Mistrust at the tap? Factors contributing to public drinking water (mis)perception across US households

Gregory Pierce* and Silvia Gonzalez

Department of Urban Planning, University of California, Los Angeles, 3250 Public Affairs Building, Los Angeles, CA 90095-1656, USA

*Corresponding author. E-mail: gspierce@ucla.edu; gpierce@luskin.ucla.edu

Abstract

How individuals perceive the safety of their public drinking water influences whether they reach for the tap to quench their thirst, or an alternative such as bottled water or a sugary drink. In turn, mistrust of drinking water quality and subsequent reliance on alternative beverage sources can adversely impact health, welfare and the environment. Using data from the 2013 American Housing Survey, we provide the first national, rigorous assessment of individuals’ perception of their public drinking water supply. We found strong evidence that perception of water quality is most influenced by individual and household indicators of socioeconomic status—education level, household income, racial or ethnic minority status, and most importantly foreign-born nativity, especially from Latin America. By contrast, our findings provide little indication that perception is tied to known built environment or neighborhood risk factors affecting water safety and quality. We outline the implications of our findings for proponents of enhanced tap water consumption, including public drinking water systems, county public health agencies, and particularly for environmental justice non-profits.

Keywords: Behavioral economics; Drinking water; Immigrants; Risk perception; Water safety

Introduction

How individuals perceive the safety of their public drinking water supply influences whether they reach for the tap to quench their thirst, or an alternative which can adversely impact their health, welfare and the environment. Mistrust of tap water is associated with decreased water consumption and increased intake of sugary drinks (Onufrak et al., 2014), contributing to obesity as well as decreased oral health (Ogden et al., 2012). Even when consumption is shifted to bottled water, oral health often suffers due to inadequate exposure to fluoridation in bottled sources (Hobson et al., 2007). Reliance on more expensive alternatives to public tap water also increases household expenditure. An increase in expenditure compounds gaps in affordability and broader service accessibility for the

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disadvantaged, who are already more likely to mistrust their tap water (Abrahams et al., 2000; Dupont et al., 2014). Misconceptions about water quality and safety also harm the environment via increased consumption of bottled drinks (Merkel et al., 2012). In addition to the marginal added air pollution associated with bottled water transport, the Natural Resources Defense Council (NRDC) estimates that only 13% of used water bottles are recycled, with the rest ending up in landfill or polluting public waterways (NRDC, 2008).

A growing literature assesses different factors which influence the general public’s perception of water quality. Much of the literature on the determinants of perception, however, is empirically grounded in low- and middle-income countries, where tap water is more likely to be unsafe (for instance, see Spencer, 2011). By contrast, drinking water quality in the United States is generally high, even if disease outbreaks from low-quality water are underestimated (Craun et al., 2010; Hanna-Attisha et al., 2016) and systemic failures such as that of Flint, Michigan become more common. Studies on water perception in the US context, however, have almost exclusively focused on subsets of the population, such as children (Gorelick et al., 2011), residents of under-served communities, most notably colonias along the USA-Mexico border (Leach et al., 1999; Regnier et al., 2015), or on the drivers for preference of bottled water over tap water (Hu et al., 2011). By contrast, our sample is representative of the adult population in the USA, the vast majority of which are served by high-quality public water systems, before the Flint water crisis was revealed in early 2016. (We outline a strategy to measure the lasting salience of Flint on perception in the US population in the Discussion section.) Our study adds to the existing literature the most comprehensive examination to date of the range of socioeconomic factors that affect tap water perception, including differentiation in perception by nativity status and place of origin.

We find strong evidence that perception of water quality is most influenced by individual demographics and household factors – education level, income, racial or ethnic minority status, and most importantly foreign-born nativity, particularly from Latin America. By contrast, our findings provide little indication that perception is tied to known built environment or neighborhood risk factors affecting water safety and quality such as the quality of housing (Pierce & Jimenez, 2015) and source of tap water (DeSimone, 2009). We outline the implications of our findings for proponents of enhanced tap drinking water consumption, including public drinking water systems, county public health agencies, and environmental justice non-profit organizations.

Based on our findings, we suggest that targeted and aggressive public education campaigns led by non-profit organizations would prove more effective in promoting the drinking of tap water than the ad-hoc, generic informational campaigns currently used. Ultimately, changing (mis)perceptions of public drinking water is only a partial solution, which will prove more meaningful alongside other policies supporting behavior change in tap water consumption, and parallel efforts to put pressure on systems to improve actual water quality to meet primary and secondary standards where necessary.

Data and methods

Using data from the 2013 American Housing Survey (AHS), a nationally representative sample of the US housing stock, we first present descriptive evidence on water quality perception and contributing factors to (mis)perception, with a particular focus on perception among foreign-born respondents. We then construct a binary logit regression model to assess the full range of factors contributing to perceived water safety. The data for this study are derived exclusively from the 2013 AHS. The AHS is sponsored
by the US Department of Housing and Urban Development and has been conducted by the US Bureau of the Census biannually since 1973. In all calculations reported in this analysis, we follow the guidance of the AHS codebook and employ 160 replicate survey weights using the balanced repeated replicate (BRR) weights command in Stata 13. The survey features questions on a wide range of topics, including head of household socioeconomic characteristics, neighborhood characteristics, and geographical location, among others (US Census Bureau, 2014). We have valid data on all relevant study characteristics for 126,424 of the 134,918 interviewed housing units in the survey (94%).

The outcome of interest in this study is perceived water safety. We construct the outcome of interest from a categorical variable in the AHS. This variable records head of household responses to the following question: ‘In your opinion, is the water from this source safe for cooking and drinking?’ (American Housing Survey, 2013). We recode this self-reported response as a binary variable that indicates whether the respondent believes their in-home water source is safe for consumption (1) or not (0). The resulting binary outcome – perceived water safety – serves as the dependent variable in the empirical analysis.

Conceptual framework

Beliefs, perceptions and behaviors related to tap water are influenced by at least three categories of explanatory factors: individual demographic characteristics, household socioeconomic characteristics, and the built environment. We design our conceptual model based on these categories, which have been shown to influence perception but have not been comparatively assessed in previous studies. We then chose variables from the AHS dataset that best operationalized our conceptual model.

Perceptions of and behaviors regarding tap water use may be due to individual taste, color and odor preferences, broader risk perceptions or willingness to pay for a preferred alternative to a public source (de França Doria et al., 2009; Noga & Wolbring, 2013). Individual perception of risk from tap water stems from both opinions regarding specific water treatment chemicals such as chlorine and fluoride as well as general trust in public services. Both these factors are influenced by access to information about water quality and the amount of trust placed in that information, which may depend on the type of media which individuals rely upon and trust (de França Doria et al., 2009). Historical experience with poor water quality and negative health outcomes stemming from consumption of public water supply also influence perceptions and behaviors towards tap water (Scherzer et al., 2010). We expect that access to publicly available information on water quality, such as annual quality reports, and trust in this scientific information will increase with educational attainment. We thus include high school graduation status as an explanatory variable in our model. We also include race and ethnicity as controls in the model as avoidance of tap water use is particularly pronounced among Latino communities (Scherzer et al., 2010) and other non-White consumers (Abrahams et al., 2000). While historical research on the public provision of water to urban households in the United States does not generally support an overt racial or ethnic discrimination hypothesis (Troesken, 2004), several studies have identified a link between racial minority status and tap water perception (Dupont et al., 2014; Onufrak et al., 2014). While the nature of the relationship between race and tap water perception has not been as clearly shown for non-Latino minority groups, we expect minority groups to perceive their water to be lower quality due to a combination of past negative experience, current housing quality, and access to information such as consumer confidence reports (CCRs) (Roy et al., 2015).

We further hypothesize that foreign-born survey respondents, particularly those from low- and middle-income countries where water quality is worse than in the USA, are more likely to have past
experience with water-related health problems (Hobson et al., 2007). The public health literature suggests a relationship between immigration status and (mis)perception of quality but there is some diversity in findings. The main focus of research showing a disparity between immigrants and the native-born population has been on immigrants’ preference for bottled water rather than tap water (Scherzer et al., 2010; Huerta-Sáenz et al., 2012), making it difficult to generalize the findings for the rest of the population. For instance, in a cross-sectional survey of parents of children treated in a pediatric emergency department, Gorelick et al. (2011) find that immigrant status does not influence water choice. In a similar survey, on the other hand, Hobson et al. (2007) find that Latino immigrants were less likely to drink tap water or provide it to their children than non-Latinos due to fear of potential illness.

In addition to race/ethnicity and foreign-born status, we test whether there are differences in perception of water quality differentially among immigrants exhibited depending on the country of origin. Our analysis disaggregates the immigrant experience in a more comprehensive fashion than previous scholarship. Only Regnier et al.’s study (2015) on the perception of water has examined the influence of place of origin with respect to immigrant populations. This study, however, limited its scope to individuals of Mexican origin. In our analysis, we differentiate between non-Latino immigrant householders and Latino1 immigrants as the latter tend to have lower incomes at the time of move to the USA than immigrants from other world regions. Moreover, we include years lived abroad as an explanatory factor in our model. We assume that a greater number of years lived abroad before residing in the USA is likely to increase the possibility of experiencing a water-related health problem and thus heighten mistrust of tap water.

In addition to individual demographics, household socioeconomic status also plays a role in tap water perception (Canter et al., 1992). We use the household as the unit of analysis to examine socioeconomic status as it is the most basic social grouping and is commonly used in microeconomic models. We include household income as an explanatory variable as previous studies have found an association between higher household income and greater water service reliability, better housing quality, and the integrity of in-home piping (Pierce & Jimenez, 2015). We also expect ownership of the housing unit to influence perception. We hypothesize that home ownership has a positive relationship with perceived water quality based on research in low- and middle-income countries. The international housing literature suggests a relationship between unit ownership status and improved water service provision, and microeconomic theory suggests owners will better maintain their housing unit than renters to directly capture the long-term benefits of maintenance (Strassman, 1994; Nakamura, 2014). We also suggest that home ownership increases familiarity with and thus trust in the drinking water source because homeowners are much more likely than renters to directly interact with their tap water provider. Familiarity with a specific drinking water supply (de França Doria et al., 2009) and perceived control over one’s own water supply (Syme & Williams, 1993) have been positively associated with perception of water safety.

In addition, neighborhood and broader built environment characteristics may influence water service reliability – among other public services – and perceptions of risk among residents, impacting their attitudes towards publicly provided water quality. For instance, in their study of personal psychological attributes impacting perception, Syme & Williams (1993) find that ‘satisfaction with drinking water

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1 We define Latino immigrants to the USA as those born in Mexico and Central American countries.
may...be simply a subset of an overall view as to the pleasantness or otherwise of neighborhood conditions’. Perception may be particularly influenced by the type of water system servicing a residence and the proximity to potential water-polluting activity, such as farming, as well as overall neighborhood environmental quality (Jones et al., 2006; Sorlini et al., 2014). In short, the quality of a housing unit and the quality of the public services provided to a neighborhood may affect both actual and perceived water quality.

To examine the impact of the immediate built environment on perceived water safety, we construct two variables. We include an interviewer-reported measure of housing unit quality (on a 1–5 scale, with 1 being best) which we expect to capture attributes of unit quality otherwise unobserved in the model. We expect higher reported unit rating to correlate with better water quality perception. Housing unit age may also impact housing and water quality via the in-home piped infrastructure. Recently built units tend to provide safer and more reliable water due to the 1991 passage of the Lead and Copper Rule (Hanna-Attisha et al., 2016). Accordingly, we include an indicator variable for units built in 1990 or later. However, it should be noted that newer, in-home piped water infrastructure may also degrade water quality through the introduction of new complex chemicals (Turek et al., 2011; Sorlini et al., 2014). Similar to unit rating, the AHS asks respondents to rate their neighborhood as a place to live on a scale of 1–10 (10 being best). We include this neighborhood quality variable as a proxy for the quality of neighborhood service provision.

To further examine the impact of the built environment, we consider housing unit type and the type of system providing water to a unit. Previous studies have shown that multiple facets of water service are worse among trailer park units (Pierce & Jimenez, 2015). To test for the impact of housing type, we construct a trailer park indicator and differentiate whether the housing unit is part of a mobile home park (Econometrica, 2013). To account for water system type, we categorize networks serving fewer than 15 households as small systems. The AHS data allow for this distinction, which effectively mirrors the public-private water system distinction made by the US Environmental Protection Agency (EPA). All water systems serving 15 or more households are regulated for water quality by the federal EPA and its state-level agencies, whereas systems with fewer than 15 connections are not subject to any routine quality testing. Small private systems are also more likely to rely on well water. As a result, small systems are more likely to experience service interruptions than larger systems (Craun et al., 2010) and are at higher risk of contamination (Wedgworth & Brown, 2013).

Results

Having outlined a conceptual framework for understanding variation in drinking water perception, we discuss descriptive findings on the relationship between race/ethnicity, nativity status and perceived water quality (full descriptive statistics for all independent variables and controls are provided in Appendix 1, available with the online version of this paper). More than 90% of the entire sample perceive their drinking water to be safe for drinking and cooking. As Table 1 shows, however, trust of tap water is highly variable across nativity, region of origin and racial-ethnic lines.

Immigrants are less likely than the native-born to trust their tap water quality, with immigrants from Latin American countries being the most cautious. Nearly one-third of immigrant Latinos indicated that they do not perceive their water to be safe for drinking and cooking. While other immigrants also
perceive their water to be less safe than native born respondents at a statistically significant rate, this difference is less than 10% below the native-born average.

Part of the reason for the gap between Latin American and other immigrants may be due to differences in the socioeconomic profile of households which emigrate to the United States from different world regions (Feliciano, 2005). While we do not have information about the socioeconomic status of households at the time of emigration, the average 2011 household income of immigrants from Latin American countries was almost half that of all other immigrants (about $41,000 compared to $73,000, respectively)\(^2\). This suggests a stark contrast in the socioeconomic status and life experience between Latin American immigrants and all other immigrants\(^3\). On the other hand, immigrants from Latin American spent less time abroad (21.7 years) before moving to the USA as compared to other immigrants (25.7 years), so length of time abroad does not appear to explain the disparity in perception across regions.

It is not only foreign-born householders, however, who note heightened levels of mistrust in the tap water. Within the native-born population, Hispanics are much more likely to mistrust their drinking water, perhaps due to a second-generation influence from parents or relatives’ home country experience. There is also a higher level of public drinking water mistrust among Black and other minority households than among Non-Latino White respondents\(^4\). While this difference is not large, it is less

<table>
<thead>
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<th>Nativity</th>
<th>Perception of safety</th>
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<tr>
<td>Foreign-born</td>
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<tr>
<td>Latin American countries</td>
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<tr>
<td>Other world regions</td>
<td>86.4%</td>
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<tr>
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<td>Hispanic (of any race)</td>
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<tr>
<td>Black</td>
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<tr>
<td>Non-Hispanic White</td>
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<tr>
<td>Other</td>
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<tr>
<td>All</td>
<td>93.5%</td>
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</tbody>
</table>

Source: American Housing Survey (2013); tabulated by authors.

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\(^2\) The disparity in incomes between Latino and non-Latino immigrants is very similar if we limit our analysis to households who emigrated in the last three years, suggesting that income differences are attributable to country of origin rather than US experiences and circumstances.

\(^3\) The disparity in public water perception also does not appear attributable to differences in water quality experienced in countries of origin. For instance, immigrants from South and Southeast Asia, where water quality is lower than in Latin America on average, report greater trust in US tap water than Latino American immigrants.

\(^4\) A persistent racial gap in satisfaction with public services has been documented since the 1960s (Van Ryzin et al., 2004). The perceived responsiveness of government to needs of minorities, such as through actions including ballot initiatives targeting minority interests, may influence perception for communities of color, specifically for Asian and Black communities (Hero & Tolbert, 2004). However, there is little evidence of outsized mistrust among Latinos specifically. On the other hand, restrictions to access of health-related public services by undocumented immigrants may also impact trust of government, as these signal the realities of discrimination, and tend to be experienced by Latinos more than other minority groups (Michelson, 2003).
likely to be explained by past negative experience with drinking water quality in another country, and may reflect other differences in cultural belief, experience, or unmeasured negative exposure.

**Multivariate regression results**

Households with foreign-born nativity and minority status share many of the experiences and risk factors we expect to be correlated with the perception of unsafe water. Accordingly, we use binary logistic regression to further examine whether there is a robust, independent relationship between these factors and trust in the tap while holding other potential correlates of perception constant. Table 2 presents our model results. We report odds ratios, coefficients and BRR standard errors for each independent variable. Odds ratios show the effect of a given explanatory factor on perception, with the deviation of a ratio above one reflecting a positive effect on perception and the deviation of a ratio below one reflecting the extent of a negative effect.

The regression model results generally bear out the hypotheses from our conceptual model, while also echoing the descriptive findings. Among individual demographic characteristics, graduating from high school increases the odds of perceiving water as safe for drinking and cooking. In terms of race/ethnicity, compared to non-Latino whites, minorities are more likely to perceive their water as unsafe. The most influential factor lowering the likelihood of perceiving water to be safe, however, is nativity status and place of origin. Immigrants, regardless of region, are much less likely to perceive their water to be safe than native-born individuals. Immigrants from Latin American countries, however, are more than twice as likely to distrust their tap water as non-Latino immigrants. As expected, length of time spent abroad before emigrating is also inversely related to perception. The longer respondents lived abroad, the more likely they are to perceive their tap water as unsafe. On the other hand, of the household socioeconomic characteristics considered in the model, both home ownership and higher household income were positively correlated with trust in water quality.

In terms of the built environment characteristics considered, each was statistically significantly associated with tap water perception except the age of the housing unit. The lower their assessed housing unit and neighborhood quality, the more likely respondents were to perceive their water as unsafe. Residents of trailer parks were also more likely to perceive their water as unsafe. Contrary to expectations and evidence on actual water quality, however, households served by a small, private water system (less than 15 connections) were more likely to trust their tap water quality. Each of the built environment factors except water system size may reflect a relationship between actual water quality and perception. However, these exogenous effects on perception still pale in comparison to the magnitude of the relationships between individual demographic and household socioeconomic status and water risk perception.

**Discussion**

Over the past two and a half decades, individual misestimations of sub-standard water quality and related behavioral responses to this perception have begun to be documented (Canter et al., 1992; 5 The model presents little cause for concern regarding collinearity between independent variables, suggesting that it is well-specified. Variance inflation factors (VIFs) for all independent variables were in the range of 1.01 to 3.85, with an average VIF of 1.46.
A broader understanding of the adverse impacts of (mis)perception on health, expenditures and the environment raise a key policy question: how can perception be changed or influenced? Public informational campaigns to enhance trust in public drinking water systems are necessary, but the effects of past and present information strategies have been limited (de França Doria, 2010). The results from our study emphasize the importance of targeting communities of color, immigrants, and other marginalized groups.

Federal and state government agencies play a vital, indirect role in influencing household perception by providing oversight and regulation of drinking water systems, and their importance in this process has been highlighted by their failure to fulfill this role adequately in Flint. In cases of misperception, however, they have little direct role to play in influencing local opinion. In fact, as discussed previously, their involvement may harm local perception of tap water quality due to growing mistrust in higher levels of government. There are three major stakeholders active in informing the public about tap water quality: individual public drinking water systems, county public health agencies and community-based environmental justice organizations. We discuss each stakeholder’s role using examples from the US state of California.

Individual public drinking water systems are ultimately required by US EPA policy, and proximately required by state agencies to which the EPA devolves authority for drinking water quality governance, to provide CCRs to their customer base which annually report on the quality of water provided by the system, as well as explain any quality violations (US EPA, 2016). Even without the requirement to disseminate CCRs, water systems would seem to have a clear incentive to inform and gain the trust of their...
potential customer base so that residents within their boundaries would consume more of their product and thus ensure revenue stability for the system. While CCRs have certain nominal standards of accessibility and simplicity, several independent assessments of CCRs find that they are incomprehensible in the English language to the average member of the general public to which they are aimed (Gold et al., 2015; Roy et al., 2015). Their legibility in Spanish language is even further diminished. Enhanced efforts to balance the provision of technical information in an engaging and legible fashion in CCRs is needed for water systems themselves to play a sizable role in improving tap perception.

In some cases, county public health agencies take on the formal role of public drinking water quality monitoring and testing from the state as local primacy agencies (California Health and Safety Code, n.d.). Given the rise in childhood obesity, many public health agencies also undertake campaigns to enhance drinking water consumption, such as Riverside County’s ‘Rethink Your Drink’ campaign (Riverside County, 2015). To date, however, both system and public health agency campaigns to enhance drinking water have not been sufficiently coordinated. Both types of information providers have largely measured success based on outputs rather than outcomes, and the effectiveness of these efforts has not been evaluated in any rigorous fashion.

Non-profit environmental justice organizations have to balance multiple different remits. In this context, non-profits’ primary role is to hold public sector agencies accountable to providing high-quality drinking water. Exactly because they play this watchdog role and tend to be more trusted by the public than government agencies, non-profits must be careful not to overstate drinking water quality problems and inaccurately influence public perceptions (Association of California Water Agencies (ACWA), 2014).

Environmental justice organizations also play a unique role in their ability to potentially alter behavior without changing perception. In addition to targeting the appropriate audience, the effectiveness of any public education campaign or program depends on the ability of individuals receiving information to use it to make sound judgments (Smith & Johnson, 1998; Abrahams et al., 2000). This research also indicates that individuals who take action to mitigate actual or perceived water quality problems will report lower perception of risk after taking such action. Aside from disseminating scientific information to improve perception of risk and consumption of tap water, community-based non-profit organizations can play a stop-gap role which systems and public health agencies are unlikely or unable to take on. They can promote the utilization of point of use treatment technologies (e.g., household water filters) that enhance use of tap water without necessarily overcoming the underlying obstacle of perception.

A final frontier in improving perception is addressing false advertising regarding tap water quality by other private, commercially minded water purveyors (Community Health Councils, 2015). While the lack of health benefits from consuming bottled water have become more widely known (Gleick, 2010), other water providers such as retail water facilities and mobile vendors continue to propagate misleading narratives regarding the benefits of their (more expensive) products. Improving perception may require that proponents of tap water employ more adversarial, fact-based tactics in debunking the myths about alternative sources of water supply. Given its potentially confrontational nature, this is likely to be a role which non-profits rather than public agencies are best suited to play.

Other exogenous factors are likely to influence tap water perception across the USA in the future. The 2016 discovery of the public sector’s initial oversight and subsequent negligence regarding high lead levels in the public drinking water supplied to residents of Flint, Michigan has drawn national attention and increased suspicion of tap supplies. Studies of short-term impacts suggest dramatically decreased levels of confidence in tap water safety across the US state of Michigan (Ballard, 2016; Kaiser,
Analysis of future rounds of the American Housing Survey will allow us to assess the long-term salience of this and other subsequent quality incidents on general levels of trust in tap water quality across the USA, and particularly in the Midwestern region. Since the outsized burden of the neglect in Flint fell on African-American neighborhoods, lasting changes in perception may also occur among this sub-population.

Conclusion

Understanding the determinants of tap water perception facilitates more effective drinking water policy development and implementation, and in turn enhances household health and welfare, as well as the environment. Our study is the first to use nationally representative data to examine the factors contributing to differences in tap water perception. We employ data from the 2013 American Housing Survey to show that perception of water quality is most influenced by individual demographic factors such as educational level, race, and immigrant status, particularly for respondents from Latin American countries. Based on our findings, we suggest that evaluation and recalibration of existing information campaigns regarding tap water, support for behavior alteration rather than perception change, and direct combat of false advertising may prove the most fruitful policies for enhancing tap water consumption.

Conflict of interest

The authors declare that they have no conflict of interest.

References


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