

Water consumption practices in university campuses. The experience of the National Autonomous University of Mexico

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ABSTRACT

The Water Network of the National Autonomous University of Mexico (Red del Agua UNAM) and the Program for the Management, Use, and Reuse of Water in UNAM (PUMAGUA) carried out a survey with the aim of knowing the water consumption practices of the university community in its campuses located in the Metropolitan Area of the Valley of Mexico. A sample of 2,095 students, academics, administrative and support staff participated in this survey. The results show that 74% of the sample consume bottled water and that their average spending is between 0.50 and 1 dollar per day (11 to 20 Mexican pesos). The rates of bottled water consumption contrasts with the perception about water quality, since only 13% consider water quality distributed in the water fountains located within university campuses as 'poor' or 'very poor'. The rates of bottled water consumption among university community are similar to the ones reported by studies in Mexico City and in Mexico as a whole, even though UNAM has a Water Observatory that allows people to know in real time water quantity and quality in university campuses.

Key words: bottled water, integrated water resources management, water consumption, water culture, water quality

HIGHLIGHTS

- Consumption practices in university campuses.
- Bottled water consumption.
- Correlation between tapwater quality and bottled water consumption.

INTRODUCTION

Mexico faces significant challenges to provide water services for its population. The technical, institutional, and economic-financial problems presented by virtually all drinking water suppliers in the country translate into insufficient, irregular, and low-quality supply (González-Villarreal & Arriaga-Medina 2014). According to the National Water Commission, access to piped water is estimated as 95.3% at national level (CONAGUA 2018). However, only 52% receive water every day, either interrupted or continuous. Although 89% of people consider the quality of piped water as good or excellent, 78% consume bottled water and spend about \$6.6 per month (149 pesos), on average (González-Villarreal *et al.* 2015).

Mexico City experiences similar conditions to the national level. Around 96% of the households have access to piped water and 82% receive water every day, either in an interrupted or continuous way. The degree of approval of this region on water quality is lower than the national average, with 74% considering it as good or excellent. Finally, 86% of the sample claimed to consume bottled water and spend, on average, almost \$8.5 per month (191 pesos) (González-Villarreal *et al.* 2016).

In this context, Mexico has become the country with the highest consumption of bottled water worldwide (Greene 2018; McCulligh *et al.* 2020). However, the bottled water market has expanded exponentially in recent decades around the world, even in places where there is access to public distribution networks that can assure that water meets the criteria to be consumed directly from the tap (Hu *et al.* 2011; JPM 2017). Marketing strategies of large corporations have transfigured the value of water, which has gone from being an essential element for life to a commodity related to a variety of lifestyles, ideas and beliefs that affect consumers' behaviors (Hu *et al.* 2011; Brei 2018; Xu & Lin 2018). It is estimated that more than 329 billion bottles of water were consumed worldwide in 2015 (Qian 2018). One of the main concerns is related to the large energy expenditure derived from the production and distribution of bottled water (Gleick & Cooley 2009), and that this product generates a strong negative impact on the environment through plastic waste (Parag & Timmons-Roberts 2009; Kasavan *et al.*

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2021). The National Association for PET Container Resources (NAPCOR) indicates that only 35% of bottles used in Canada, USA, and Mexico were recycled in 2019 (Paben 2020).

Access to safe drinking water in quantity, and especially with guaranteed quality, is seen as a complex problem related to governance, management, and infrastructure for distribution (Gleick 2014; Greene 2018). However, social conditions are also decisive in people's perception of drinking water quality, such as trust in management and regulatory institutions (Doria 2010; Saylor *et al.* 2011; Greene 2018). Some criteria are often interpreted as part of past experiences and can also generate some expectations about water systems (Doria 2010). For instance, after the earthquake in 1985 in Mexico City, the authorities' warnings about the risks associated with drinking tap water during and after the incident triggered a process of institutionalization of bottled water consumption, first in the capital city and then all over the country (Montero 2019). Past experiences with poor water quality in public distribution systems and their poor functioning lead some communities to turn to bottled water as a supply strategy (Cohen & Ray 2018).

Water consumption practices are determined by several highly complex technical, economic, social, and cultural factors. Numerous studies have evaluated a multiplicity of factors that influence the choice of one source of supply over another; in particular, we are interested in those factors that influence the preference of bottled water over tap water, even when it meets quality criteria. These factors are linked to demographic criteria (age, sex, nationality, social status, educational level, among others) (Doria 2006, 2010; Hu *et al.*, 2011), and other contextual, institutional, infrastructure, and informational conditions (Linden 2015; Etale *et al.* 2018).

Some of the criteria identified in the literature were the following: dissatisfaction with the organoleptic characteristics of tap water (Doria 2006, 2010; Saylor *et al.* 2011; Espinosa-García *et al.* 2015; Linden 2015; Delpla *et al.* 2020), presence of minerals and other chemicals in tap water (such as chlorine, fluoride, nitrates, pesticides, heavy metals, and industrial chemicals) (Doria 2010) and also in bottled water (Diduch *et al.* 2013; Da Silva *et al.* 2021); perception that bottled water is healthier and higher quality than tap water, or tap water implies a health risk (Saylor *et al.* 2011; Qian 2018; Ballantine *et al.* 2019; Delpla *et al.* 2020); the belief that bottled water is easier to transport and to access (Doria 2006; Etale *et al.* 2018; Qian 2018); social and environmental concerns about bottled water (Prasetyawan *et al.* 2017; Díez *et al.* 2018; Qian 2018; Borusiak *et al.* 2021), among others. The role of advertising, packaging, brand design and the values attributed to bottled water (health, youth, beauty, social status, etc.) is also a factor that should be considered (Brei & Tadjewski 2015; Xu & Lin 2018; Brei 2018; Ballantine *et al.* 2019).

Several studies have been carried out to identify the reasons for people to prefer bottled water over tap water in a university campus, even when there are optimal conditions of quality, availability, and also free drinking water is provided. Saylor Stalker & Amberg (2011) found that one of the most important obstacles to promoting tap water consumption was the perception that tap water constitutes a health risk and the belief that bottled water is a safer alternative. In a cross-regional study, Qian (2018) compared consumer practices among universities in Singapore, Hong Kong, and Macao. Despite the availability of drinkable tap water, population of these three areas still consume a considerable quantity of bottled water. It was observed that students from Hong Kong and Macao preferred bottled water over tap water, even when tap water met the highest standards of accessibility, no costs and quality, in all three countries; in contrast, students from Singapore had a favorable image of tap water. A similar study was carried out in a university of Florida. Some differences were identified between non-consumers and heavy consumers of bottled water. Taste, convenience and the belief that bottled water is a safer source are drivers of bottled water consumption. In addition, some of the participants recognized some of the benefits of tap water, in particular those related to its price, its environmental impact, and the convenience of having filling stations at campus (Graydon *et al.* 2019). Also, norms, peer behavior, and perceived health benefits were found to be linked to purchase intention (Xu & Lin 2018).

One of the aims of these studies was to identify behaviors that contribute to the sustainability of the different university campuses. In that sense, Wikkeling & Karim (2018) analyzed a sample of 500 questionnaires involving undergraduate students from the United Arab Emirates. Although more than 60% of the participants recognized the importance of a more sustainable campus, 80% claimed to buy bottled water and more than half did so frequently. In another article, the attention was directed to analyzing the relationship of PET (polyethylene terephthalate) waste, which is the most used material in water bottles, with the consumption of bottled water in Iran. In this research, it was reported that 74% of the participants believed that tap water could be contaminated and it did not constitute a reliable source, even when the public network complies with the standards established by the WHO (Aslani *et al.* 2021). Díez *et al.* (2018) examine the beliefs and attitudes of the members from a university in the Basque country. Research findings contrast with the previous studies since most of the

respondents preferred tap water. They did not perceive this source as a health risk and other properties, such as taste, did not influence their choice either. However, 33% of the participants claimed to buy two or fewer bottles per week, and they used those bottles to fill with water from filling stations.

As part of the activities to ensure smart water management and the sustainability of its campuses, the National Autonomous University of Mexico, through the UNAM Water Network and the Program for the Management, Use and Reuse of Water in UNAM (PUMAGUA), implemented a drinking water distribution system to supply to more than 318,000 members of the university community, including students, academics, and administrative staff at higher education campuses or research centers located within the Valley of Mexico. In 2008, some challenges were identified to guarantee the quality and availability of water in the system in the central campus of the UNAM. For example, the absence of hydro-sanitary information, lack of monitoring of water quality, water losses in the distribution networks above 50%, lack of participation and knowledge about the distribution system among the university community (González-Villarreal *et al.* 2020).

Then Espinosa-García and others (2015) observed the preferences for drinking either tap water or bottled water of the university community. According to them, it was shown that 75% of the participants consumed bottled water, while the consumption of water from the distribution network was low (only 14%), and 11% consumed both. The main reason for the low consumption of bottled water was related to the organoleptic characteristics of the water from the public network. However, it highlights the fact that people were unaware of the quality of the water. Therefore, tap water was perceived as a health risk derived from unfamiliarity with disinfection methods and the belief that tap water could cause illness. This study concludes that the lack of information on water quality and negative perceptions of water from the distribution network, which were based on some of the organoleptic characteristics, have driven consumption of bottled water, not only within the university campus but also in Mexico City.

In this context, the main goal of this paper is to show the results of the institutional survey of the consumption practices related to drinking water in UNAM's campuses located in the Metropolitan Area of the Valley of Mexico and to discuss the decision-making process of the university community when drinking either tap water or bottled water. In order to move towards smart management of water in its campuses and to contribute to the sustainability of its areas, it is necessary for UNAM to identify the reasons that lead people to choose bottled water over water from the public network, even when it meets the quality criteria. It is also pertinent to identify the reasons for people to pay for a good that is available for free on the university campus. Another aspect to consider is related to the fact that tap water has a lower environmental impact as a result of its energy efficiency and its contribution to reducing the use of single-use plastics. Integrating the information resulting from this exploration guides a better understanding of water management and risk communication associated with different sources and has the potential to be used in the design and implementation of policies regarding the water system for UNAM authorities.

MATERIALS AND METHODS

With the aim of analyzing the consumption practices of the community of the National Autonomous University of Mexico (UNAM), the UNAM Water Network and PUMAGUA, conducted the Water Consumption survey at UNAM. The survey included 32 questions and it was designed to reveal information about the level of perception (attitudes and beliefs) and experience (facts or events in which the user has participated) of the participants. It was conducted by electronic media and was available to be answered during three weeks of May and June 2020. To ensure statistical consistency, all were open-ended questions. They included dichotomous and multiple-choice models. The sample considered students, academics, administrative and support staff enrolled in some of the UNAM campuses situated in the Metropolitan Area of the Valley of Mexico. Total population of the university community is estimated at more than 318,000 people. Prior to aggregation, the respondent-level data were analyzed following the World Economic Forum method for data treatment and score computation (WEF, 2018). This method suggests excluding surveys with a completion rate of less than 50%, duplicate surveys, and surveys presenting a pattern of 80% of the same answers, as this behavior demonstrates a lack of focus on the part of the respondent.

Criteria

Perception

The perceptions around water for human consumption are determining elements for the choice of one source of supply over another. Several authors have pointed out that there are differences between the beliefs of those who consume tap water with respect to people who prefer bottled water (Espinosa-García *et al.* 2015; Linden 2015; Xu & Lin 2018). According to Doria

(2006, 2010) some of the factors that affect water perception are organoleptic properties, quality (determined by the perception of health risks), individual preferences, and comfort. Other factors that can be considered are access to bottled water in terms of convenience and price. Table 1 shows a description of the criteria considered for this research design.

Experience

In addition to sensory and cognitive components from drinking water perceptions, there are other factors related to peoples' direct experiences. On the one hand, demographic factors can significantly influence perceptions of the risks associated with a source, organoleptic properties, and some other criteria. On the other hand, access to information, past experiences, and trust in the institutions that provide water services are relevant elements when choosing a source. A strong concern has been identified among users of public supply systems regarding water quality and the context in which this resource is provided, sources of supply, treatment methods, pollutants, and others. Also, public knowledge of such aspects is generally limited (Doria 2006, 2010; Hu *et al.* 2011). Table 2 describes the criteria referred to in this analysis.

Questionnaire design

The survey was structured in five main sections: sociodemographic data, general data of water consumption, bottled water consumption, tap water consumption, and access to information (Table 3). For the sociodemographic section, participants were asked about the sector of the university community to which they belonged (students, academics, and staff), school or research center, age range, gender, academic degree, permanence within the university spaces (hours per day). The first question served as a filter to discard those questionnaires that did not correspond to members of the university community. Within the general data related to water consumption, it was considered to know the amount of water that people drink per day, their sources of supply inside the university spaces (dispensers, bottled water, containers for common use, or other), and also identify if there is a dispenser within the unit where the participants study or work.

To distinguish between bottled water consumers and tap water consumers, participants were asked if they had purchased bottled water within the university campus. Those who answered affirmatively were asked about the frequency of consumption (per week and per day); place of purchase (stores established within the university spaces, UNAM Store, unauthorized sale, convenience stores near campus, stores or supermarkets outside the university spaces); and average spending per day. The main reason why they buy bottled water was also consulted and five responses were provided associated with the perception criteria: organoleptic properties, accessibility, quality, comfort, and price. In this section, bottled water consumers were also asked what actions they were taking with waste.

Table 1 | Perception criteria

| Criteria | Description |
|-------------------------|--|
| Organoleptic properties | Sensory information from taste, smell, color, and turbidity related to quality and perceived health risks. |
| Quality | Discernible qualities of water dependent on the degree of technical information on supply sources (acceptability), and influenced by social, political, and economic relationships between service providers and regulatory bodies (confidence level). |
| Accessibility | Access to improved supply sources. |
| Price | Expenses for water purchase. |
| Comfort | User preference with respect to the source of supply. |

Table 2 | Experience criteria

| Criteria | Description |
|-----------------------|--|
| Demographic factors | Differentiated consumption for each population sector. Contrasts are considered based on sex, education, and population group. |
| Access to information | External information from multiple sources (service providers, regulatory bodies, media, other social groups) and influences the perceptions of individuals. |

Table 3 | Questionnaire design

| Variable | Item |
|--------------------------------------|---|
| Sociodemographic | 1. Sector of the university community 2. School or research center 3. Age range 4. Gender 5. Academic degree 6. Permanence within the university spaces (hours per day) |
| General data of water consumption | 7. Average daily water consumption 8. Sources of supply inside university spaces. 9. Access to dispenser within the faculty or dependency |
| Bottled water consumers (perception) | 10. Have you bought bottled water inside the university spaces? 11. Frequency (per day/per week) 12. Quantity (per day) 13. Place of purchase 14. Average spending per day 15. Main reason of purchase related to perception criteria 16. Waste management |
| Tap water consumers (perception) | 17. Have you taken water from the dispensers inside the university spaces? 18. Frequency (per day) 19. Quantity (per day) 20. Main reason for consumption related to perception criteria 21. Perceived differences between bottled water and tap water: Taste. (Likert scale) 22. Perceived differences between bottled water and tap water: Smell. (Likert scale) 23. Perceived differences between bottled water and tap water: Appearance. (Likert scale) 24. Perceived quality |
| Experience | 25. Do you know the quality of the water distributed in the dispensers located in the university spaces? 26. How would you rate the quality of the water of the dispensers? 27. Do you know where to obtain information on the quality of the water distributed from the dispensers? 28. Do you know where to report infrastructure alterations or failures of dispensers? 29. Level of agreement (Likert scale) 29.1 I am well informed about the quality distributed in the dispensers 29.2 I am confident in the quality of the water distributed in the dispensers. 29.3 I prefer to use a reusable bottle and consume water from dispensers than to buy bottled water. 29.4 When I use a reusable bottle, I motivate others to do the same. 29.5 If I consume water from the dispensers, I promote the reduction of plastic waste within my school or workplace. 29.6 If I consume water from the dispensers, I help to build a more sustainable campus. 29.7 If I consume water from the dispensers, I contribute to the fight against climate change 30. Do you know of any initiative to make more efficient use of water in university spaces? If yes, which one? 31. What information do you consider relevant to guarantee a safe consumption of water from the dispensers located in the university spaces? 32. Additional comments (optional) |

The next section was focused on identifying the practices of the water consumers of the dispensers located in the university spaces. As in the previous section, the participants were asked if they consumed water from the dispensers, frequency of consumption (per week), quantity (per day) and the main reason for consumption associated with the same criteria as for bottled water. This section wanted to explore into the perceived differences between tap water and bottled water using Likert scale (from much better to much worse), mainly to organoleptic properties (taste, smell, and appearance) and their quality.

The last section of the survey was used to explore the relationship between access to information and water consumption practices in university spaces (user experience). The participants were asked if they knew the quality of the water distributed in the dispensers. They were also asked to rate this criterion on a Likert scale (from very good to very bad). It was asked if they knew where to get quality information or where to report infrastructure alterations or failures. To identify some practices, a series of statements related to different behaviors were presented that could influence the preference of one source of supply over another (level of information, trust and pro-environmental attitudes). Finally, the participants were asked to identify any

initiative within the university spaces to make more efficient use of water and indicate the type of information they considered relevant to guarantee safe water consumption from the dispensers.

ANALYSIS AND RESULTS

A total of 2,117 forms were received, but 21 were discarded since they did not meet the sample criterion recommended by the World Economic Forum method for data treatment and score computation (WEF, 2018). Duplicate surveys and surveys presenting a pattern of 80% of the same answers were discarded. No surveys with a completion rate of less than 50% were found, since the online tool was programmed to consider only surveys with 100% completion rate. Therefore, 2,095 questionnaires were analyzed. Responses were received from 66 university faculties, research centers and schools. The largest proportion of the sampled population was students with 78%, followed by academics and administrative staff, with 14.4 and 4.8%, respectively. 62.5% of the sample was women and 37.5% male or other. More than 70% of participants indicated that they spend more than 7 hours within university spaces.

On daily water intake, 70% of participants expressed that they consumed between one and two liters per day, 21% more than two liters, and 9% less than 1 liter. In terms of sources of supply, 78.7% of the respondents reported consuming water from dispensers; from this population, 57% mentioned using them daily. The quantity of consumption from this source ranges from 500 ml-1litre (46.2%) to 1–2 liters (37.7%). However, 74.5% of the participants reported buying bottled water in university spaces, but only 18% mentioned that it was their only source of supply.

As may be observed, mixed consumption is detected among participants. In the context of the university community from UNAM, where community members have access to reliable sources of water supply, it is relevant to analyze the factors that affect drinking water consumption preferences. Below are results about perceptions and experiences influencing the choice between tap water and bottled water.

Perception

Two phases were carried out to assess the perception criteria. First, five criteria were evaluated to determining a hierarchy of the reasons that lead members of the university community to purchase bottled water or drink tap water. Second, each of the criteria was analyzed to identify relevant areas of opportunity. Table 4 shows a weighted comparison of the perception criteria between those who consume bottled water and those who consume water from dispensers.

It is observed that accessibility (30.1%), quality (24.9%), and comfort (20.7%) are the most relevant criteria to those who consume bottled water on campus. Accessibility is directly related to the difficulty of accessing a filling point and the effortlessness of purchasing bottled water, as 90% of purchases are made within university campuses, specifically in authorized stores. However, this criterion contrasts with the number of people who claimed that there was a water dispenser within the unit (faculty, research center, school) in which they studied or worked. In addition, in this subgroup there was a perception that bottled water has higher quality over tap water. They also considered it uncomfortable to transport a bottle to refill. With respect to people who consumed tap water, comfort (37.8%) and accessibility (34.3%) proved to be the most relevant factors. People considered that it was easy to transport a container for filling in water stations within university spaces, and they indicated that it was easy to access a drinking water supply point.

Organoleptic properties

This criterion was not as significant as expected. In the integrated assessment, three factors (taste, smell and appearance) of water between the two sources of supply were evaluated. Consistent with the literature, the most important differences were perceived around the taste of tap water with respect to bottled water. 41.8% of the participants indicated that tap water tastes

Table 4 | Perception criteria between bottled water consumers and tap water consumers

| Criteria | Bottled water consumers (%) (N = 1,561) | Tap water consumers (%) (N = 1,649) |
|-------------------------|---|-------------------------------------|
| Organoleptic properties | 16.5% | 1% |
| Quality | 24.9% | 11.7% |
| Accessibility | 30.1% | 34.3% |
| Price | 7.8% | 15.2% |
| Comfort | 20.7% | 37.8% |

Table 5 | Comparison of the organoleptic properties

| Criteria | Taste (%) | Smell (%) | Appearance (%) |
|------------------|-----------|-----------|----------------|
| Much better | 6.7 | 5.6 | 5.9 |
| Little better | 10.4 | 6.7 | 6.5 |
| Equal | 31.7 | 52.3 | 70.4 |
| Little worse | 41.8 | 29.2 | 13.8 |
| Much worse | 9.4 | 6.2 | 3.4 |
| <i>N</i> = 1,649 | | | |

a little worse and 9.4% much worse. For the odor and appearance criteria, 52.3% and 70.4% of the participants did not perceive any difference between two sources, respectively. Table 5 presents the general results on organoleptic properties criteria.

Quality

Participants were asked to rate the water quality of the dispensers. Then, they were asked to express their degree of agreement with the statement ‘I trust in the quality of water distributed in water fountains located in university spaces’. 50% of the sample rated the quality of tap water as acceptable, 40% considered it in a range between very good to good, and only 2% as very bad (Figure 1). It is noted that 77% of the participants agreed or strongly agreed with that statement (Figure 2). In general, there was a favorable perception about the quality of tap water.

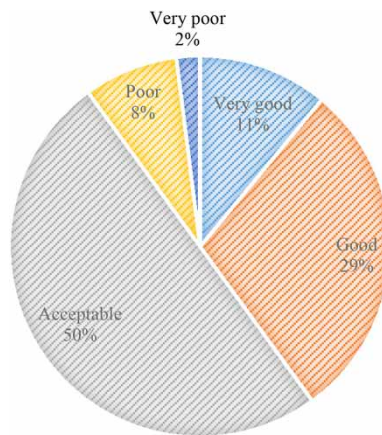


Figure 1 | Perception of tap water quality.

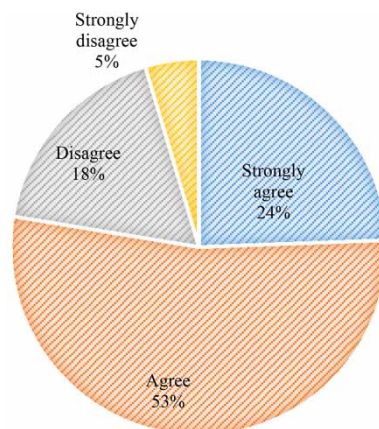


Figure 2 | Level of trust in distribution system.

Accessibility

In contrast to the results on the reasons that lead people to buy bottled water within university spaces, in which accessibility turned out to be the main reason for preference, it was identified that 94% of the participants ensured that there was a water fountain within their unit (faculty, research center, or school). This data suggests that, even though there is the necessary infrastructure to access tap water, buying bottled water was easier at one of the authorized premises within the university campus. The results are similar to some of the findings shown in the literature review.

Price

Despite the high water consumption rates of tap water, 74% of the participants reported buying bottled water in university spaces. They spend between \$0.5 and \$1 per day. A simple extrapolation indicates that the university community spend around \$176,000 per day in the purchase of bottled water. However, 49% of them reported making the purchase less than once a week (Figure 3) and 6% expressed consuming only one bottle per day.

Comfort

Over 80% of the participants indicate that they prefer to transport a reusable bottle to consume water from dispensers within university spaces. Table 6 shows the attitude of participants towards this criterion.

Experience

Demographic factors

Differences between the consumption patterns of the groups of the university community were evaluated. It is observed that 39.7% of students indicated consuming tap water, 36.1% performed mixed consumption and 19% exclusively consumed bottled water. In the group of academics, there was a similar hierarchy in sources of supply, considering that 40% pointed to consuming tap water, 30.8% performed mixed consumption, and only 13.2% exclusively consumed bottled water. 56.7% of workers declared to obtain water from dispensers, and 28.3% performed mixed consumption, while bottled water was only preferred in this group by 12% (Table 7). With respect to other demographic criteria, such as gender or academic grade, there were no significant differences.

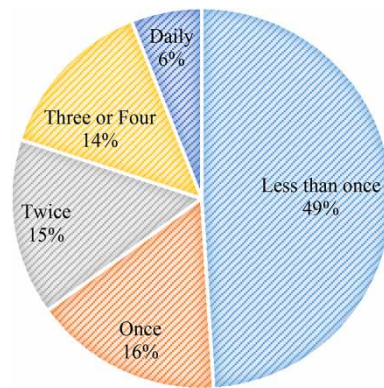


Figure 3 | Frequency of bottled water consumption per week.

Table 6 | Attitude towards the convenience of consuming tap water

| Item | Totally agree or agree (%) | Disagree or totally disagree (%) |
|---|----------------------------|----------------------------------|
| I would rather use a reusable bottle and consume water from dispensers located in college spaces than buying bottled water. | 81.2 | 18.8 |

N = 2,095

Table 7 | Type of consumption by group

| Sources | Students (%) <i>N</i> = 1,654 | Academics (%) <i>N</i> = 305 | Administrative staff (%) <i>N</i> = 136 |
|---------------|-------------------------------|------------------------------|---|
| Bottled water | 19.0 | 13.2 | 12.0 |
| Dispensers | 39.7 | 40.0 | 56.7 |
| Both | 36.1 | 30.8 | 28.3 |
| Others | 5.2 | 16.0 | 3.0 |

Access to information

Even though data on perception of tap water indicate a high level of acceptance and trust among members of the university community, those results contrast with the high number of people who said they did not know the quality of the water distributed in the water stations (62%), or where to obtain information about it (76%). That result is consistent with the data obtained in another question, in which the participants were asked about their level of agreement with the following statement 'I am well informed about the quality distributed in the dispensers located in university spaces'. 63.6% indicated that they totally disagree or disagree with the statement (Table 8).

CONCLUSIONS

Strong contrasts were found with respect to the criteria that lead members of the university community to buy bottled water, even when the institution guarantees access to drinking water of sufficient quality and without representing an expense for its community. Most of the participants expressed higher levels of confidence in the quality of the water distributed within the university spaces, but the purchase of bottled water persists due to the ease of access in any of the authorized stores. Paradoxically, most people recognize that there is extensive coverage of water stations within university facilities. Despite these contrasts, the comparison between the study carried out by [Espinosa-García et al. \(2015\)](#) and the one being discussed in this article shows an increase in the water consumption from the dispensers, and that the members of the university community consume water from mixed sources. Among the reasons for the increase of tap water consumption are the communication strategy implemented by PUMAGUA in the previous years, especially dedicated to students using social media, and the expansion of the number of water fountains throughout the campus, where there are now more than 180. More information is needed to validate this hypothesis.

Water consumption practices of the university community reflect similar patterns to those that has been reported for Mexico City and the country as a whole. People prefer to purchase bottled water even when the conditions of the campuses' water systems meet quality criteria. Criteria of accessibility, quality, and comfort are important to those who consume bottled water on campus. Also, organoleptic properties were not found to be a significant criterion in the preference of one source over another. Nevertheless, more than 20% of the participants consider that the quality of bottled water is superior to tap water. This condition is closely related to the perceived health risks, presence of contaminants, and other factors that may be implicit. Consumers generally do not have enough information to support such argument.

There is a growing concern to adopt sustainable approaches to smart water management and institutions are trying to design and apply programs under this perspective. The National Autonomous University of Mexico, through its Water Network and PUMAGUA, has adopted an integrated approach to the provision of drinking water for its community. Perceptions and experiences of the users help to detect and diagnose areas of opportunity. For instance, it is necessary to strengthen access to information and communication strategies related to the quality of the tap water. This data constitutes a baseline

Table 8 | Attitude towards information on the water quality of dispensers

| Item | Totally agree or agree (%) | Disagree or totally disagree (%) |
|---|----------------------------|----------------------------------|
| I am well informed about the water quality distributed in the dispensers located in the university spaces | 36.4 | 63.6 |
| <i>N</i> = 2,095 | | |

for the design, implementation, and improvement of the technical, social, and administrative solutions. Since PUMAGUA is generally recognized as an example of good practices in integrated water resources management, UNAM constitutes an ideal environment to implement strategies towards a more sustainable city, but this experience can also be implemented in spaces with similar characteristics. For example, in 2012 PUMAGUA designed the Water Development Support Program for the states of Oaxaca, Puebla and Tlaxcala (PADHPOT, in Spanish) with the intention to share with society the results, knowledge and experience achieved in university campuses. The aim of the program was to ensure water management and wastewater services in an efficient and sustainable way for cities with a population between ten thousand and one hundred thousand inhabitants, promoting not only hydraulic infrastructure development, but also social participation (González-Villarreal Arriaga-Medina & Juárez 2017).

One of the main achievements of PUMAGUA is the development of a Water Observatory that allows people to access to information about water quality and quantity in real time. The Water Observatory is a decision-making tool that allows people to access information about water quality and quantity in real-time through a digital platform. This instrument is one of the first systems in place in Mexico and is being replicated in other communities since it promotes transparency, accountability, and access to information, one of the main objectives of the current Federal administration. Despite the multiple benefits of water observatories, their potential cannot be achieved without the participation of authorities and water users. Thus, the design and implementation of a strategic plan to create awareness and participation of the community is needed. The plan should highlight the opportunities of having an open and public platform for decision-making but also consider the implication for the authorities regarding breaches in meeting the criteria previously defined.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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