household use of safe drinking water.

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