# Chapter 85

## Public sources in the municipality of Poços de Caldas - MG: practices of consumption and their implications to user's health

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**ABSTRACT**
The objective of this work was to evaluate the habits and practices of the inhabitants of Poços de Caldas - Minas Gerais, regarding the consumption of water resources from alternative sources (fontes/minas). The information was collected through questionnaires, sent by *e-mail*. The return rate of the questionnaires was 36.6%. 90.2% of respondents had already consumed water from alternative sources and 9.8% said they had never consumed it. It was found that the consumption was monthly: 54.5%; less than monthly: 24.5%; weekly: 9.1% and daily: 19.1%. 50.1% of the interviewed consumed the resource at the place of source and 49.9% consumed it at home. For 74.5% the consumption purpose was human and for 25.5%, consumption was for other purposes. 69.1% did not use any technique and 30.1% used simplified techniques. About the places of storage and transport, 7.3% used boxes; 50.1%, gallons, buckets, and clay buckets and 22%, reused packages. 20% did not consume water at home. In view of the results obtained, it was found that the practices and habits of the interviewers represented health risks, that suggests that policies for monitoring sources and disseminating information are recommendable.

**Keywords:** Alternative Solutions, Water supply, Habits and practices; Health Risks.

## 1 INTRODUCTION

The population can access water through alternative sources of supply, such as mines or bicas, and this collection occurs directly and without treatment (SILVA, YAMNAKA; MONTEIRO, 2017). Mines or bicas are classified as collective alternative sources of supply, because they serve an undetermined number of people, unlike individual alternative sources, whose water is consumed at home by families or a restricted group of people (TAVARES et al., 2017).

Alternative water sources are considered by the population as having superior quality to the water provided by sanitation and supply companies (SILVA; YAMANAKA; MONEIRO, 2017). Such belief stems from cultural factors, being passed from parents to children, in which it is believed that the superior quality and "purity" have as a cause the fact that the water from such sources has not received chemical additives such as chlorine and has not been subjected to industrial processes of disinfection and decontamination (HAMAD; YAACOB; OMRAN, 2021).

However, in principle, alternative water supply solutions for human consumption represent the most vulnerable sources of contamination, since they have not undergone decontamination processes, and

therefore need to be included in the databases of the Health Surveillance Agency (VISA). The quality of water from these points should be monitored frequently, since various events, especially problems related to basic sanitation, can affect its potability (TAVARES et al., 2017).

Contrary to popular belief, the use of water from fountains is considered a public health problem because, even if the potability parameters set by legislation are reached, the use of resources by residents and tourists can be performed inappropriately (SILVA; YAMANAKA; MONTEIRO, 2017).

Groundwater reserves, despite being one of the largest sources of water for human consumption, reflect the dynamics of external environmental factors, such as consumption, storage, weather conditions and human activities (FRANCIS et al., 2015; BRITO et al., 2021). Based on this assumption, we arrive at the idea that groundwater is susceptible to contamination by anthropic activities and infiltration of urban effluents (BRITO et al., 2021).

The contamination of the waters of the alternative underground sources can occur due to diffuse causes, such as industries, domestic sewage, decomposition of organic matter, agrochemicals, leaking fuel tanks, solid waste deposits, and percolation of feces from confined animals. Pollution from sources can contribute to the presence of toxic inorganic substances in water, such as arsenic, manganese, iron, calcium, potassium, sodium, lead, magnesium, nitrates, ammonium, chlorides, carbonates, sulfates, and radionucleotides. At high levels, some of these compounds can cause a wide range of health problems (SILVA; YAMANAKA; MONTEIRO, 2017; HAMAD; YAACOB; OMRAN, 2021).

Among the contaminating factors, sewage is the main source of groundwater pollution, since, when infiltrating the soil, it is capable of contaminating the water with a large amount of pathogenic microorganisms and toxic chemicals. The pipes that conduct the sewage, especially due to the excess of pollutants, can suffer wear and tear and there is the possibility of its contents escaping (BORETI; ROSA, 2021). In addition, there are factors capable of threatening the quality of the fountain waters citing, above all, the hygiene habits of the inhabitants and visitors (SILVA; YAMANAKA; MONTEIRO, 2017).

According to Nascimento, Maia, and Araújo (2016), groundwater pollution is generally difficult to detect and expensive and prolonged to monitor. Sometimes, contamination is only evidenced when the existence of harmful substances in reservoirs is proven, at which point pollution has already spread over large areas. The population growth experienced by urban areas in recent years has brought with it challenges for the conservation of water resources, in addition to placing a greater number of citizens at risk (HAMAD; YAACOB; OMRAN, 2021).

The contamination of alternative water systems can cause health problems for users, and it has been found that the risk of contracting waterborne diseases by consuming water from alternative public sources is 22 times higher than the risk from consuming water from the public supply system. Alternative supply solutions, because they are not subject to constant inspection, pose risks to health, since they may not

adequately meet the normative precepts that stipulate the quality of water resources (MARTINS et al., 2017).

According to Boreti and Rosa (2019), the presence of microorganisms in fountain water is capable of causing diarrhea and other diseases caused by protozoa, viruses, and bacteria. High incidence of contamination of sources by domestic sewage has been observed. This is even more serious in developing countries, since in these territories the population has a high degree of confidence in the quality of water from these sources and does not receive information about its proper consumption (HAMAD; YACOOB; OMRAN, 2021).

Waterborne diseases cause millions of deaths annually in developing countries, especially in tropical climates, since the alternation between droughts and floods intensifies the water pollution picture. Most of the diseases related to the water system have as their source of contamination the fecal-oral route, in which pathogenic viruses, bacteria, protozoa, and helminth eggs, when thrown into a deficient sanitation system, can cause damage to the health of the local population. Amebiasis, ascariasis, cholera, giardiasis anemia, and hepatitis A are diseases related to the consumption of contaminated water. Their symptoms are similar and include fever, abdominal pain, bloody diarrhea, flatulence, anemia, and can lead to death (SARFAZ; SULTAMA; TARIQ, 2019).

Acute diarrheal disease (ADD) is a syndrome whose manifestations are related to a high number of bowel movements, with watery or soft stools, fever, and abdominal pain. The most frequent etiologic agents are of bacterial and viral origin that, alone or in association, cause ADD. Other less common symptoms of the syndrome include respiratory, neurological, liver, eye, skin, and lymphatic system disorders. About 90% of ADI cases in Brazil are caused by the ingestion of contaminated water (TAVARES et al., 2017).

Schistosomiasis is transmitted by *Schistosoma* ssp. larvae that can penetrate the skin and mucous membranes. Its symptoms may include weight loss, headache, nausea and vomiting, diarrhea, and fever. In the chronic phase, the disease can affect the liver and spleen (VITOR et al., 2021).

In 2020, the first cases of infection by the SARS-CoV2 virus appeared in Brazil, whose transmission can also occur through water contaminated by untreated sewage containing feces and secretions of sick individuals. Although the transmission rate of COVID-19 through sewage systems is low, the low rate of sewage treatment by disinfection in the country aggravates the risk of contamination (VITOR et al., 2021).

Although most of the chemical elements in water are essential nutrients for humans, some pose serious health risks if found in concentrations above certain limits. High levels of nitrates and calcium are associated with kidney stones and kidney damage. Trace elements ingested in excess also have health implications. Iron, for example, is related to low birth weight in newborns. Excess calcium and magnesium can cause problems in the digestive system. High concentrations of sulfates can have a laxative effect, as well as being responsible for problems such as dehydration, weight loss, diarrhea, and respiratory syndrome. High chloride intake can cause digestive problems and kidney stones. Excessive sodium

consumption can lead to increased blood pressure. Too much fluoride can cause fluorosis and bone and ligament problems. Exposure to arsenic, in high concentrations and for long periods, can cause mental retardation, epilepsy, hearing loss, and brain damage; it can also affect the skin, kidneys, lungs, intestines, and liver (SARFAZ; SULTANA; TARIQ, 2019; HAMAD; YAACOB; OMRAN, 2021).

Thus, it is necessary to constantly evaluate the water from alternative sources because, given the possibility of contamination, it is necessary to develop public policies to ensure the safe consumption of this resource. Additionally, there is a gap regarding the existence of studies on the subject. Thus, this research aimed to contribute information about the consumption of water from alternative sources of supply, such as bicas or mines, in the municipality of Poços de Caldas, MG, and its impacts on the health of users.

## 2 METHODOLOGY

### Study area

The municipality of Poços de Caldas (MG) has approximately 166,000 inhabitants. This city is one of the most developed in the region, with industry, commerce, and a wide range of services. The municipality has the highest life expectancy (78.2 years) in the state and the second highest income *per capita* nationally. Besides being classified as one of the best cities in terms of quality of life, it is among the 100 cities with the lowest social inequality index in the country; it has an HDI (Human Development Index) of 0.779 and a *per capita* income of 39,985.71 reais *per* year (IBGE, 2022). According to the Municipal Department of Water and Sewage of Poços de Caldas (DMAE, 2022), 99.6% of the population receives treated water and sewage collection serves 99.8% of households, while 30% of domestic sewage is treated before its final disposal.

Poços de Caldas is known nationally for its hot springs with medicinal effects. The probability of biological contamination of the thermal waters of Poços de Caldas is small, since the high temperature and long period of residence of the waters (12,500 years) make the survival of contaminating organisms impossible. Nevertheless, possibilities of contamination of thermal waters and underground sources should not be ruled out, since the city is undergoing intense urbanization and population growth, generating impact on the dynamics of natural resources (RIBEIRO; COELHO; MÉROLA, 2021; DMAE, 2022).

### Collecting the information

The information was collected from the inhabitants of the urban area of the city through a structured questionnaire, designed so that the questions were as direct and objective as possible, in order to avoid obscurity, doubts, or misinterpretation (FALEIROS et al., 2017).

The sample number was calculated taking as parameters a sampling error of 7%, with a confidence level of 90%. The population considered for the sample calculation was 130,000 components, since from

the total population projected for 2017 (166,085), the inhabitants of the rural area[12] were disregarded. In this sense, stratified random sampling was used.

To calculate samples from finite populations, the equation adapted from Faleiros et al. (2017) was used. The sample was selected based on the accessibility of the researchers to the inhabitants of the municipality and the availability of people to participate. The questionnaire consisted of seven closed questions in which the interviewees should mark the alternative that corresponded to the conduct that best fit their habits. The identities of the interviewees were preserved, and they signed a consent form to publish the answers obtained for this research.

The research conducted was qualitative, with snowball sampling in which, first, some users were directly approached when they consumed or collected water from public fountains (VINUTO, 2014). Eleven users under these conditions, who agreed to participate in the study, were approached. They provided their phone contacts and *emails*. Along with the *e-mails* sent to this group, they were asked to indicate the telephone numbers of other users of the water resource. Through telephone contact, participants living in the municipality of Poços de Caldas - MG, who had access to *email* service, who were willing to participate and who were of legal age were selected, with verbal consent to forward the electronic messages. Along with the approach by telephone, it was requested that other users were indicated, until the number of 200 (two hundred) individuals was obtained. This procedure was adopted since the return rate of questionnaires is around 25% and 50 (fifty) participants were needed to ensure the representativeness of the sample (FALEIROS et al., 2017).

Through questionnaires, it was possible to collect information about the practices related to the consumption of water from public fountains in the city of Poços de Caldas, to find out whether such habits present risks to human health.

This stage was about social research, in which we sought to work with a universe of beliefs, values, attitudes, motives and meanings, marked by the subjectivism of the interviewees. In this aspect, we chose the descriptive approach in order to understand and elucidate the phenomenon studied, from the presentation of its characteristics, without intending to explain it exhaustively, but aiming to bring useful information for its clarification (FALEIROS et al., 2017).

## 3 RESULTS AND DISCUSSION

Of the 187 questionnaires sent out, 61 were answered, and the return rate was 32.6%.

The first assertion asked the participant to state whether he or she had ever consumed water from the city's public fountains. A total of 55 (90.2%) of the answers were positive, while 6 participants (9.8%) were negative to the question. The second and following questions were to be answered only if the first question had been answered in the affirmative. Thus, for questions 02, 03, 04, 05 and 06 only n=55

questionnaires (90.2%) of the total were evaluated. For questions 02 to 06, the percentage was calculated according to this value (55 elements that claimed to use water from public sources).

The second question asked the temporal frequency with which water from alternative sources was consumed. In this item, the frequency comprised the habit of 30 (54.5%); 14 (25.5%); 5 (9.1%), and 6 (10.9%) for monthly, less than monthly, weekly, and daily, respectively.

Question number 03 required the respondent to inform where the water was consumed (at the source environment or elsewhere). Twenty-eight answers (50.1%) showed that water consumption took place at the source environment. While 27 (49.9%) responses showed that water consumption took place in residences.

In question number 04, the question was about the purpose for which the water was intended (human consumption, domestic activities, vegetable cultivation, animal husbandry or other). Forty-four (80%) respondents informed that the use, to a larger extent, was for human consumption; another 11 (20%) informed that they used the resource for domestic activities and other purposes.

Question number 05 asked the participant about the use of water treatment techniques, being presented the alternatives: a) does not use techniques; b) uses simplified techniques (such as filtration or boiling) and; c) uses more complex techniques (such as disinfection, chlorination and others). Thirty-eight (69.1%) respondents reported that they did not use any treatment technique; another 17 (30.9%) said they used simplified treatment techniques, and none of the people reported using more specific techniques to treat the water.

Question 06 was about the containers in which water, if consumed at home, was transported and stored. The list of possible answers included: (a) not applicable (when there was no residential consumption); (b) water tanks; (c) jerry cans, buckets or clay utensils; and (d) *pet* bottles and reused containers. In the answers, 11 (20%) said they did not consume water at home; 4 (7.3%) said they stored or transported the water in water tanks; 28 (50.1%) used jerry cans, buckets and clay pots to transport and store water; 12 (22%) transported or stored it in *pet* bottles or other recycled containers.

The return rate of the questionnaires was considered above average, since the average return rate by *email* is 25%, as indicated by Faleiros et al. (2017). It is believed that this rate has reached a higher value because there is a tendency of the population to prefer the virtual means of participation as opposed to the interviews granted in person. The increasing use of the *Internet* by people of all age groups makes the virtual questionnaire a good source of data collection, besides being a more flexible and dynamic means of communication (GOMES; FRANCO; VIANA, 2017).

It was noted that there was a greater number of positive responses regarding the habit of using water from fountains. This use is often associated with the belief about the quality, purity, and gratuity of the resource (SILVA; YAMANAKA; MONTEIRO, 2017). The consumption of such sources is widespread among urban dwellers, especially in outlying communities, places where the lack of efficient water supply

by public agencies results in greater consumption of water from alternative sources (FRANCIS et al., 2015). Precisely in these outlying regions, there is less coverage of sanitary surveillance and water quality surveillance services (BORETI; ROSA, 2019). Among the inhabitants of the outskirts, there is greater ignorance about the sanitary quality of water, places where residents consume water without treatment, often clinging to the belief that groundwater is endowed with adequate characteristics for consumption (FRACIS et al., 2015).

Vasconcelos et al. (2016) indicate a growing trend in the frequency of use of resources from alternative sources as a form of supply by the population. In Poços de Caldas, no data were found that could bring information regarding the frequency of use and monitoring records. Silva, Yamanaka and Monteiro (2017) and Boreti and Rosa (2019) evaluated that there is an association between population increase and a greater use of water resources from alternative sources. In this sense, the population increase of the municipality verified in recent years seemed to justify the high rate of consumption of such sources.

Water is consumed at the source and without prior treatment (50.1% of respondents have this habit), which is worrisome, since it can negatively affect the health of users, especially due to the possibility of contamination with domestic sewage (FRANCIS et al., 2015; HAMAD; YAACOB; OMRAN, 2021). In Poços de Caldas, it is verified that 70% of domestic effluents are discarded *in natura*, which shows ample possibility of contamination of the sources (VITOR et al., 2021; IBGE, 2022).

Based on the belief that water from underground sources has good quality, due to the filtering power of the soil, capable of purifying and immobilizing substances harmful to health, the tendency is that users consume the water without using treatment techniques. Another pertinent analysis is that the population often lacks the knowledge and education to understand that water can be contaminated, even if it comes from natural sources. The capacity of water purification is limited, and changes in water quality can occur due to the cumulative effect of atmospheric pollutants and inadequate disposal of industrial and urban solid waste, toxic and radioactive materials. Additionally, shallow aquifers are influenced by the water that percolates through the surface, subjecting them to contamination (MARTINS et al., 2017; BORETI; ROSA, 2019).

The lack of hygiene in daily water use practices can negatively affect the health of users of alternative water sources. The answers obtained in this study show that most interviewees do not use any disinfection technique prior to consumption, which is alarming, considering that untreated water can carry several diseases and health problems. Water collected from alternative sources should be submitted to simplified sanitization techniques or, at least, to disinfection. The results of this study are in contrast to Hamad, Yacoob, and Omran (2018), who found that most respondents used techniques to ensure water potability.

Francis et al. (2015), developed a study in a small province of India, on the perception of inhabitants about water from alternative sources: most respondents believed in the suitability of the resource for human

consumption and domestic activities, so that, based on this belief, only a few employed disinfection methods. Among those who believed that the water was unsafe, most used boiling as a disinfection method, and the candle filter was mentioned but less used.

This result contrasts with the Brazilian reality, since in the country the candle filter is widely used as a means of water purification, even among the population that receives treated water. The equipment is effective in retaining chlorine, pesticides, iron, aluminum, lead, and parasites that cause diarrhea and abdominal pain. However, the candle filter is not able to guarantee the potability of the water. A recent study indicated the efficiency of the equipment in improving the variables: color, turbidity, iron and manganese concentration, although the complete inactivation of pathogenic microorganisms has not been proven (GOMES; FRANCO; VIANA, 2017).

Water filtration at home represents an additional stage of water treatment, before it is used for drinking (FRANCIS et al., 2015; GOMES; FRANCO; VIANA, 2017). Brito et al. (2021) point out that it is of great importance to disinfect the water consumed, either by filtration or chlorination, to ensure its quality, considering that the water may be contaminated from its source, or it may even be contaminated through inadequate plumbing or in reservoirs whose sanitation, packaging, and maintenance steps are inadequate. However, as Silva, Yamanaka, and Monteiro (2017) indicate, the lack of knowledge leads users to adopt procedures of unproven effectiveness for disinfecting water at home.

Regarding the ways used to transport and preserve water at home, it should be noted that, depending on the conditions under which they are carried out, there is a great risk for the consumer. Even if the water from sources is of good quality, the adoption of inadequate transportation procedures, such as the reuse of containers unsuitable for this purpose, can put the user's health at risk (SILVA; YAMANAKA; MONTEIRO, 2017).

A study in public fountains in Curitiba-PR showed the presence of fecal coliforms and *Escherichia coli* in 2 of the 3 sampled sites (66%), which identifies recent contamination by domestic sewage (SILVA; YAMANAKA; MONTEIRO, 2017). The transportation of water for consumption in the residence further aggravates the health risk, because according to Francis et al. (2015), containers and conservation techniques can lead to water contamination. Gomes, Franco, and Viana (2017) found in their study that in four of five samples (80%) conditioned in clay pots, there was presence of thermotolerant coliforms. The transportation of water is a risk factor for human health, especially due to the possibility of the water being exposed to environments where there are pathogens such as those that cause diarrhea (FRANCIS et al., 2015).

Another habit of consumers that can cause harm to health is the failure to periodically clean the containers for transporting and storing water. Proper cleaning and disinfection practices of reservoirs and the correct storage of water are essential to ensure that there is no negative interference in its quality, when

water is obtained in good sanitary conditions. The absence of the necessary care facilitates the proliferation of vectors generating health risks (BRITO et al., 2021).

Considering that most residences are served by a sewage collection system (99.8%), there is the possibility of contamination by domestic and industrial effluents, since 70% of them are not treated, being directly thrown into the environment (DMAE, 2022; IBGE, 2022). There is the possibility that the sewage transportation pipes may be affected by the pressure exerted, generating leaks, as indicated in the study by Santos et al. (2021). Several chemical compounds present in untreated effluents are capable of corroding and damaging the pipes, causing the effluents to leak (HAMAD; YACOOB; YAMANAKA, 2021). Underground deposits can be contaminated, since the possibility of interference between wells, sources, and potentially contaminating urban effluents is verified (HAMAD; YACOOB; YAMANAKA, 2021).

Other possibilities of contamination include pesticides, detergents, and fertilizers, making it necessary basic attention policies aimed at protecting springs and soil (BORETI; ROSA, 2019; BRITO et al., 2021), it should be noted that this situation is worsened when the sources are superficial, as indicated by Vasconcelos et al. (2016).

## 4 FINAL CONSIDERATIONS

In the present study, it was concluded that the practices of resource use by users of public fountain water in Poços de Caldas are not able to ensure health protection. The attitudes and practices of users, probably due to the false sense of security that exists in relation to the quality of water from fountains, are not adequate to the care indicated so that the risks associated with direct consumption are minimized or eradicated.

Therefore, a re-evaluation of the phenomenon of water consumption from alternative sources and an intervention in the situation in question is necessary, since there are many factors that tend to worsen the health of consumers. Public policies to monitor and ensure water quality need to be established and disseminated. In addition, it is important that the consumer be made aware of how practices and attitudes regarding water use can compromise the health of the population.

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