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Factors Influencing Water Consumption in the Kingdom of Bahrain and Environmental Consequences of Bottled Water Consumption

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Key words: Bottled, drinking, environmental, consequences, water
Parole chiave: Acqua in bottiglia, bere, ambientale, conseguenze, acqua potabile

Abstract

Background. *The drinking of bottled water has remarkably increased at a global scale even in the regions possessing other adequate water sources. This study elaborates on the factors influencing the consumption of tap, filtered, and bottled water in the Kingdom of Bahrain and on the environmental consequences of bottled water consumption.*
Methods. *A cross-sectional study was performed on 483 participants in the Kingdom of Bahrain between April and May 2019. A questionnaire-based survey was conducted to assess the preferred water type, to estimate the amount of bottled water consumption per year/capita, and other water consumption-related information.*
Results. *The study revealed that filtered (35.90%) and bottled (34.50%) waters were predominantly consumed in the Kingdom, while the consumption of tap water was negligible (8.90%). The total consumption of bottled water was 0.51 liters/day, which is equivalent to 184.69 liters/year. Thus, 295.50 liters/capita/year of bottled water were consumed based on the approximate 1.6 million population in 2019. This consumption rate is extremely high in comparison to other countries.*
Conclusions. *The study recommended improving population satisfaction of tap water, conducting tap water marketing campaigns, investments in recycling infrastructures, and introducing educational plans to properly dispose of water bottles.*

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Introduction

Water is of key importance in everyday life to maintain human health. Several body functions, structure, and homeostasis essentially require an ample intake of water (1). The perception of people always varies about the type of good water and the beliefs about drinking water quality have significantly changed over time. Previously, without considering chemical and biological water quality, cold, transparent, and pleasant drinking water was preferred. Irrespective of economic and social status, the World Health Organization (WHO) has been emphasizing easy access to safe drinking water for everyone (2).

Bahrain is a small island in the Arabian Gulf having a population of approximately 1.6 million (1,867 individuals per km^2) (3, 4). In 2015, the market value of bottled water in Bahrain was 59 million USD, which is estimated to reach 134.23 million USD at a Compound Annual Growth Rate (CAGR) of 7.39% from 2020 to 2025 (5). Freije et al. (6) have revealed improvement in the tap water quality in Bahrain as compared to filtered water. The study also stated that minor adjustments in the magnesium concentration can further enhance tap water quality. However, the consumption of bottled water is rapidly increasing in Bahrain as compared to the global total CAGR (6.20%) (5). The waste production per person in Bahrain is the highest among the Middle East nations (4). Municipal solid waste (MSW) collects a high percentage of recyclable plastics (7%) but the recycling rate in Bahrain is less than 1% (7-9). Freije et al. (10) have reported a high public awareness (75%) in Bahrain about recycling and its environmental benefits. However, due to the lack of recycling infrastructures and other obstacles, the public's willingness to participate in recycling was limited (54.30%). This situation demands environmental awareness, the presence of sustainable waste management systems, effective legislation, and large-scale investments in recycling infrastructure (4).

Due to various factors such as reducing natural water resources and low rainfall, desalinated seawater has emerged as an important drinking water source in various regions especially the Arabian Gulf, which has led to negative public perceptions of tap water quality (11-17). Despite the health issues and more costs, the demand for filtered and bottled water has consistently increased by 7% worldwide (1, 18). In 2017, almost 378.54 billion liters of water bottles were produced and mostly marketed in plastic bottles worldwide. These plastic bottles contribute a major share in global plastic pollution (19). In 2017, the total worth of the global bottled water market was 198.50 billion USD where the "still water" category contributed three-quarters of the sales among four main water categories (still water, flavored water, carbonated water, and functional water) (20). The production of bottled water was started in the early1990s and now it has emerged as the second biggest market after carbonated drinks (12). The annual consumption of bottled water was noted as 44.30 billion liters in the USA in 2015, whereas the values remained as 188.50, 139.30, and 177.30 liters per capita in Italy, France, and Germany, respectively (19).

Several recent studies revealed that unreliable tap water quality has mainly contributed to such a tremendous increase in bottled water consumption. Therefore, public satisfaction regarding tap water should be enhanced (21- 27). Ballantine et al. (28) have depicted that bottled water was preferred due to various aspects such as hygiene, healthiness, superior taste, convenience, and attractive packaging that reflected self-image of purity and healthiness among the participants from New Zealand. The scenario urged the policymakers to maintain the quality of the municipal

water supplies through frequent testing and cleanliness (28). During another study (27), negative perceptions about tap water quality urged the majority of the participants (74%) to consume bottled water. Such negative perception has overall increased the bottled water consumption from 0.41 to 48.90 liters/capita/year from 2000 to 2015. The study recommended several measures for reducing the health and environmental hazards of bottled water consumption, which included the validation of water supply quality to improve the tap water perception among people (27). Similarly, the negative perceptions (unhealthy and unsafe) about tap water quality have exceptionally increased the bottled water consumption per capita in Flanders, Belgium (26). The authors suggested that future research should integrate behavioral aspects and policy measures to develop more effective governments and private sector support for tap water supply networks (26).

Delpla et al. (24) have demonstrated that 90-96% of the respondents categorized tap water quality from good to very good based on the overall quality, colorlessness, and taste. However, the majority of the participants (57%) either occasionally (42%) drank bottled water at home or exclusively (15%). The study established a loose link between overall tap water satisfaction and drinking water quality. The factors such as home water treatment strategies (cooling, filtering), knowledge of water quality and production, and risk perception among those who either only consume bottled water or tap water have been attributed to influence tap water satisfaction and water consumption behavior of the individuals. Targeted information campaigns have been observed to reduce bottled water consumption and risk perception among the individuals who were exclusively consuming bottled water (24). Fifty percent of the respondents from the Inuite community of Rigolet, Canada were addicted to high consumption of purchased water because of the negative perception of tap water safety. Previously, purchased water was considered as the primary source of drinking water in the area, followed by tap, and brook water. The installation of a potable water-dispensing unit (PWDU) has replaced the tap, purchased, and brook water consumption and 67.20% of the respondents started frequent usage of water from PWDU in 2014 (23). Similarly, poor tap water quality led to a very high Polyethylene terephthalate (PET) bottled water consumption in Salento (Italy). Bottled water became the decisive choice of consumers and a threat to the environment and public. Therefore, tap water consumption should be promoted through effective communication strategies (25). Contrarily, 58.25% of the Shanghai (China) residents consumed boiled tap water as the main drinking water. It remained a stable preferable choice over one decade, with a minor increase in filtered water consumption (11.85%), and a decrease in barreled/bottled water consumption (11.11%). Several factors contributed to the increase in the domestic filtered water consumption such as economic development, marketing effect, and improvement in the living conditions (29), whereas recent negative reports decreased the consumption of barreled/ bottled water (29). In Barcelona (Spain), public water supply was a preferred drinking water choice than bottled water, which gradually reduced the risk of bottled water consumption related to bladder cancer (30).

Fossil fuels, especially natural gas and petroleum are mostly used for the production of bottled water and due to the high cost, the bottles are rarely recycled. The consumption of fuels and energy during the transportation and distribution of bottled water exerts an extra burden on the environment. Highly recyclable PET material is commonly used for manufacturing plastic bottles but, naturally, it takes 400 years to decompose. However, less than 50% of the bottles are collected for recycling and only 7% are recycled (31).

A global trend of preferring bottled water consumption over other water sources has been observed (19, 24, 32, 33). Consumers from many countries choose bottled water even in the presence of accessible, cheaper, and high-quality tap water (16). However, this trend was not based on scientific information, which makes it questionable and requires further investigations (32-34). Doria (15) and Fischer et al. (35) revealed that such a high demand for bottled water reflects the consumer`s beliefs that because of organoleptic properties (taste, color, odor, and turbidity) it is safer and healthier than tap water. Contrarily, Talatala (36) could not find such a relation. Several other studies have associated the negative perception of tap water safety, health risk, and quality concerns with the increased bottled water consumption (14, 25, 29, 30, 36-40).

A doubtful assumption that bottled water does not exhibit tangible cumulative environmental impact (41-46) can be countered by overwhelming pieces of evidence regarding the positive environmental impacts of tap water (43-46). Some studies have indicated that microbial contamination in tap water affects human health and leads to looking for alternatives (47). Other factors, such as widespread marketing of bottled water (48), improved living standards, and changed lifestyle in some countries (37) have also been attributed the responsibility for the increased bottled water consumption. Queiroz et al. (49) have highlighted the role of business strategies and marketing campaigns in promoting bottled water. The regulations and policies related to the safe storage and handling of bottled water are not efficient in many countries (50). However, the environmental toxicity of discarded water bottles plastic has received less attention as compared to the market growth rate (37, 51, 52).

This study was aimed to find the preferred type of drinking water (tap, filtered, or bottled) for the population of Bahrain (citizens and residents). Different parameters including their beliefs regarding the drinking water quality in the Kingdom of Bahrain, awareness in terms of water mineral contents, and the potential environmental consequences related to bottled water consumption were also investigated. To our knowledge, the bottled water consumption rate has not yet been documented in Bahrain. Therefore, this is the first qualitative study to examine the consumer's beliefs regarding drinking water quality in the Kingdom of Bahrain and the relative rate of bottled water consumption.

Materials and methods

1. The instrument

A cross-sectional study was conducted in the Kingdom of Bahrain between April and May 2019 for 7 weeks. The study consisted of an English (Appendix A) and Arabic questionnaire that was designed based on the related studies (34, 53, 54). The questionnaire was divided into two sections. The first section covered the socio-demographic data including information about the age, gender, marital status, nationality, occupation, place of residence, educational level, and income. The second section consisted of 16 questions for assessing the participant's perception of drinking water, the prevalence of consuming different water types, justification of the participant`s preferences regarding drinking water, and participant`s concerns about drinking different water types (Appendix A). An online questionnaire was administered using Google Electronic Forms and the link was distributed through WhatsApp (mobile social media). The study population was estimated to be approximately 1.60 million in 2019 (3). The study sample was calculated based on the equation of Lindell and Whitney (55), online sample calculator (survey system), and the following equation:

The standard normal deviate for $\alpha = Z\alpha = 1.960$
The standard normal deviate for $\beta = Z\beta = 0.842$
$C = 0.5 * \ln [(1+r)/ (1-r)] = 0.424$"
Total sample size = $N = [(Z\alpha+Z\beta)/C] 2 + 3 = 47$

The sample size was found to be 384 at a confidence limit of 95% and a confidence interval of 5%. The questionnaire was randomly distributed among the citizens and residents of the Kingdom of Bahrain to collect 384 responses (convenient size).

2. Statistical analysis

The data were analyzed using the Statistical Package for Social Science (SPSS) version 21.0 (SPSS, Inc., Chicago, IL, USA) and the statistical package of Excel 2017 (Microsoft Office). The possible association between categorical variables was assessed through cross-tabulation using Pearson Chi-Square analysis. Spearman's correlation analysis was conducted to assess the association between tap water consumption and demographical characteristics. Logistic regression analysis evaluated the independent role of each variable (marital status, age, residential area, gender, monthly income, educational level, and nationality) on the consumption of different types of drinking water.

Results

Demographic characteristics of the respondents (384) are presented in Table 1. The results depicted that 54% of the participants were males, whereas 46% were females. The age of participants ranged from 18 up to 56 years or above. Most of the participants (89.20%) were Bahraini citizens who were either married (48.20%) or single (47.90%) whereas only 13 participants (3.9%) of the total sample size represented divorced or widowed. The majority of the participants were from the Southern governorate (58.20%) followed by 21.50% from the Muharraq governorate, 10.30% were from the Capital governorate, and 10% from the Northern governorate (Figure 1). More than half of the participants (50.40%) were aged between 18 to 25 years whereas the age group of 22.90% participants was 26 to 35 years. The majority of participants were either students (41.40%) or employees (40.90%) whereas more than half of the participants (56%) had a monthly income of less than 500 Bahraini dinars (BD). The participants holding a master's degree represented 39.10% whereas 20.10% of the participants had a Diploma or a Bachelor's degree.

The results revealed a significant association (p=0.001) between the marital status, age, residential area, gender, monthly income, educational level, nationality, and the consumption of different water types (Table 2). Most of the single participants (83.30%) consumed tap and filtered water (68.50%), whereas 84.4% of married participants consumed bottled water (p=0.001). 71.90% of the participants from the age group of 26-35 mainly consumed bottled water whereas 83.30% and 57.40% of the participants from the age group of 18-25 consumed tap and filtered water respectively (p=0.001). The participants from the Northern Governorate presented the highest tap water consumption (79.20%). The highest consumption of bottled water (75%) was noted among the participants from the Muharraq Governorate whereas the participants from Capital Governorate (61.10%) mainly consumed filtered water (p=0.001). Males (84.40%) consumed more bottled water whereas females consumed more tap water (79.20%) and filtered water (57.40%) (p=0.001). The increase in tap water consumption was associated with a decrease in income (p=0.001). Tap water (91.70%), bottled water (75%), and filtered water (59.30%) were mainly consumed by the participants with an income of less than 500 Bahraini dinars (BD). The majority of diploma

Table 1 - Demographic characteristics of the respondents.

Variables		%	*p*-value*
Marital Status	Married	48.20%	0.001
	Single	47.90%	
	Divorced	2.40%	
	Widowed	1.50%	
Age	18-25 years	50.40%	0.001
	26-35 years	22.90%	
	36-45 years	13.50%	
	46-55 years	5.80%	
	56 years or older	7.40%	
Residential Area	Muharraq governorate	21.50%	0.001
	Capital governorate	10.30%	
	Northern governorate	10.00%	
	Southern governorate	58.20%	
Gender	Male	54.00%	0.001
	Female	46.00%	
Monthly Income	Less than 500 BD	56.00%	0.001
	Between 500-1000 BD	26.40%	
	More than 1500 BD	17.60%	
Educational Level	Below Secondary School	0.80%	0.001
	Secondary Certificate	7.40%	
	Diploma degree	20.10%	
	Bachelor's degree (B.Sc.)	20.10%	
	Master's degree (M.Sc.)	39.10%	
	Doctorate (PhD)	8.50%	
	Others	3.90%	
Nationality	Bahraini	89.20%	0.001
	Non-Bahraini	10.80%	
Occupation	Employee	40.90%	0.001
	Student	41.40%	
	Unemployed	5.10%	
	Retired	8.40%	
	Housewife	4.20%	

*Significant level $p<0.05$, a significant association between the marital status, residential area, age, gender, nationality, educational level, monthly income, and consumption of different water types.
BD: Bahraini dinars

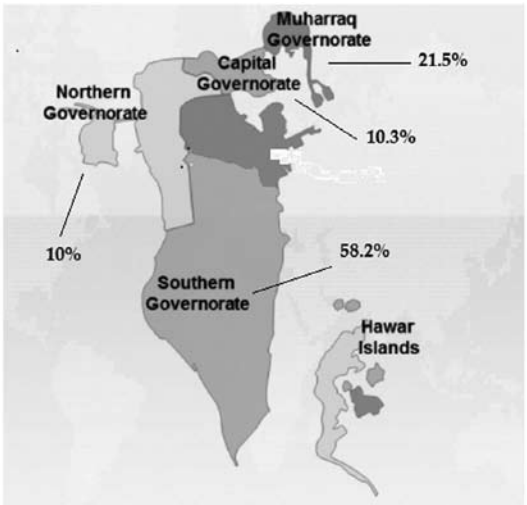

Figure 1 - Map of Bahrain demonstrating the respondent percentages in four residential areas.

holder participants (91.70%) consumed tap water whereas most of the Bachelor degree holders (75%) consumed bottled and filtered water (44.40%) (p=0.001). Bahraini citizens mainly consumed bottled water (93.80%) and filtered water (98.10%) as compared to non-Bahraini residents who mainly consumed tap water (95.80%). Employee (38.30%), and students (24.90%) mostly consumed bottled water (p=0.001) (Table 2).

The logistic regression analysis demonstrated that income was the only significant factor affecting the consumption of tap water as compared to other water types (filtered, and bottled) (Table 3).

The logistic regression analysis revealed that gender was the only significant factor affecting the consumption of filtered water as compared to other water types (tap, and bottled) (Table 4).

The logistic regression analysis further depicted that none of the factors significantly affected the consumption of bottled water as compared to other water types (tap, and filtered) (Table 5).

Figures 2-6 represent participants' responses regarding their perception of drinking water quality in the Kingdom of Bahrain. Filtered water (35.90%) and bottled water (34.50%) were noted to be the predominantly consumed water types in the Kingdom (Figure 2). A small number of participants (8.90%) preferred tap water as a drinking source whereas 20.60% of the participants consumed all types of water without any specific preference. The factors such as bottled water availability (38.90%), mineral contents (21.80%), taste, smell, color (17.10%), and finally the cost (13.50%) urged the participants to prefer it. Approximately, half of the participants (48.80%) preferred a drinking water brand other than Arwa, Aquafina, and Nestle whereas 27.40%, 17.70%, and 6.10% preferred Arwa, Aquafina, and Nestle, respectively (Figure 2).

The second question was stated as "How many bottles of water do they drink every day?" The bottled water consumption per day was verified as cup [200mL], small bottle [330 mL], medium bottle [500 mL], and large bottle [1.5 liters]. Total consumption of bottled water was estimated to be 0.51 liters/day, which is equivalent to 184.69 liters/year. The bottled water consumption/capita was calculated as 295.50 liters/capita/year based on the population (1.6 million) in 2019 (3). One-third of the participants (29.90%) justified their preference of drinking bottled water as a social habit whereas others preferred it because of pH level (22.60%), mineral contents (20.30%), and taste (19.20%) (Figure 3). 42.30% of participants rated the quality of the tap water in Bahrain as being good, 21% rated it as fair, and 11.60% rated it as poor. Only 6.60% rated the tap water quality as excellent whereas 3.60% rated it as very poor. More than half of the participants (57.70%) responded that they never drink tap water while approximately less than one-third of the participants (25.50%) rarely drink tap water (Figure 3).

Table 2 - Demographic characteristics of the respondents and their association with consumption of different water types.

Variables		Water Drinking Type			
		Bottled	Filtered	Tap	*p-value**
Marital Status	Married	**84.40%**	25.90%	12.50%	0.001
	Single	3.10%	68.50%	**83.30%**	0.001
	Divorced	9.40%	3.70%	4.20%	
	Widowed	3.10%	1.90%	0.00%	
Age	18-25 years	15.60%	57.40%	**83.30%**	0.001
	26-35 years	**71.90%**	18.50%	12.50%	0.001
	36-45 years	6.30%	14.80%	4.20%	
	46-55 years	0.00%	1.90%	0.00%	
	56 years or older	6.30%	7.40%	0.00%	
Residential Area	Muharraq governorate	**75.00%**	5.60%	8.30%	0.001
	Capital governorate	3.10%	**61.10%**	0.00%	0.001
	Northern governorate	12.50%	16.70%	**79.20%**	0.001
	Southern governorate	3.10%	11.10%	**12.50%**	
Gender	Male	**84.40%**	42.60%	20.80%	0.001
	Female	15.60%	57.40%	**79.20%**	0.001
Monthly Income	Less than 500 BD	75.00%	59.30%	**91.70%**	0.001
	Between 500-1000 BD	18.80%	25.90%	0.00%	
	More than 1500 BD	6.30%	14.80%	8.30%	
Educational Level	Below Secondary School	6.30%	0.00%	0.00%	
	Secondary Certificate	6.30%	38.90%	0.00%	
	Diploma degree	6.30%	5.60%	**91.70%**	0.001
	Bachelor's degree (B.Sc.)	**75.00%**	44.40%	4.20%	0.001
	Master's degree (M.Sc.)	0.00%	**5.60%**	0.00%	
	Doctorate (PhD)	3.10%	3.70%	0.00%	
	Others	0.00%	0.00%	4.20%	
Nationality	Bahraini	93.80%	**98.10%**	4.20%	0.001
	Non-Bahraini	6.30%	1.90%	**95.80%**	0.001
Occupation	Employee	**38.30%**	11.60%	25.00%	0.001
	Student	**24.90%**	10.30%	7.70%	
	Unemployed	3.40%	1.30%	2.60%	
	Retired	4.70%	2.10%	5.20%	
	Housewife	3.40%	0.90%	2.20%	

*Significant level $p<0.05$, a significant association between the marital status, age, residential area, gender, monthly income, educational level, nationality, and consumption of different water types.
BD: Bahraini dinars.

Table 3 - Logistic regression analysis based evaluation of the independent role of each variable on the consumption of tap water as compared to other water types.

	What is the type of water you drink?*					
	B	SE	Wald	df	Sig.	Exp(B)
Marital Status	-0.24	0.27	0.74	1.00	0.39	0.79
Age	-0.10	0.17	0.33	1.00	0.57	0.91
Residential Area	-0.06	0.12	0.27	1.00	0.60	0.94
Gender	0.65	0.36	3.20	1.00	0.07	1.92
Monthly Income	0.76	0.34	4.83	1.00	0.03	2.13
Education Level	-0.17	0.18	0.90	1.00	0.34	0.85
Nationality	-0.47	0.79	0.35	1.00	0.55	0.63
Occupation	0.18	0.16	1.26	1.00	0.26	1.19
Constant	0.03	0.72	0.00	1.00	0.97	1.03

Significant level $p<0.05$
* Bottled water represents the reference category.

Table 4 - Logistic regression analysis based evaluation of the independent role of each variable on the consumption of filtered water as compared to other water types.

	What is the type of water you drink?*					
	B	SE	Wald	df	Sig.	Exp(B)
Marital Status	-0.09	0.34	0.07	1.00	0.80	0.92
Age	-0.17	0.20	0.73	1.00	0.39	0.84
Residential Area	-0.05	0.13	0.14	1.00	0.71	0.95
Gender	-.095	0.42	5.14	1.00	0.02	0.39
Monthly Income	-0.14	0.38	0.13	1.00	0.72	0.87
Education Level	-0.05	0.19	0.08	1.00	0.78	0.95
Nationality	-20.41	14066.78	0.00	1.00	1.00	0.00
Occupation	-0.10	0.19	0.27	1.00	0.61	0.91
Constant	0.21	0.80	0.07	1.00	0.79	1.23

Significant level $p<0.05$
* Bottled water represents the reference category.

Table 5 - Logistic regression analysis based evaluation of the independent role of each variable on the consumption of bottled water as compared to other water types.

	What is the type of water you drink?*					
	B	SE	Wald	df	Sig.	Exp(B)
Marital Status	0.24	0.28	0.71	1.00	0.40	1.27
Age	-0.23	0.18	1.72	1.00	0.19	0.79
Residential Area	0.07	0.12	0.32	1.00	0.57	1.07
Gender	-0.36	0.36	0.97	1.00	0.33	0.70
Monthly Income	0.34	0.35	0.92	1.00	0.34	1.40
Education Level	-0.04	0.18	0.05	1.00	0.82	0.96
Nationality	-1.24	0.79	2.47	1.00	0.12	0.29
Occupation	0.14	0.16	0.72	1.00	0.40	1.15
Constant	0.57	0.74	0.60	1.00	0.44	1.77

Significant level $p<0.05$
* Bottled water represents the reference category.

Figure 4 shows that less than one-third of the participants (23.20%) used tap water for preparing tea and coffee while the majority (76.80%) do not use tap water for this purpose. Most of the participants (47.30%) who drink tap water justified their choice because of convenience whereas others preferred it for safety and pH level (14.50%), mineral constituent (9.10%), availability (7.30%), and cost (3.60%). The majority of filtered water-consuming participants (23.90%) preferred it due to its availability whereas others consumed it due to its taste (22.90%), convenience (21.80%), and safety (18.40%). The participants were found to be least concerned about the environmental factors (4.40%), pH level (3.40%), cost (2.70%), and mineral contents (2.40%).

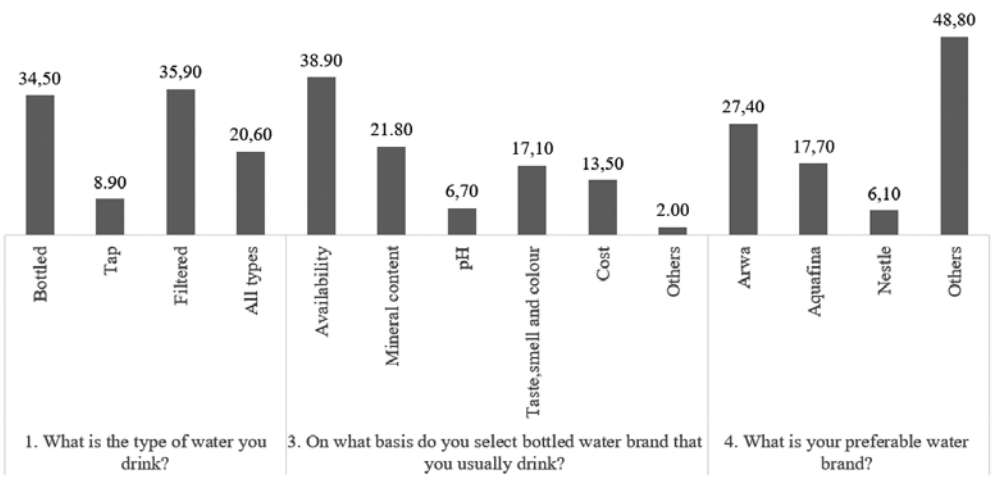

Figure 2 - Participants' responses (%) regarding water type preference and basis of choosing drinking water.

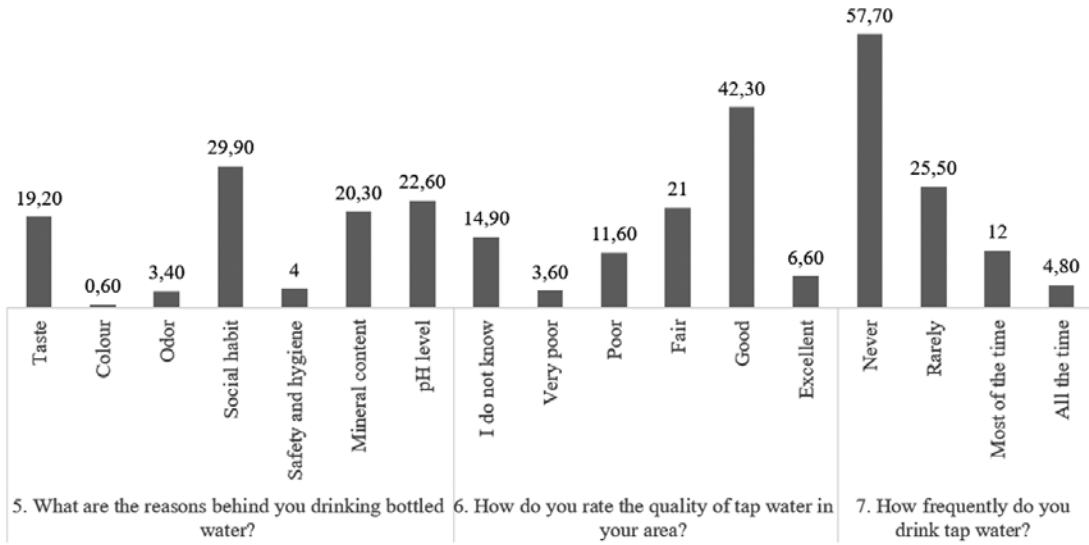

Figure 3 - Participants' responses regarding the reasons behind the consumption of bottled and tap water.

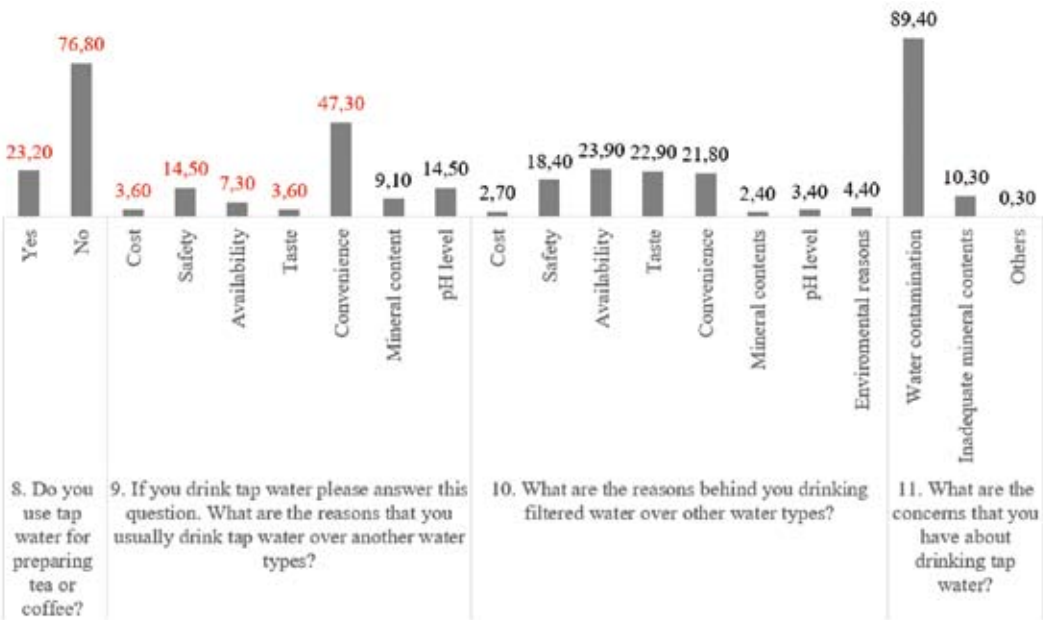

Figure 4 - Participants' responses (%) regarding the use of tap and filtered water

Figure 5 represents the concerns of participants about the quality of tap and bottled water and the sources of their information about water quality. The majority of participants (89.40%) considered water contamination as the most common concern about drinking tap water whereas 10.30% of the participants considered inadequate mineral contents in tap water as their main concern. Regarding the drinking of bottled water, 39.30% of the participants were found to be concerned about the bottle's contaminants while 34.70% considered it bad for the environment. 10% of the participants were concerned about the inadequacy of the mineral content in the bottles, and 9.70% believed that bottled water is costly. The results also revealed that 75.40% of the participants were interested in gaining more knowledge and insight about mineral contents and water pH whereas 24.60% were not interested in such information (Figure 5). In addition, a wide variety of responses were noted regarding the source of information related to water quality. Social media (25.10%) was found to be the main source of obtaining information regarding tap water quality, whereas other sources included the internet (18.60%), friends and relatives (11.40%), media (10.30%), television (TV) (4.9%), and newspaper (4.30%) (Figure 5).

The majority of participants (72.50%) stated that they would prefer to drink tap water if periodic reports are announced by the water authority whereas 27.50% preferred not to drink tap water even if the water quality reports are announced (Figure 6). Finally, participants were asked about the actions that could be taken to encourage the public for drinking tap water (question 16). The majority of participants (75.40%) highlighted the need for governmental

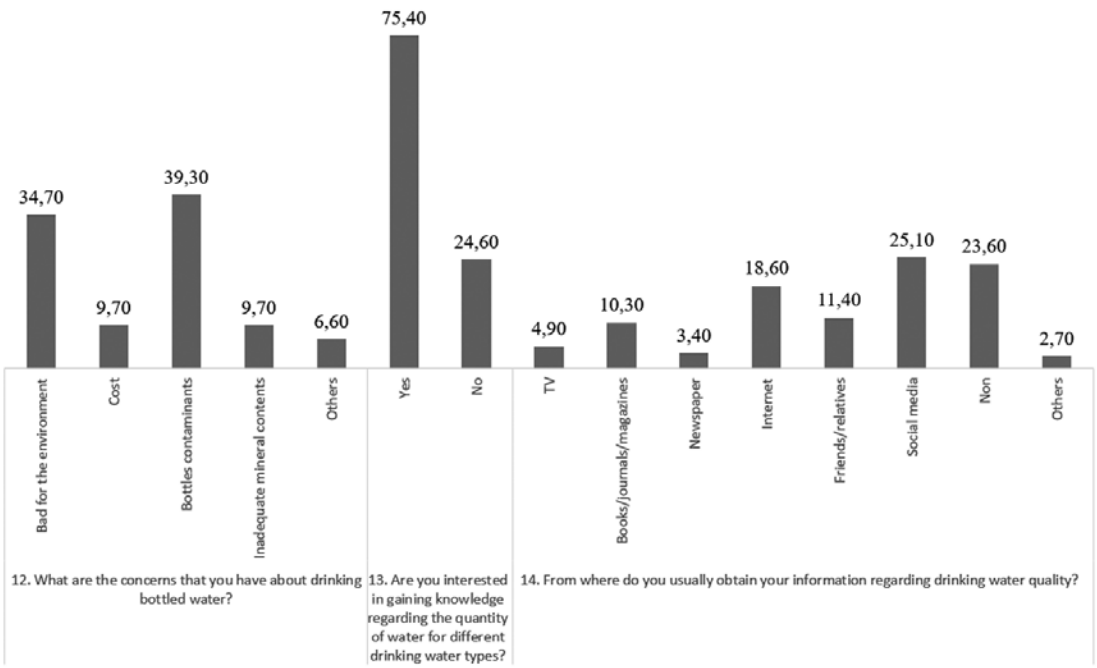

Figure 5 - Participants' responses (%) regarding their concerns about tap and bottled water quality and their sources of information.

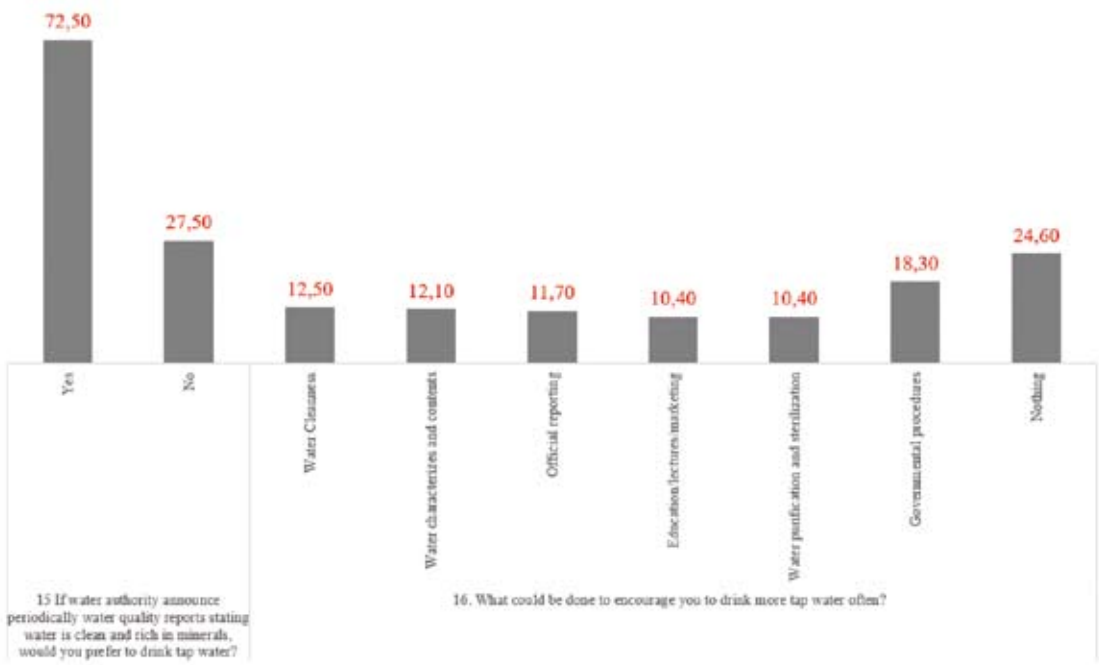

Figure 6 - Participants' responses (%) about the possible measures to encourage tap water drinking.

procedures to raise awareness whereas 24.60% stated that nothing can encourage them to drink tap water (Figure 6).

Discussion

Several studies have reported diverse preferences, beliefs, perceptions, and attitudes of consumers towards drinking water quality (2, 15). The present study revealed that most of the participants preferred drinking filtered or bottled water because of taste, safety, availability, and contents. However, 78.6% of the participants avoided drinking tap water mainly because of safety concerns (89.4%) (Figure 4). These results are consistent with several studies reporting consumers' concerns about tap water safety. Hobson et al. (53) have reported that due to safety concerns, Latino and non-Latino adults and children from Salt Lake City, Utah (USA) mainly consume filtered or bottled water. Maraqa and Ghoudi (56) have also demonstrated that 78% of the UAE population prefer drinking bottled water and due to safety concerns, they either rarely or never drank tap water. Choate et al. (57) have also revealed that tap water taste and safety concerns caused the first-year university students to commonly consume disposable bottled water. The hygiene and healthiness of the bottled water mainly attracted the participants of the study more than the tap water in New Zealand and Flanders, Belgium (28, 26).

A study conducted at the Western Michigan University (WMU), USA by Makos, (58) indicated that tap water provides 66.77% of the daily water consumption of students (24,000). However, significant bottled water consumption at an average of 2.53 bottles/ day (60,720 bottles per week) was also noted mainly due to the

perception of disadvantages of drinking tap water. The authors further recommended conducting more research for understanding the perception of students about tap and bottled water. In addition, launching a social marketing campaign for encouraging tap water consumption was also suggested. Díez et al. (2) demonstrated that the community of Basque Country, Spain predominately drink tap water and bottled water is rarely consumed. Pro-environmental awareness and positive perceptions could attract people to consume tap water. Similarly, 58.25% of the Shanghai (China) residents mainly drink boiled tap water which led to increased filtered water consumption and a decrease in bottled/barreled water consumption. Risk perception, health belief, and housing conditions were the main factors affecting drinking water choices. Administrative departments should provide knowledge, health education, and effective measures to safeguard public health related to drinking water choices (29).

Most of the participants (71.9%) of this study consuming bottled water were males (26 to 35 years) whereas females mainly consumed tap and filtered water. In addition, 83.3% and 57.4% of participants from the age group (18-25) also consumed tap and filtered water, respectively. However, the results did not depict any correlation between bottled water consumption, age, and gender. Contrarily, the tap water consumption was found to be significantly correlated with monthly income ($p<0.05$) whereas filtered water consumption exhibited a significant correlation with gender ($p<0.05$) (Tables 2-5). This could be attributed to the higher income association with age, and education level. Table 2 presents that 75% of bottled water consumption was among the Bachelor degree holders whereas 38.30% of the employed participants also consumed bottled water. Tap water consumption was noted to be significantly affected by the income of the individual ($p<0.05$) (Table 3). Females preferred tap and filtered water as compared to bottled water and a significant correlation between filtered water consumption and gender was noted ($p<0.05$) (Table 4). A recent study in the United Arab Emirates (UAE) found the highest consumption of bottled water in the age group of 18-25 years that could be attributed to the high income of the UAE population (56). The study further elaborated that females consumed more water bottles than males because they were more conscious about water safety and perceived that tap water contains high microbial and chemical contamination (58). However, the current study could not establish a significant difference in the bottled water consumption of males and females, which is consistent with the findings of Díez et al. (2018) at the University of the Basque Country, Spain (2).

During this study, the water bottles related environmental concerns of the Bachelor Degree holders (20.1%) and university students (41.4%) were not as expected. 75% of these individuals consumed bottled water only because of the safety concerns about tap water. However, bottled water consumption and education were significantly correlated. This could be attributed to the fact that 75% of the participants were aware of the positive impact of recycling on the environment (10). However, in the absence of proper recycling infrastructure, only 1% of the MSW is generally recycled in Bahrain (7-10). A rapid rise in bottled water consumption has somehow increased the recycling of the plastic waste in the country. Similarly, 75% of the students at Mexico City University preferred bottled water rather than tap water without considering its negative effect on the environment (39).

Qain et al. (59) have concluded that positive perception about tap water influenced the university students from Singapore, Hong Kong, and Macau to consume only 13.44%, 24.76%, and 24.45% bottled water, respectively. DuPont et al. (16) have found

that highly educated individuals in Canada consumed fewer water bottles as they were aware of the better tap water quality than bottled water. Sajjadi et al. (60) have also reported the direct impact of educational level on consumers' water quality perception. Educated people having better awareness about the low risk of tap water contamination and bottled water contents were less hesitant to drink tap water. Similarly, Diez et al. (2) found that the majority of the lecturers/ researchers (37.7%) at the University of the Basque Country were non-bottled water users. Highly educated participants in the present study having a master (39%), and Ph.D. (8.5%) degree also consumed the least numbers of bottled water (0%) and (3.1%), respectively. In contrast to other studies, 91.7% of the low-income participants (less than 500 Bahraini Dinars) of this study consumed more tap water. Most of these tap water consumers were non-Bahraini residents with very low incomes (Table 3). Sajjadi et al. (60) have stated that consumers with low socio-economical and educational levels tend to be more uncomfortable with drinking tap water. Similarly, only 4% of individuals of the lowest income group drank tap water in Istanbul, Turkey (61).

During this study, 43.2% of the participants considered tap water quality as good (Figure 3). However, most of them preferred to drink bottled water because of social habits, mineral contents, pH level, and taste. Social habit (29.9%) was found to be the main drive for bottled water consumption that can be linked to the high living standards. Contrarily, the taste has been reported to be the main reason for preferred bottled water consumption among the UAE population and residents (57), and in Istanbul City (Turkey) (61). Similarly, lack of trust in tap water quality and organoleptic features of bottled water (taste, turbidity, odor, and color) urged 75% of Mexico City University students to drink bottled water (39). These findings contradict several other studies (16, 60, 61). Some studies have concluded that tap water contamination is the main reason behind the increase in bottled water consumption (1, 38). The results of the present study revealed that the trend of selecting water bottle brands was in line with previous studies where availability and quality in terms of mineral contents were the factors of the selection (50, 57, 61).

The university students in Singapore, Macau, and Hong Kong chose drinking water based on hygiene and safety followed by availability and convenience. The students from Singapore exhibited the lowest water bottled consumption because of the safety of tap water transfer, accessibility of filtered tap water, and trust in government (59). In contrast, Victory (62) revealed that consumers in Mexico were concerned about the storage conditions and chemical leaks from bottled water and did not consider water bottles necessarily safer than tap water. The results of this study depicted that participants were least concerned about the cost of bottled water. These findings are consistent with Maraqa and Ghoudi (56), who reported an affordable cost of bottled water due to high living standards in UAE. In addition, the participants of the present study mostly consumed affordable bottled water rather than spring water. The participants mainly consumed filtered and bottled water but their water bottles related environmental concerns were similar to the previous studies (2, 16). However, it did not affect their bottled water consumption behavior, which aggregates the low recycling rate issue in Bahrain (4, 7, 8) that can be only overcome by developing recycling infrastructure (10). Contrarily, Diez et al. (2) reported that the consumers in Spain considered water bottles as a potential environmental and health issue that decreased its purchase by a good proportion of the participants.

Social media can serve as a powerful communication tool but all the information shared through social media is not necessarily

from reliable and accurate sources (15). The bottled and filtered water in Bahrain indicate the mineral contents and pH but most of the participants in the present study obtained the water quality information through social media. These findings are consistent with the study of Doria et al. (63) stating that the influence of mass-mediated sources on the public perception of drinking water quality is stronger than interpersonal sources (family members and friends). Approximately 73% of the present study participants indicated to consume tap water if reliable confirmations are conveyed from the Bahrain water authorities regarding its safety, cleanliness, and rich mineral content. They further stated to consume tap water if regular reports about tap water quality are provided by the authorities. Kanat (61) has also reported such tap water quality assurance from the relevant authorities in Istanbul, Turkey. The study of Qian (59) on University students in Singapore, Macau, and Hong Kong support these findings. He found the lowest consumption of bottled water among students from Singapore because they trusted in the government. However, some participants of the present study indicated that they would not drink tap water even if a similar assurance is given. They might be concerned about the water contamination inside in-house storage tanks or during distribution that requires adequate inspections and controls on the water network (57, 61).

The population of Bahrain was estimated as 1.6 million in 2019 (3). The results of the current study demonstrated extremely high bottled water consumption in Bahrain (295.50 liters/capita/year) as compared to Italy (188.5 liters/capita/year), France (139.3 liters/capita/year), Germany (177.3 liters/capita/year), (19), Saudi Arabia (115.46 liters/capita/year), Iran (48.91 liters/capita/year), and UAE (128.33 liters/capita/year) (64). Therefore, tap water quality reports should be regularly published to improve public satisfaction. The steps including tap water marketing campaigns by water authorities and non-governmental organizations (NGOs) and investments in recycling infrastructure supported by educational plans for proper disposal of bottled water among consumers are of primary importance. The findings of Freije et al. (6) about the mineral compositions of tap, filtered, and bottled water in Bahrain support this approach. The study further concluded that tap water quality has improved as compared to the early 1990s and could be a better option than filtered water whereas improved magnesium levels could also make it a better option than bottled water. Public trust in scientists and non-governmental organizations (NGOs) has been reported in several studies as compared to lower trust in mass media and governmental groups (63-65). Such approaches could facilitate sustainable community behavior for reducing or eliminating bottled water consumption.

Conclusions

Most of the current study participants consumed filtered and bottled water whereas the consumption of tap water was very low even though a large fraction of participants considered the tap water quality in Bahrain as good. Filtered water was preferred due to the taste, availability, safety, and convenience whereas social habits, mineral contents, pH levels, and taste resulted in higher bottled water consumption. Tap water contamination was considered as the main concern among participants to cause its low consumption. Participants responded that more clarification about tap water safety, regular official reports related to water safety and mineral contents, government surveillance, and disinfection could encourage them to drink tap water. One of the main findings of this study is the high consumption of bottled water in

Bahrain in comparison to neighboring Gulf Cooperation Council (GCC) countries. Therefore, improving public satisfaction about tap water, effective environmental legislation and campaigns presenting hazards of bottled water consumption, and investments in recycling infrastructure are necessary.

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Riassunto

Fattori che influenzano il consumo idrico nel Regno del Bahrain e ricadute ambientali del consumo di acqua in bottiglia

Premessa. Il consumo di acqua imbottigliata negli anni più recenti è visibilmente aumentato a livello globale, persino in aree rifornite di sorgenti adeguate al consumo umano. Il presente studio indaga i fattori che influenzano il consumo di acqua d'acquedotto, acqua filtrata ed acqua imbottigliata nel Regno del Barhain, nonché sugli effetti ambientali che il consumo acqua imbottigliata comporta.

Metodi. Tra l'Aprile ed il Maggio 2019 è stata effettuata un'indagine trasversale su 483 partecipanti residenti nel Regno del Barhain, utilizzando un questionario autosomministrato per definire la tipologia di acqua preferita nonché la quantità di acqua in bottiglia consumata per anno/persona ed altre informazioni relative al consumo d'acqua in generale.

Risultati. Lo studio ha rivelato che erano l'acqua filtrata e quella imbottigliata ad essere le più consumate nel Regno (rispettivamente il 35.90 ed il 34.50%), mentre il consumo di acqua condottata era trascurabile (8.90%). Il consumo di acqua imbottigliata raggiungeva 0.51 L/persona/giorno, pari a 184.69L/persona/anno. Pertanto, su di una popolazione di circa 1.6 milioni di abitanti, ben 295.50 L/persona/anno di acqua imbottigliata risultano consumati, e questo consumo appare assai elevato se confrontato con quello di altre realtà nazionali

Conclusioni. Lo studio conclude raccomandando di intervenire per migliorare la percezione dell'acqua condottata attraverso campagne di promozione, investimenti in infrastrutture di riciclo ed introducendo progetti di educazione al corretto smaltimento delle bottiglie usate.

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