Received: January 29, 2024
Accepted: June 6, 2024
Acad Med J 2024;4(2):54-63
UDC:628.1.033-021.465(497.713)
DOI: https://www.doi.org/10.53582/AMJ2442054gj
Original article

THE QUALITY OF DRINKING WATER FROM NATURAL PUBLIC WATER TABS IN THE MUNICIPALITY OF VELES FROM A PUBLIC HEALTH ASPECT

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Abstract

Introduction: In many urban areas worldwide, drinking water from public water tabs is a widespread practice. However, the water quality of these sources has been questioned by some experts and authorities. This drinking water offers an open and free service to the population who usually expect to receive a high-standard and healthy city water. The water from public water tabs provides a substitute for packed water or sweetened beverages to both humans and animals. The aim of this paper was to assess the prevalence of unsafe water samples consumed by the citizens of Veles, despite prior notifications regarding their compromised safety.

Materials and methods: The water quality was examined in accordance with the national program for public health. A total of 261 water samples were meticulously tested, encompassing both physical-chemical and microbiological analyses, according to parameters in the Regulation on drinking water safety.

Results: A total of 40 (15%) samples were unsafe in relation to the physico-chemical parameters, because of contamination with nitrates, and 200 (76%) samples were unsafe because of microbiological contamination with *E. coli.*

Conclusions: The city's natural public water tabs have poor and variable water quality, which makes them unsuitable for human consumption and are a public health hazard. Nevertheless, the residents continue to use them in summer, ignoring the expert opinion that the water is not safe for human consumption. It is advisable to perform hygiene maintenance and disinfection procedures on a regular basis, and to entrust the water supply to a qualified and licensed entity, which would ensure its availability as a backup source in case of emergencies. These findings are useful for local authorities to remove the source of the contamination of the water sources and to integrate them into the municipal water supply network.

Keywords: coliform bacteria, nitrates, water-related diseases, public health

Introduction

Drinking water from public fountains is a widespread practice worldwide, especially in urban areas. The history of drinking fountains dates to ancient Greece, with modern versions emerging in London in 1850[1]. Despite its long history and widespread use, the safety and quality of water from these fountains have been subject of concern.

The quality of drinking water is crucial for human health. Contaminated water can transmit diseases such as cholera, diarrhoea, dysentery, typhoid, and polio. In 2022, it was reported that at least 1.7 billion people globally used a drinking water source contaminated with feces[1]. Therefore, the safety of public water sources, including fountains, is of paramount importance.

Healthy drinking water is water that does not contain pathogenic microorganisms, parasites in numbers that pose a danger to human health; it has good organoleptic properties with an adequate composition of micro- and macronutrients; it does not contain chemically toxic substances and it is not radioactive[2].

The causative agents of bacterial, viral, and parasitic diseases, so-called intestinal infectious diseases, can be transmitted through drinking water. By providing sufficient amounts of healthy, safe drinking water, not only the occurrence of hydric epidemics with intestinal infectious diseases is prevented, but also the quality of life is improved, the health culture of the population is raised to a higher level and the environment is improved as a whole.

Water quality is assessed according to the organoleptic, microbiological, and physicochemical properties of the water. In order to find whether drinking water is safe for human health, laboratory findings of all examined parameters have to be within the maximum allowed concentrations determined by the National Regulation on the safety of drinking water (Official Gazette of the Republic of North Macedonia No.183/18)[3].

The sanitary-hygienic and epidemiological professional and administrative supervision of the water supply in the municipality of Veles is carried out by the Public Health Center - Veles, the Institute for Public Health Skopje and the Agency for Food and Veterinary Medicine - regional unit Veles, based on the existing legal regulation.

Experts from Public Health Center - Veles perform regular sanitary-hygienic inspections and take water samples for analysis from rural areas (local water pipes, natural water tabs, and wells) of the municipality of Veles and from water tabs in the city. Based on laboratory testing they give final opinion on water safety for human consumption.

The hygienic-epidemiological and social-medical significance of drinking water is reflected in the following two aspects: positive, when drinking water contributes to health and general well-being, and at the same time the used (waste) water is disposed of in a health-ecologically correct way and does not pose a danger to the health of the population and the environment; negative, when infectious or non-infectious diseases occur in epidemic or endemic form due to biological or physico-chemical defects[4].

Surveillance of waterborne diseases focuses on the early detection of individual cases of infection with waterborne pathogens or the occurrence of an increased number of cases of waterborne disease or the occurrence of an epidemic spread of the disease[5].

The aim of this paper was to assess the prevalence of unsafe water samples consumed by the residents of the Veles municipality, despite prior notifications regarding their unsafety for drinking. By analyzing the data, we intend to present a comprehensive overview of the extent of contamination and its potential health implications. Furthermore, our findings will be shared with the local government authorities, emphasizing the urgency of addressing this issue.

Material and methods

According to the Annual National Program for Public Health in the Republic of North Macedonia for the period 2018-2022, sanitary-hygienic inspections were made, and water samples were taken for analysis from rural areas (local water pipes, natural water tabs, and wells) of the Veles municipality and from water tabs in the city. Locations of the measurement points are shown in Figure 1. Water safety was controlled by water sampling for bacteriological and physicochemical analyses with dynamics of 1 to 4 samples per water supply facility, and according to epidemiological indications. Frequency of taking water samples, testing parameters, maximum limit values were used from the Regulation on drinking water safety (Official Gazette of the Republic of North Macedonia No.46/20008, ##2018 page 35[6,7]. The following parameters of the water samples were examined:

- Physicochemical parameters: temperature, colour, fragrance, turbidity, pH, concentration of KMnO4, electrolyte conductivity, ammonia, nitrites, nitrates, chlorides, iron
- Microbiological parameters: total number of bacteria in 1 ml water at 37^oC, total number of bacteria in 1 ml water at 22^oC, *Enterococci* in 100 ml, *Pseudomonas aeruginosa* in 100 ml, *E. coli*, and the most probable number of coliform bacteria in 100 ml.

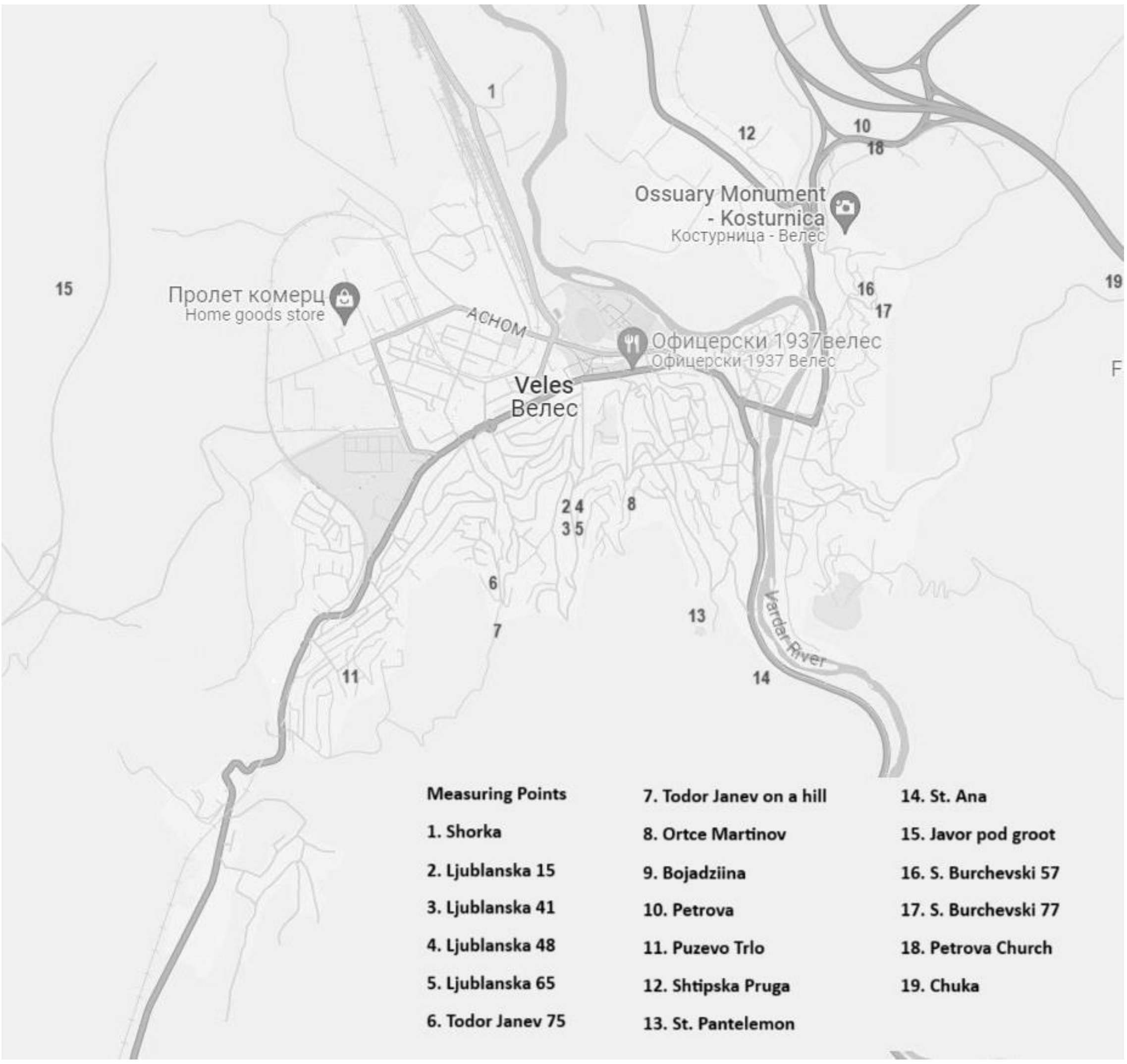

Fig. 1. The city map of Veles with localities of the public water tabs.

Results

A total of 261 water samples from the territory of the Veles municipality was analyzed, as well as from the water tabs in the city and its immediate surroundings, which are occasionally used, especially in the summer-autumn period.

Table 1. Total number of water samples taken in 2018 – 2022, for physicochemical analysis

Total number of water samples for physicochemical analysis							
Measuring place	**No. water sample**	**Unsafe**	**%**	**Measuring place**	**No. water sample**	**Unsafe**	**%**
Shorka	16	0	0.0	Puzevo Trlo	17	8	47.1
Ljubljanska 15	16	2	12.5	Shtipska Pruga	13	0	0.0
Ljubljanska 41	16	10	62.5	St. Pantelemon	7	0	0.0
Ljubljanska 48	16	8	50.0	St. Ana	7	0	0.0
Ljubljanska 65	16	0	0.0	Javor pod groot	10	0	0.0
Todor Janev 75	17	0	0.0	S. Burchevski 57	10	0	0.0
Todor Janev on a hill	16	0	0.0	S. Burchevski 77	10	0	0.0
Orce Martinov 45	15	12	80.0	Petrova church	15	0	0.0
Bojadziina	15	0	0.0	Chuka	13	0	0.0
Petrova	16	0	0.0	SUM	261	40	15.3

Table 1 presents the total number of samples and the proportion of samples that met the standards for physicochemical analysis for each measurement site. Out of 261 samples taken from 19 sites, 44 samples (15.3%) did not comply with the criteria for drinking water safety.

Table 2. Total number of water samples taken in 2018 – 2022, for microbiological analysis

Total number of water samples for Bacteriological analysis							
Measuring place	**No. water sample**	**Unsafe**	**%**	**Measuring place**	**No. water sample**	**Unsafe**	**%**
Shorka	16	4	25.0	Puzevo Trlo	17	13	76.5
Ljubljanska 15	16	10	62.5	Shtipska Pruga	13	13	100.0
Ljubljanska 41	16	12	75.0	St. Panteleimon	7	7	100.0
Ljubljanska 48	16	10	62.5	St. Ana	7	6	85.7
Ljubljanska 65	16	8	50.0	Javor pod groot	10	9	90.0
Todor Janev 75	17	11	64.7	S. Burchevski57	10	8	80.0
Todor Janev on a hill	16	15	93.8	S. Burchevski77	10	8	80.0
Orce Martinov 45	15	15	100.0	Petrova church	15	14	93.3
Bojadziina	15	8	53.3	Chuka	13	13	100.0
Petrova	16	16	100.0	SUM	261	200	76.6

Table 2 provides the data on the microbial quality of the water samples from urban water tabs in the city of Veles and the surrounding areas. The table indicates the total number of samples and the percentage of samples that passed the standard for safe drinking water for each measurement place. Out of 261 samples taken from nineteen sites, 199 samples (76.6%) did not meet the criteria for drinking water.

Table 3 illustrates the data on the physical chemical quality of the water samples from urban water tabs in the city of Veles and the nearby areas, collected and tested from 2018 to 2022. The table presents the total number of samples that satisfied the standards for safe drinking water for each measurement place and year. Out of 261 samples taken from 19 sites, 40 samples (15.3) did not conform to the criteria for safe drinking water.

Table 4 depicts the data on the microbial quality of the water samples from urban water tabs in the city of Veles and the neighbouring areas, collected and analyzed from 2018 to 2022. The table displays the total number of samples and the percentage of samples that complied with the standards for safe drinking water for each measurement place and year.

Out of 261 samples taken from 19 sites, 200 samples (76.6%) failed to meet the criteria for drinking water.

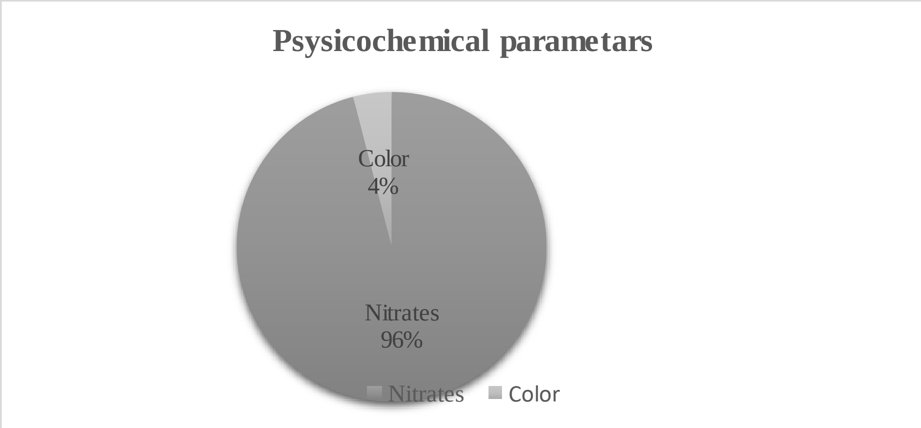

Fig. 2. Percentage of unsafe samples according to physicochemical analysis

Figure 2 shows that nitrates were the main reason for unsafe water according to physicochemical analysis (96% of unsafe samples).

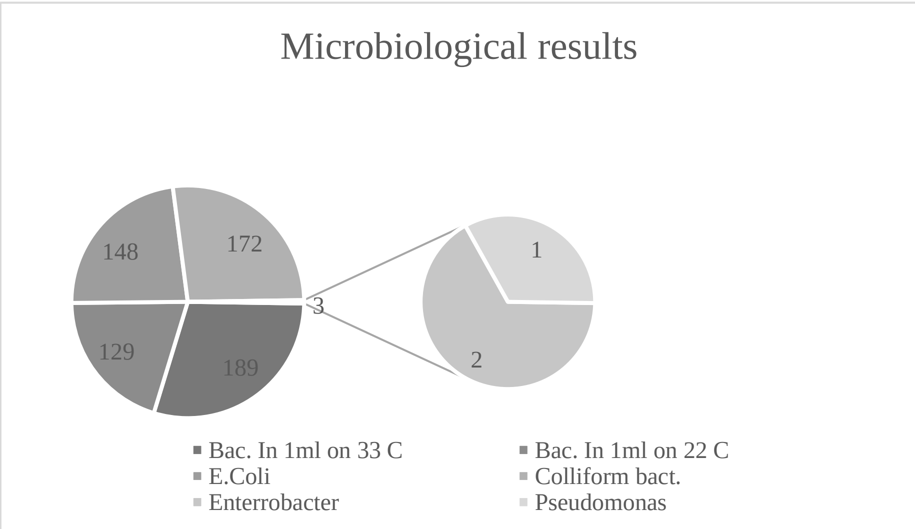

Fig. 3. Number of unsafe water samples according to microbiological testing

Figure 3 shows that the main reason for unsafe water according to microbiological analysis was the total number of bacteria in 1 ml at 33°C (72% of the samples). 56% of the samples were unsafe because of contamination with *E. coli*, 49% of the samples were unsafe because of contamination with coliform bacteria. In the microbiological analysis none of the samples exhibited unsafety in only one parameter .

Table 3. Total number of water samples taken in 2018 – 2022, for physicochemical analysis, by years

Measuring place	Physicochemical analysis														
	2018			2019			2020			2021			2022		
	Total	Unsafe	%	Total	Unsafe	%	Total	Unsafe	%	Total	Unsafe	%	Total	Unsafe	%
Shorka	4		0.0	4		0.0	3		0.0	2		0.0	3		0.0
Ljubljanska 15	3	1	33.3	4		0.0	4		0.0	3		0.0	2	1	50.0
Ljubljanska 41	3	2	66.7	4	2	50.0	4	2	50.0	3	3	100.0	2	1	50.0
Ljubljanska 48	3	2	66.7	4	1	25.0	4	2	50.0	3	3	100.0	2		0.0
Ljubljanska 65	3		0.0	4		0.0	4		0.0	3		0.0	2		0.0
Todor Janev 75	3		0.0	3		0.0	4		0.0	4		0.0	3		0.0
Todor Janev on a hill	2		0.0	3		0.0	4		0.0	4		0.0	3		0.0
Orce Martinov 45	3	3	100.0	4	4	100.0	2	1	50.0	2	2	100.0	4	2	50.0
Bojadziina	2		0.0	4		0.0	4		0.0	2		0.0	3		0.0
Petrova	4		0.0	4		0.0	3		0.0	2		0.0	3		0.0
Puzevo Trlo	3	2	66.7	3	2	66.7	4		0.0	4	3	75.0	3	1	33.3
Shtipska Pruga	4		0.0	4		0.0	2		0.0	2		0.0	1		0.0
St. Panteleimon	1		0.0	2		0.0	1		0.0	2		0.0	1		0.0
St. Ana	2		0.0	1		0.0	/	/	/	2		0.0	2		0.0
Javor pod groot	3		0.0	2		0.0	1		0.0	3		0.0	1		0.0
S. Burchevski 57	4		0.0	/	/	/	2		0.0	2		0.0	2		0.0
S. Burchevski 77	4		0.0	/	/	/	2		0.0	2		0.0	2		0.0
Petrova church	4		0.0	4		0.0	3		0.0	2		0.0	2		0.0
Chuka	4		0.0	3		0.0	4		0.0	1		0.0	1		0.0
SUM	59	10	16.9	57	9	15.8	55	5	9.091	48	11	22.9	42	5	11.9

Table 4. Total number of water samples taken in 2018 – 2022, for microbiological analysis, by years

Measurement site	Bacteriological analysis														
	2018			2019			2020			2021			2022		
	Total	Unsafe	%	Total	Unsafe	%	Total	Unsafe	%	Total	Unsafe	%	Total	Unsafe	%
Shorka	4	1	25.0	4	2	50.0	3		0.0	2		0.0	3	1	33.3
Ljubljanska 15	3	2	66.7	4	3	75.0	4	3	75.0	3	1	33.3	2	1	50.0
Ljubljanska 41	3	2	66.7	4	3	75.0	4	3	75.0	3	3	100.0	2	1	50.0
Ljubljanska 48	3	2	66.7	4	4	100.0	4	2	50.0	3	1	33.3	2	1	50.0
Ljubljanska 65	3	2	66.7	4	2	50.0	4	2	50.0	3	1	33.3	2	1	50.0
Todor Janev 75	3	2	66.7	3	2	66.7	4	3	75.0	4	1	25.0	3	3	100.0
Todor Janev on a hill	2	2	100.0	3	3	100.0	4	3	75.0	4	4	100.0	3	3	100.0
Orce Martinov 45	3	3	100.0	4	4	100.0	2	2	100.0	2	2	100.0	4	4	100.0
Bojadziina	2	2	100.0	4	2	50.0	4	1	25.0	2		0.0	3	3	100.0
Petrova	4	4	100.0	4	4	100.0	3	3	100.0	2	2	100.0	3	3	100.0
Puzevo Trlo	3	2	66.7	3	1	33.3	4	3	75.0	4	4	100.0	3	3	100.0
Shtipska Pruga	4	3	75.0	4	4	100.0	2	3	150.0	2	2	100.0	1	1	100.0
St. Panteleimon	1	1	100.0	2	2	100.0	1	1	100.0	2	2	100.0	1	1	100.0
St. Ana	2	2	100.0	1	1	100.0	/	/	/	2	1	50.0	2	2	100.0
Javor pod groot	3	3	100.0	2	1	50.0	1	1	100.0	3	3	100.0	1	1	100.0
S. Burchevski 57	4	3	75.0	/	/	/	2	2	100.0	2	2	100.0	2	1	50.0
S. Burchevski 77	4	3	75.0	/	/	/	2	2	100.0	2	1	50.0	2	2	100.0
Petrova church	4	4	100.0	4	4	100.0	3	2	66.7	2	2	100.0	2	2	100.0
Chuka	4	4	100.0	3	3	100.0	4	4	100.0	1	1	100.0	1	1	100.0
SUM	59	47	79.7	57	45	78.9	55	40	72.7	48	33	68.8	42	35	83.3

Discussion

Public fountain water is a common source of drinking water in many urban areas, but its quality and safety are often questioned by the public. There are several factors that can affect the quality of public fountain water, such as the source of the water, the treatment process, the maintenance of the pipes and the water tabs, and the exposure to environmental contaminants and human pathogens.

According to some studies, there is little evidence that public fountain water poses a significant health risk to the general population as long as it meets the standard and regulations set by the authorities. To assess the quality and safety of public fountain water in the city of Veles and the adjacent areas, a series of physical chemical and microbial analyses were conducted on the water samples collected from 19 measurement places from 2018 to 2022. The results of these analyses are presented in tables and figures.

Samples collected from 31 artesian fountains in the city of Zaječar were contaminated and the causes were physicochemical parameters, increased pH value, turbidity, and noticeable colour[7]. In our case, the water samples were high in nitrates and with noticeable color change. There were 96% of chemically unsafe water samples regarding the quantity of nitrates. According to the World Health Organization (WHO) nitrate level in drinking water is 50 mg/L. High levels of nitrates in drinking water can pose health risks, especially for infants and pregnant women. Drinking water that has nitrate levels above 50 mg/L can cause a condition called methemoglobinemia, or blue-baby syndrome, in infants under six months of age. This condition occurs when nitrates are converted to nitrites in the digestive system and interfere with the ability of the blood to carry oxygen. Symptoms include bluish skin, shortness of breath, headache, and fatigue. In severe cases, it can lead to coma and death[1]. The WHO says that drinking water should ideally have no visible colour. Colour in drinking-water is usually due to the presence of coloured organic matter (primarily humic and fulvic acids) associated with the humus fraction of soil. Colour is also strongly influenced by the presence of iron and other metals, either as natural impurities or as corrosion products. It may also result from the contamination of the water source with industrial effluents and may be the first indication of a hazardous situation. The source of colour in a drinking-water supply should be investigated, particularly if a substantial change has taken place. No health-based guideline value has been proposed for the colour in drinking water.

Figure 2 illustrates the results of the microbiological analysis of the water samples from urban water tabs in the city of Veles and the adjacent areas, conducted by the Public Health Center - Veles. The analysis tested for six indicator microorganisms that reflected the presence of fecal contamination in the water. The most prevalent indicator was the total number of aerobic mesophilic bacteria, which exceeded the standards in 189 water samples. The second most prevalent indicator was the coliform bacteria, which were detected in 172 water samples. *E. coli*, another indicator of fecal pollution, was found in 148 water samples. Other indicators, such as pseudomonas and enterobacteria, were found in very low numbers, with one and two water samples respectively. A high level of fecal pollution in water samples from the urban water tabs was found.

E. coli is a bacterium that shows the presence of fecal pollution in water and soil, as it is widely distributed in the feces of humans and animals. It can be detected in natural waters and soils that have been exposed to fecal contamination from various sources, such as human, animal, wildlife, or agricultural activities. Its identification is a crucial indicator of water quality and safety as it reflects the potential risk of exposure to harmful pathogens and toxins[2].

Another indicator that reflects the fecal pollution in water is the coliform bacteria, which are a group of bacteria that are commonly found in the intestines of humans and animals. The presence of coliform bacteria in drinking water indicates that the water has been subjected to insufficient treatment, contamination, or nutrient enrichment. Even though coliform bacteria are not necessarily indicative of the existence of fecal contamination or harmful pathogens in drinking water, the coliform test is still a valuable tool for assessing the microbiological quality of the water.

However, there may be some cases where public fountain water can cause illness or infection, especially in vulnerable groups involving children, elderly, or immunocompromised individuals.

Therefore, it is important to monitor and test the quality of public water regularly, and to educate the public about the proper use and hygiene of the water tabs.

Water consumption from the studied public fountains in the Sintra Municipality seemed to present a high risk for the population's health, due to the potential contamination with pathogenic microorganisms[8].

Although our findings indicate the presence of potentially pathogenic microorganisms, the results showed no correlation between the number of isolated microorganisms and the number of water fountain users. No specific correlation between the frequency of use of drinking water fountains and restroom's location was identified. We therefore suggest that the contamination present on the surface of the drinking water fountains is due to both the inefficacy of the cleaning procedures and the location of the water fountains[9].

Conclusion

The quality of drinking water from the city's public water tabs is constantly monitored by various tests and measurements. However, the results of this ongoing assessment show that the water does not comply with the legal requirements for safe drinking water.

The city's natural public water tabs have poor and variable water quality, which makes them unsuitable for human consumption and public health hazard. They have a high level of polluted water samples in terms of bacteria and physical-chemical properties. Nevertheless, the residents continue to use them in summer, ignoring the expert opinion that the water is not safe for human consumption.

The water quality of these springs is very low and poses a serious threat of waterborne outbreaks of gastrointestinal illnesses. It is advisable to perform hygiene maintenance and disinfection procedures on a regular basis, and to entrust the water supply to a qualified and licensed entity, which would ensure its availability as a backup source in case of emergencies.

Drinking water from water tabs is the main source of free drinking water in public spaces; microbiological quality standards in such facilities are strongly relevant to public health. These findings are useful for local authorities to remove the source of the contamination of the water sources and to integrate them into the municipal water supply network.

Conflict of interest statement. None declared.

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