

# Criticisms of chlorination: social determinants of drinking water beliefs and practices among the Tz'utujil Maya

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## ABSTRACT

**Objective.** To explore social determinants of drinking water beliefs and practices among the Tz'utujil Maya of Santiago Atitlán, Guatemala, through analysis of demographics, socioeconomic status, memory of historical events, sensory experience, and water attitudes.

**Methods.** Parallel mixed (qualitative and quantitative) methods, including participant observation, in-depth interviews based on a purposive sample, and 201 semi-structured interviews based on a regional quota sample, were used to collect data from March 2007 to August 2008. Data analysis included the use of grounded theory methodology and Pearson's chi-square test for independence.

**Results.** Qualitative results based on grounded theory highlighted how memory of the Guatemalan Civil War and Hurricane Stan, attitudes about Lake Atitlán water, and the taste and smell of chlorine influenced Tz'utujil Maya drinking water beliefs. Quantitative survey results revealed that differences in ethnicity, literacy, years of schooling, distrust of the water supply during the Civil War and Hurricane Stan, and current beliefs about Lake Atitlán and tap water quality were associated with significantly different water self-treatment practices.

**Conclusions.** In accordance with social determinants of health paradigms, demographic, socioeconomic, social, cultural, political, and historical factors continue to be significant determinants of water-related health. Public health water interventions must address inequalities related to these underlying factors in order to achieve maximum effectiveness.

## Key words

Potable water; water treatment; water supply; chlorination (environmental health); indigenous health; anthropology; Guatemala; Latin America.

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Access to clean water and sanitation continues to be a major public health challenge worldwide. Globally, 900 million people rely on unimproved drinking water supplies and 2.5 billion people remain without improved sanitation facilities (1). The United Nations Millennium Development Goals, which include a specific aim to cut in half by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation, highlight the inter-

national salience of water-related issues (2). Although many people worldwide lack access to improved drinking water, firm progress has been made in Latin America, where 89% of the population has improved drinking water coverage. In Guatemala, improved drinking water coverage increased from 77% to 95% from 1990 to 2002, although only 55% of Guatemalans had a household water connection in 2002 (3). While access to clean water has improved in Guatemala,

water-borne infections remain at high levels.

Diarrhea, intestinal helminth infections, dracunculiasis, schistosomiasis, and trachoma, the main diseases or infections associated with inadequate water supply and sanitation, collectively affect nearly half of all persons in developing countries, and more than half the hospital beds in the world are occupied by people who have these diseases (4). Water and sanitation-related diseases such as diarrhea, dysentery, and intestinal parasites comprised 22% of cases among males and 19% of cases among females reported at the Ministry of Health post in Santiago Atitlán, Guatemala, in 2007 (5).

Since the late 19th century, chlorine has been widely recognized as an effective, practical, and affordable disinfectant of drinking water (6). Chemical disinfection of drinking water such as chlorination is now promoted and practiced at the community level as well as at point-of-use (6).

Despite the international salience of water-related issues, relatively few studies have examined people's beliefs about drinking water and its association with water treatment practices. One study in the Dominican Republic demonstrated a positive association between education and water purification practices, including boiling (7). One Guatemalan study examining psychosocial factors related to water treatment demonstrated that self-confidence, a positive attitude toward water treatment, the belief that a majority of the population treats water, and communication with one's partner are associated with self-treatment of water (8). Societal and cultural beliefs and norms have been shown to influence adherence to public health recommendations for drinking water (7, 9, 10).

Anthropological scholarship has demonstrated how sensory experience can influence people's perceptions of health (11). The unique smell and taste of chlorinated water has been documented in several contexts. In the United States and Canada, chlorine was one of consumers' most frequently reported odor and taste complaints to water utilities (12). In the United Kingdom, one study found that people preferred neutrality in the taste and smell of their drinking water; any additional smell or taste was perceived as unnatural, alarming, or bad

(13). Respondents even reported setting water out overnight to lessen the presence of chlorine (13). In Guatemala, among seven different types of water, including tap, well, boiled, bottled, spring, purified, and chlorinated, chlorinated water was the least preferred type and was perceived as being the least clear, natural, and "good tasting" (8). Although the critical medical anthropology literature emphasizes political and social factors that influence water-related practices, this relationship has not yet been demonstrated quantitatively (14, 15).

The social determinants of health, or the underlying social and economic conditions that shape people's health, provide a conceptual framework useful for illuminating how historical, political, and socioeconomic factors can lead to water-related health inequity (16, 17).

In the current study, it was hypothesized that differential water self-treatment practices would exist based on ethnicity, education, distrust of water during both the Guatemalan Civil War and Hurricane Stan, current beliefs about water from Lake Atitlán and tap water, chlorination preferences, and sensory experience (taste and smell). The study aimed to illuminate the social determinants of drinking water beliefs and practices among the Tz'utujil Maya of Santiago Atitlán, Guatemala, through analysis of demographics, socioeconomic status, memory of historical events, sensory experience, and water attitudes.

## MATERIALS AND METHODS

### Study community

Located between the southwest shore of Lake Atitlán and the base of the Tolimán volcano, the town of Santiago Atitlán has a population of 32 254 and is divided into nine municipal divisions known as cantons (18). A vast majority of the population (98.16%) identifies with Tz'utujil Maya (indigenous) ethnicity, while the remainder mainly identifies with *Ladino* (related to European descent) ethnicity (18). Among Santiago Atitlán residents, 89% live in urban cantons and 11% live in rural regions. Most residents get their drinking water from household or public taps (90%), with the remainder receiving their water directly from the lake (7%) or other sources such as streams and wells (3%) (18).

**Historical determinants: war and natural disaster.** For nearly five centuries, the Tz'utujil Maya have experienced repeated cycles of conquest: first by imperial Spain, in 1524, and later by international and local capitalism, as well as state terror during the Guatemalan Civil War from the 1960s to the 1990s (19). During the Civil War there were many confrontations between the Guatemalan Army and the Maya, claiming an estimated 50 000 to 100 000 Maya and other Guatemalan lives (20). In Santiago Atitlán, more than 500 violent deaths were attributed to Guatemalan Army troops stationed in the area (20). Violence peaked on December 2, 1990, when members of the Guatemalan Army opened automatic weapons fire on a crowd of more than 2 000 Tz'utujil Maya, resulting in the deaths of 14 unarmed residents and the injury of 21 others (20). Contemporaneously to the war, in the early 1990s, there was a cholera epidemic in Santiago Atitlán for the first time in more than 100 years.

Another significant event in Santiago Atitlán's history was Hurricane Stan, which hit Central America in October 2005, and caused more than 900 landslides in 251 of Guatemala's 331 municipalities (21). As a result of the hurricane, about 650 Guatemalans died and about 90 000 were relocated to temporary shelters (21).

**Water treatment.** In response to the cholera epidemic that hit Santiago Atitlán near the end of the Civil War, and in partnership with external aid organizations, the municipality developed its public water system and improved water quality in the early 1990s. In 1991, to help protect public health in Santiago Atitlán, the United Nations Children's Fund (UNICEF) donated a 125-horsepower water pump that ultimately provided water from Lake Atitlán to about 3 500 household taps. Later, in 1993, when Guatemala ranked third in the northern hemisphere in reported cases of cholera (22), the municipality was advised by engineers from international aid organizations to add chlorine treatment to the town's water supply as an additional public health measure. The Civil War ended in 1996, three years after the initiation of chlorine treatment. In the aftermath of Hurricane Stan in 2005, Santiago Atitlán again increased the levels of chlo-

ration in its water supply, based on the advice of international aid organization engineers.

Six pumps currently siphon water from Lake Atitlán for distribution to household taps throughout Santiago Atitlán. The municipal water system is treated with chlorine dioxide, generated by the reaction of sodium chlorite with chlorine gas. The municipal government manages chlorine treatment, which is monitored by the local Ministry of Health post (*Centro de Salud*).

## Study design

The current study used a parallel mixed methods design (23). Exploratory qualitative data were gathered in 2007 and both qualitative and quantitative data were collected in 2008.

**Qualitative data.** Qualitative methods included participant observation, in-depth interviews based on a purposive sample, and 201 semi-structured interviews based on a regional quota sample. All ethnographic, interview, and quantitative data were gathered by the lead author, and episodic data validity checks were conducted in the field by coauthors throughout the 2007–2008 study period. Participant observation included taking part in the daily lives of host families and working with Ministry of Health and municipal government employees responsible for water treatment, maintenance, and surveillance.

A grounded theory approach (24–26) helped identify salient themes related to drinking water beliefs and social determinants of health. In-depth qualitative interviews conducted from March to July 2007 were coded and combined with analytic memos to discern major themes. The identified themes informed the creation of a semi-structured questionnaire.

The mixed (qualitative and quantitative) semi-structured questionnaire was administered from March to August 2008, using both closed and open-ended questions that focused on beliefs and practices related to drinking water. Because of the lack of a household-level map, and the inability to enumerate the population, structured interview respondents were selected using regional quota sampling methods based on location (canton of residence) (27). Based on a 2006 municipal census, a canton-level re-

gional quota of households was calculated to give a total sample of approximately 200 households (18).

The first author and a field assistant chose a position near the geographical center of each canton to begin interviewing. An attempt was made to visit every 10th house from this position, including those comprised by multifamily compounds and other extended household configurations, until the regional quota was reached (7). If present, the head of household was interviewed; if the head of household was not available another household adult was selected. Interviews were conducted daily, excluding holidays, between 09:00 and 18:00 h, and typically lasted between 10 and 45 minutes. A total of 207 houses were visited to complete the regional quota sampling process. Of these 207 households, one declined to interview and five were not available during both the initial and subsequent visit, resulting in a total of 201 structured interviews and a response rate of 97.10%.

The qualitative data from the in-depth and semi-structured interviews were recorded using paper-based field notes and, when possible, a digital audio or video recorder. During each interview, one of two female field assistants facilitated translation between Spanish and Tz'utujil, if necessary (approximately half of the respondents spoke Spanish). After each interview, the first author and the field assistant reviewed the interview notes and summarized and clarified specific points. Field notes, narrative comments, and recorded interviews were then transcribed into an electronic format using Microsoft Word word-processing software (Microsoft Corporation, Redmond, WA, USA).

**Quantitative data.** Quantitative data were recorded on field notes and then entered into a spreadsheet. SPSS 12.0 for Windows (SPSS Inc., Chicago, IL, USA) was used to conduct statistical analyses of the data.

Drinking water practices were dichotomized to “self-treated” and “not self-treated” drinking water sources. Self-treated sources included self-chlorinated, filtered, or bottled water. “Not self-treated” sources included water from the tap and water taken directly from the lake. Literacy was defined as self-reported literacy in Spanish, as Tz'utujil is not a written

language. The literacy variable was then dichotomously coded as illiterate (“0”) or literate (“1”).

Associations were calculated among water practices and various demographic, socioeconomic, and beliefs variables. An independent samples Student's *t*-test for comparison of means was used to compare the continuous variables of age and years of schooling among persons who self-treat versus persons who do not self-treat their drinking water. Pearson's chi-square test was used for water practices and the following categorical variables: sex, ethnicity, literacy, distrust of water during the Guatemalan Civil War, distrust of water during Hurricane Stan, current beliefs about Lake Atitlán and tap water quality, belief that tap water is chlorinated, tap water preferences related to chlorine, and belief that chlorine has a bad taste or smell.

## Ethics

This study was approved by the University of Pennsylvania's Social and Behavioral Sciences Institutional Review Board. In the year preceding the study, researchers worked closely with key community leaders from the Municipality of Santiago Atitlán, the local *Centro de Salud*, Hospitalito Atitlán, and the community at large to understand water- and health-related issues in Santiago Atitlán and to identify salient research questions. Local approval for the study was provided by the Office of the Mayor of the Municipality of Santiago Atitlán and by the Ministry of Health.

## RESULTS

### Qualitative results

Analysis of semi-structured interviews based on grounded theory methodology revealed three main categories of themes related to water practices: memories of historical events, current beliefs about Lake Atitlán, and preferences regarding tap water chlorination (Table 1).

### Memories of Guatemalan Civil War.

Among interview respondents old enough to remember it, the Guatemalan Civil War was a significant political determinant of people's views about drinking water. Eighty respondents agreed that they distrusted the local water sup-

**TABLE 1. Number and proportion of semi-structured interview respondents identifying various themes related to historical memory, water attitudes, and chlorination preferences, Santiago Atitlán, Guatemala, March–August 2008**

Theme	Agreed		Disagreed		Did not address	
	No.	%	No.	%	No.	%
Historical memory						
Distrust of water during Guatemalan Civil War ( <i>n</i> = 201)	80	39.8	42	20.9	79	38.3
Among those who distrusted water						
Changed water-related practices during Civil War ( <i>n</i> = 80)	49	61.2	31	38.8	0	0.0
Distrust of water during Hurricane Stan ( <i>n</i> = 201)	150	74.6	51	25.4	0	0.0
Among those who distrusted water						
Changed water-related practices during Hurricane Stan ( <i>n</i> = 151)	127	84.1	24	15.9	0	0.0
Water attitudes						
“The water in Lake Atitlán is dirty” ( <i>n</i> = 201)	120	59.7	76	37.8	5	4.2
Among people who believe Lake Atitlán is dirty						
“Trash is the main cause of contamination” ( <i>n</i> = 120)	52	43.3	43	35.8	25	20.8
Chlorination preferences						
Prefer unchlorinated tap water for drinking ( <i>n</i> = 201)	97	48.3	103	51.2	1	0.5
Among people who prefer unchlorinated water						
“Chlorine has a bad smell or taste” ( <i>n</i> = 97)	47	48.5	50	51.5	0	0.0

ply during the Civil War, and 49 of those respondents said they changed their water-related practices during the Civil War period as a result (Table 1).

Some respondents said that when chlorination was first introduced in Santiago Atitlán during the cholera epidemic and the Civil War period, they distrusted the drinking water supply, believing that it had been tainted or poisoned by the Guatemalan Army due to its unusual taste. One 49-year-old man said, “I remember that the water began to taste strange, and I thought maybe the army had tainted or poisoned the water.”

Images of violence and death during the Civil War remain vivid among the Tz'utujil Maya. Several respondents said they believed that many of the dead or missing during the Civil War period had been dumped into Lake Atitlán by the Guatemalan Army, thereby contaminating the water supply. One 63-year-old woman said, “Sometimes, the lights and electricity would go out at night, and the next day we would hear that people had disappeared or been killed. It was rumored that the missing people’s bodies were dumped in the lake.” Another 60-year-old woman said, “The army killed my husband during the war. I was so scared during that time and I did not trust the drinking water.”

Tz'utujil Maya respondents coupled the theme of limited resources with fears of contamination during interviews, suggesting both economic and social determinants of health and memory. One 55-year-old man said, “I knew the water

was contaminated and that people’s bodies were thrown in the lake, but we had no other options for drinking water. Where else could we get water?”

**Memories of Hurricane Stan.** Hurricane Stan, the natural disaster that struck the area in 2005, also remains in the memories of many Tz'utujil Maya and continues to influence their drinking water-related beliefs and practices. Almost 75% of respondents (150 people) mentioned distrust of the water supply during Hurricane Stan, and 127 said they changed water-related practices (e.g., consuming bottled water instead of tap water) during the hurricane. In addition, some respondents reported self-treating water (boiling, chlorinating, or filtering it) for the first time during Hurricane Stan. Respondents again described their fears of dead bodies washing into Lake Atitlán as a result of hurricane-related mudslides, as well as various sensory experiences. One 18-year-old male said, “There was a river of mud, full of pieces of homes, persons, and children who had died. My uncle said he saw firemen taking out dead bodies from the lake. There were also dead animals like dogs and cats. The roads were so muddy and blocked that you could no longer travel on them, but you had to travel in boats to get around.” One 45-year-old woman said, “After the hurricane, the water was very dirty. You could see dirt in the tap water, so I stopped drinking it, but I still used it for washing clothes. I was scared to use the water because many people

and animals had died in the water, and their bodies never surfaced for several months.” One 57-year-old woman said, “During Hurricane Stan, I found something in my tap water that looked like part of a finger or a fingernail. The water was dirty and full of contamination. After that, I only drank bottled water.”

Memories of Hurricane Stan included olfactory experiences related to the water. Some respondents who lived near the mudslides remembered the distinctive smell of the lake. One 54-year-old woman said, “There was a bad smell around the lake. The water smelled of suffering, of mud and rocks and people being mashed together.” Some people noted a change in the smell of water due to higher chlorination levels after the hurricane. One 56-year-old woman said, “The water really had an awful and strong smell to it, but I guess it was just the chlorine.”

**Current beliefs about Lake Atitlán water quality.** More than half of the respondents (120 people) said the water of Lake Atitlán is dirty (Table 1). The most frequently mentioned sources of contamination included trash produced by residents of Santiago Atitlán or the other communities that share Lake Atitlán (52 responses), rain (18 responses), bacteria or germs (17 responses), laundry runoff (8 responses), and boats (6 responses). One 54-year-old man said, “Many people throw trash into the lake, nobody cleans the streets, and people just do not care. I’ve seen people throw dead chickens in the lake.” Several respondents (18

**TABLE 2. Demographic and socioeconomic characteristics of participants in study on drinking water beliefs and practices, Santiago Atitlán, Guatemala, March–August 2008**

Characteristic	(n = 201)		Mean (SD <sup>a</sup> )	Self-treat their drinking water	Do not self-treat their drinking water	Significance test results	P
	No.	%					
Demographics							
Age (years)	NA <sup>b</sup>	NA	44.20 (18.25)	42.23 (16.02)	45.84 (19.84)	-1.397 <sup>c</sup>	0.164
Sex						2.497 <sup>d</sup>	0.114
Female	125	62.2	NA	62	63	NA	NA
Male	76	37.8	NA	29	47	NA	NA
Ethnicity						7.476 <sup>d</sup>	< 0.01
Ladino	6	3.0	NA	6	0	NA	NA
Tz'utujil Maya	195	97.0	NA	85	110	NA	NA
Socioeconomic status							
Schooling (years)	NA	NA	2.28 (3.98)	3.92 (5.01)	0.92 (2.05)	5.731 <sup>c</sup>	< 0.01
Literacy <sup>e</sup>						18.416 <sup>d</sup>	< 0.01
Literate	62	32.0	NA	42	20	NA	NA
Illiterate	132	68.0	NA	46	86	NA	NA

<sup>a</sup> SD: standard deviation.

<sup>b</sup> NA: not applicable.

<sup>c</sup> Student's *t*-test.

<sup>d</sup> Pearson's chi-square test.

<sup>e</sup> Sums do not equal total sample due to a lack of response from seven participants.

people) mentioned that during the rainy season, many lake contaminants such as trash, fecal matter, and insecticides get washed into the lake.

Some respondents (8 people) explained that local women often launder their family's clothes in a particular alcove of the lake, near the municipal water pump, where colored residue from the dirty clothes and soap is often visible.

**Chlorination preferences.** A slight majority of respondents (103 people) said they preferred drinking water that was chlorinated. The reasons cited most frequently for preferring chlorination included its ability to kill bacteria and germs (cited 42 times), the fact that only a small amount is necessary (24 responses), its ability to clean (10 responses), prevention of illness (9 responses), and prevention of diarrhea (7 responses).

In contrast, 97 respondents said they preferred unchlorinated drinking water. The most common reasons cited were the chlorine's bad taste or smell (cited 47 times), its ability to cause illness (19 responses), their belief that it had no real function (10 responses), and their belief that it was too strong (4 responses).

### Quantitative results

Among participants in the structured questionnaire, the average age was 44.20 years and a slight majority (62.2%) were female (Table 2). Most were Tz'utujil

Maya (97.0%), with the remaining 3.0% identifying themselves as Ladino. According to the study results, Ladinos had significantly different water treatment practices than Tz'utujil Maya ( $P < 0.01$ ). All Ladinos interviewed reported self-treating their water, versus only 77.3% of Tz'utujil respondents. In terms of socioeconomic status, respondents reported an average of 2.28 years of schooling, and about two-thirds were illiterate. The mean number of years of schooling for those who self-treated their drinking water was significantly higher than that of those who did not (3.92 versus 0.92;  $P < 0.01$ ). Similarly, there was a significant difference in the frequency of self-treating water depending on the literacy of the respondent ( $P < 0.01$ ).

Regarding drinking water beliefs during the Guatemalan Civil War, nearly twice as many respondents distrusted as trusted the water supply (65.6% versus 34.4%) (Table 3). Based on the qualitative data, these perceptions are due to beliefs about contamination by poison or dead bodies. Those who distrusted the water during the Civil War had significantly different water self-treatment practices than those who trusted the water, and a higher proportion of those who distrusted the water during the Civil War versus those who trusted it reported self-treating their current water supply ( $P = 0.016$ ). Similarly, during Hurricane Stan, a significantly higher proportion of those who distrusted the water supply

during Hurricane Stan versus those who trusted it reported self-treating their current water supply ( $P < 0.01$ ).

Currently, a slight majority of respondents (61.2% versus 38.8%) believe the water in Lake Atitlán is dirty; however, a slight majority of respondents believe the tap water is clean (Table 3). This indicates that respondents recognize that the municipal tap water is treated before distribution to household taps. Most respondents (84.6%) were aware that the municipal water was treated with chlorine, while a minority (15.4%) did not think the tap water was treated with chlorine.

Those who believe the lake water is clean versus dirty have significantly different water self-treatment practices. Santiago Atitlán residents who believe the water of Lake Atitlán is dirty comprise 74.2% of current self-treated water drinkers but only 50.5% of current non-self-treated water drinkers ( $P < 0.01$ ). Although municipal tap water was rated as "clean" by more respondents than Lake Atitlán water, those who believe it is dirty are also significantly more likely to self-treat their current drinking water supply ( $P = 0.024$ ). There was no significant difference in water self-treatment practices between 1) those who believed the current tap water was chlorinated versus those who did not, 2) those who preferred chlorinated water versus those who did not, and 3) those who cited sensory factors such as taste and smell as

**TABLE 3. Beliefs and preferences related to self-treatment of water, Santiago Atitlán, Guatemala, March–August 2008**

Belief/preference	<i>n</i>	No.	%	Self-treat water (No.)	Do not self-treat water (No.)	$\chi^2$ <sup>a</sup>	<i>P</i>
Distrusted water during Guatemalan Civil War	122					5.792	0.016 <sup>b</sup>
Yes		80	65.6	45	35		
No		42	34.4	14	28		
Distrusted water during Hurricane Stan	201					30.971	< 0.01
Yes		150	74.6	85	65		
No		51	25.4	6	45		
Think Lake Atitlán water is clean	196					11.486	< 0.01
Yes		76	38.8	23	53		
No		120	61.2	66	54		
Think tap water is clean	197					5.123	0.024 <sup>b</sup>
Yes		107	54.3	41	66		
No		90	45.7	49	41		
Think tap water is chlorinated	201					0.165	0.685
Yes		170	84.6	78	92		
No		31	15.4	13	18		
Prefer tap water	201					0.095	0.758
With chlorine		104	51.7	46	58		
Without chlorine		97	48.3	45	52		
Prefer unchlorinated tap water because of chlorine's bad taste or smell	97					0.006	0.936
Agree		47	48.5	22	25		
Disagree		50	51.5	23	27		

<sup>a</sup> Pearson's chi-square test.

<sup>b</sup> *P* < 0.05.

the reason for preferring unchlorinated water versus those who did not.

## DISCUSSION

Using the social determinants of health framework, this study illuminates several factors that lead to differential water- and health-related outcomes. The social determinants of health paradigm emphasizes the underlying social, cultural, and political factors that may lead to health inequity (16, 17). In terms of demographics, this study identifies significant differences in water self-treatment practices between Ladino and Tz'utujil populations. Although it was hypothesized that Tz'utujil people might historically distrust water and therefore self-treat water more because of events such as the Civil War, quantitative results demonstrate that Ladino populations self-treat water more than Tz'utujil populations. This relationship may be mediated by socioeconomic factors such as education level. Education is a significant determinant of water practices; both those who had more years of schooling and those who were literate were more likely to self-treat their drinking water than those without those characteristics.

Many beliefs, influenced by political, historical, and cultural factors, serve as

significant social determinants of health related to drinking water practices. In particular, distrust of the water supply during both the Guatemalan Civil War and Hurricane Stan was significantly associated with differential water self-treatment practices. Residents who distrusted the water supply during Hurricane Stan comprise 93.4% of current self-treated water drinkers but only 59.1% of current non-self-treated water drinkers. Qualitative data suggests that distrust of drinking water during the Civil War stems from memories of political and historical factors as well as sensory experiences, including graphic images of violence and bad or strange smelling/tasting water.

Because the municipal government, through an international aid intervention, introduced chlorination near the height of the Civil War in response to a cholera epidemic in the early 1990s, many Tz'utujil Maya began to associate the smell and taste of chlorine with death and contamination or poison. Similarly, the municipal government raised water chlorination levels after Hurricane Stan when mudslides carried debris and dead bodies into Lake Atitlán, reinforcing the collective experience associating death and destruction with the smell and taste of chlorination. Although qualita-

tive interviews suggested that sensory experience was an important reason for distrust of water during both Civil War and Hurricane Stan, quantitative analysis indicated beliefs about the taste and smell of the water were not significantly associated with differential water self-treatment practices.

Municipal chlorination remains a divisive issue in Santiago Atitlán, where 48.3% of residents prefer tap water without chlorine. Future research might examine residents' preferences related to water treatment methods other than chlorination, such as filtration or boiling, which could inform municipal water policy alternatives or identify popular water treatment interventions to promote at the household level. Local beliefs about the relation between water consumption and health impacts could also be explored further.

Limitations of this study include a relatively small sample size and non-randomization of the cross-sectional survey. Because of the cross-sectional design, only associative relationships can be determined from the results. In addition, because of the small number of Ladino residents in the sample, definitive conclusions about comparisons between ethnic groups require further exploration. Strengths of the study include the use of

mixed (qualitative and quantitative) methods, including participant observation, in-depth interviews, and semi-structured interviews, which provide novel and relevant means to analyze the social determinants of drinking water practices.

Local perceptions of public health interventions such as chlorination of a municipal water supply are often influenced by social determinants, such as demographic, socioeconomic, social, cultural, political, and historical factors. Global public health intervention planning and implementation should take social determinants of health into consideration in order to improve the over-

all health of the population and minimize health inequalities.

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**RESUMEN****Críticas a la cloración:  
factores sociales  
determinantes de las  
creencias y prácticas con  
respecto al agua potable de la  
población maya tz'utujil**

**Objetivo.** Explorar los factores sociales determinantes de las creencias y prácticas con respecto al agua potable de la población maya tz'utujil, que habita en Santiago Atitlán (Guatemala), mediante el análisis de la información demográfica, la situación socioeconómica, la memoria de hechos históricos, la experiencia sensorial y las actitudes con respecto al agua.

**Métodos.** De marzo del 2007 a agosto del 2008, se recopilaron datos por medio de métodos paralelos mixtos (tanto cualitativos como cuantitativos), como la observación de participantes, entrevistas en profundidad basadas en un muestreo intencional y 201 entrevistas semiestructuradas basadas en un muestreo por cuota regional. En el análisis de los datos se usó el método de la teoría fundamentada o muestreo teórico y la prueba de la chi al cuadrado de Pearson para la independencia.

**Resultados.** Los resultados cualitativos basados en la teoría fundamentada pusieron de relieve que los recuerdos de la guerra civil guatemalteca y del huracán Stan, las actitudes acerca del agua del Lago Atitlán, y el gusto y el olor del cloro influían las creencias de los tz'utujiles con respecto al agua potable. Los resultados cuantitativos de la encuesta indicaron que las diferencias a raíz del grupo étnico, el alfabetismo, los años de escolaridad, la desconfianza del abastecimiento de agua durante la guerra civil y el huracán Stan, y las creencias actuales acerca de la calidad del agua del Lago Atitlán y del agua de grifo estaban asociadas con prácticas de autotratamiento del agua sumamente diferentes.

**Conclusiones.** En consonancia con el paradigma de los factores sociales determinantes de la salud, los factores demográficos, socioeconómicos, sociales, culturales, políticos e históricos siguen siendo determinantes significativos de la salud en relación con el agua. Para que puedan lograr la mayor eficacia posible, las intervenciones de salud pública con respecto al agua deben abordar las desigualdades relacionadas con estos factores fundamentales.

**Palabras clave**

Agua potable; tratamiento del agua; abastecimiento de agua; cloración (salud ambiental); salud indígena; antropología; Guatemala; América Latina.