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Panorama of the water supply in the Campinas region and a brief comparison with other regions in the Southeast of Brazil

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ABSTRACT

Access to drinking water is one of the most important factors for health. The lack of access to safe drinking water results in a high prevalence of infections, such as bacterial gastroenteritis and outbreaks of diarrhea. This study evaluated the quality of the public water supply in 42 municipalities located in the eastern region of the State of São Paulo, Brazil, from 2016 to 2020. Physical, chemical, and microbiological parameters were investigated. Sample collection, preservation and analyses were carried out in accordance with national and international standards. The results demonstrated non-compliance with Brazilian legislation for apparent color (1.1%), turbidity (0.4%), fluoride content (14.2%), total coliforms (4.4%) and *Escherichia coli* (*E. coli*) (0.4%). In a brief comparison with other studies in the southeastern region of Brazil, the highest percentage of unsatisfactory samples is due to the fact that fluorine is below the minimum of <0.6 ppm, demonstrating the need for training in the fluoridation process. The need to invest in the training of health surveillance teams to carry out field analyses (chlorine and pH) was also observed. This study can inform future actions, guiding the adoption of preventive and corrective measures and demonstrating the importance of monitoring water-supply quality.

Keywords: drinking water, public health, water quality.

Panorama da água de abastecimento da região de Campinas e uma breve comparação com outras regiões do Sudeste do Brasil

RESUMO

O acesso à água potável é um dos fatores mais importantes para a saúde. A falta de acesso à água potável resulta em alta prevalência de infecções, como gastroenterite bacteriana e surtos de diarreia. Este estudo teve como objetivo avaliar a qualidade da água de abastecimento público em 42 municípios, localizados na região Leste do Estado de São Paulo, Brasil, durante os anos de 2016 a 2020. Os parâmetros investigados incluíram físicos, químicos e microbiológicos. A coleta de amostras, preservação e análises foram realizadas de acordo com as normas nacionais e internacionais. Os resultados obtidos demonstraram não conformidade com a legislação brasileira para cor aparente (1,1%), turbidez (0,4%), fluoreto (14,2%), coliformes totais (4,4%) e *Escherichia coli* (*E. coli*) (0,4%). Em uma breve comparação com outros estudos, o maior percentual de amostras insatisfatórias se deve ao fato de o flúor estar abaixo do mínimo de <0,6 ppm, demostrando a necessidade de treinamento no processo de fluoretação. A necessidade de investir na capacitação das equipes de vigilância sanitária para realizar análises de campo (cloro e pH) também foi observada. O presente estudo pode ser um guia para ações futuras, orientando a adoção de medidas preventivas e corretivas, demonstrando a importância do monitoramento da qualidade da água de abastecimento.

Palavras-chave: água potável, qualidade da água, saúde pública.

1. INTRODUCTION

Access to safe drinking water is one the most important socioeconomic determinants of the health of a community and is considered one of the main characteristics of a developed country (Tolentino *et al.*, 2019). Consumption of untreated or inadequately treated water remains a major public health burden and can expose the community to the risk of outbreaks of intestinal and other infectious diseases (WHO, 2022).

According to the Guidelines for Drinking Water Quality (WHO, 2022), the safety of drinking water is guaranteed by implementing a Water Safety Plan (WSP), which includes monitoring and verification of quality drinking water, which can be carried out by the supplier, surveillance agencies or a combination of the two. The WHO also emphasizes that the microbial water quality is based on the analysis of faecal indicator microorganisms, the organism of choice being *E. coli*, as it provides conclusive evidence of recent faecal pollution and should not be present in drinking water. The chemical quality of water involves many compounds and contaminants and judicious choices for monitoring and an analysis must be completed before starting an assessment (WHO, 2022).

In Brazil, the quality of drinking water is regulated by the Ministry of Health, which defines the organoleptic, physical, chemical, and bacteriological parameters (Brasil, 2004; 2021). To ensure water quality, three indicators specifically related to compliance with the National Directive are evaluated monthly in the water supplied to a population: Turbidity, Total Coliforms and Residual Disinfectant Agent (Brasil, 2016; 2020). In 1992, the State Program for the Surveillance of Water Quality for Human Consumption (PROÁGUA) was initiated in the State of São Paulo, Brazil, aimed at developing actions to improve the sanitary conditions of the systems and alternative solutions for the water supply and, as a result, to reduce mortality from waterborne diseases (São Paulo, 1992).

In general, even after treatment, the public water supply samples analyzed in several studies in Brazil were exposed to several conflicting factors that could affect their quality, resulting in one or more physicochemical and microbiological parameters in disagreement with the potability standards established and/or recommended by the legislation in force in the country (Palmeira *et al.*, 2019; Douvidauskas *et al.*, 2017a; Freitas *et al.*, 2002; Tolentino *et al.*, 2019; Anversa *et al.*, 2019; Romani *et al.*, 2018; Faria *et al.*, 2021; Scalize *et al.*, 2018). This study therefore evaluated the quality of the public water supply in 42 cities located in the eastern region of the State of Sao Paulo, Brazil, during the years from 2016 to 2020, and conducted a brief comparison with other studies in the southeastern region of Brazil. The parameters investigated included apparent color, turbidity, fluoride content and the presence of total coliforms and E. coli.

2. MATERIAL AND METHODS

2.1. Data collection and sampling

From 2016 to 2020, during the activities of the PROÁGUA Program, the Adolfo Lutz

Institute - Campinas Regional Laboratory Center (IAL-CLR Campinas) received approximately 16,500 samples of treated drinking water obtained from water supply systems and alternative supply solutions in the cities included in the XVII Sanitary Surveillance Group - Campinas (GVS XVII), which comprises 42 cities located in the Eastern region of the State of Sao Paulo, Brazil. The GVS XVII is divided into four Regions: Metropolitan Campinas, Water Circuit, Jundiaí and Bragança Paulista (Figure 1) with a population of approximately 4,500,000 (± 10% of the population of the State of São Paulo) (IBGE, 2022).

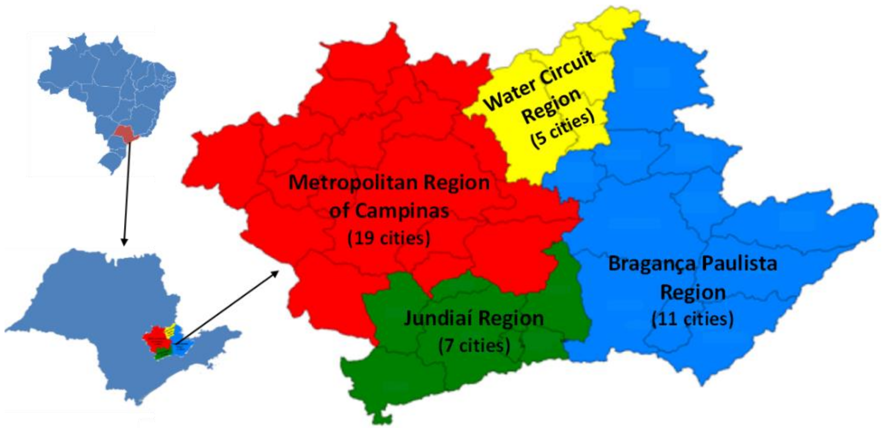

Figure 1. Map according to GVS XVII region.
Source: Elaborated by the authors, 2022.

Regarding the type of water sources evaluated: Amparo, Artur Nogueira, Bom Jesus dos Perdões, Cabreúva, Hortolândia, Itatiba, Jaguariúna, Joanópolis, Lindóia, Monte Mor, Nazaré Paulista, Pedreira, Pinhalzinho, Santo Antônio de Posse, Serra Negra, Valinhos and Vinhedo have mixed water abstraction (surface water and groundwater) offered by water supply systems; Americana, Bragança Paulista, Indaiatuba, Jundiaí, Monte Alegre do Sul, Piracaia, Santa Barbara d'Oeste and Sumaré also have mixed water abstraction, but offered both by water supply systems and alternative supply solutions; Águas de Lindóia, Atibaia, Campinas, Campo Limpo Paulista, Cosmópolis, Holambra, Itupeva, Jarinu, Louveira, Morungaba, Nova Odessa, Paulínia, Socorro, Vargem and Várzea Paulista use surface water and water supply systems; in Pedra Bela and Tuiuti, water is from groundwater and by water supply systems (Brasil, 2022).

The samples were collected by the Municipal Sanitary Surveillance (MSS) teams, according to the basic requirements of the American Public Health Association (APHA *et al.*, 2012) and the sampling plan considered the population density and other criteria, following the criteria established by the National Guideline of the Sampling Plan Surveillance Quality for Drinking Water, defined by the Ministry of Health (Brasil, 2016). The samples were sent to IAL Campinas with a registration form with information concerning the location collected, type of system and data obtained from the analyses carried out in the field (chlorine and pH).

2.2. Analytical methods

To carry out the research, the following physical, chemical, and microbiological parameters were analyzed at the IAL-CLR Campinas. Approximately 200 mL samples of water were collected in sterile, disposable bags. Each sample was analyzed as described in the Standard Methods for The Examination of Water and Wastewater (APHA *et al.*, 2012) for apparent color (visual comparison method 2120 B), turbidity (nephelometric method 2130 B), and fluoride content (ion-selective electrode method 4500-F- C). For the microbiological analyses, 100 mL samples of water were collected in sterile, disposable bags containing sodium thiosulfate. Each sample was evaluated for the presence or absence of total coliforms and *E. coli* by the chromogenic/enzymatic substrate method (Colilert system®, Idexx

Laboratories/USA), method 9223 B as described in APHA *et al.* (2012).

The results were evaluated according to the Decree that establishes the potability standards of water for human consumption (Brasil, 2017; 2011), and Resolution SS-250/1995, which defines the fluoride ion content in water supply systems of the State of São Paulo (São Paulo, 1995).

2.3. Statistical analysis

Statistical analysis was performed with software Jamovi® – Version 1.6.23. For the “satisfactory and unsatisfactory aspects,” the chi-square test was applied. The significance level was set at 5%.

3. RESULTS AND DISCUSSION

Data referring to the field analyses, chlorine and pH, were not considered in this study due to divergences and, frequently, difficulty in understanding the data. Having identified the need for training of MSS teams on how to carry out field analysis.

Most samples from the 42 cities were satisfactory for the parameters analyzed, as can be seen in Table 1. An increase in the number of total samples analyzed over the years is evident. This increase was due to a greater adhesion of cities to the monitoring program over the years and to the increase in the analytical capacity of the laboratory (capacity from 2,928 samples per year in 2016 to 5,460 in 2020).

The number of total samples analyzed did not increase in the year 2020 due to the beginning of the Covid 19 pandemic. With the declaration of the pandemic in April, 2020, many cities required about 2 months to adapt to the new reality according to the sanitary protocols and reorganization of the field teams.

Statistical analysis showed no significant differences between the different years for the parameters of turbidity, total coliforms and *E. coli* in the water samples. However, the percentage of samples that reported the presence of an apparent color and fluoride contents showed significant differences ($p < 0.05$) over the years (Table 1).

For fluoride, the reference value was set by the SES-SP (São Paulo, 1995) value for samples collected in water supply systems and by the Brasil (2017; 2011) legislations (these two legislations did not change the reference values for the parameter analyzed) for samples collected in alternative supply solutions. The unsatisfactory fluoride results obtained in this study were due to values obtained outside the range of 0.6 to 0.8 ppm, as established by SES-SP (São Paulo, 1995).

The number of samples collected in alternative supply solutions correspond to less than 2% of the total samples analyzed, most of them in private systems of closed condominiums in the regions of Jundiaí and Campinas. These samples showed no difference in relation to the water supply systems for the analyzed parameters.

The parameters of apparent color and turbidity (Table 1) showed unsatisfactory values of 1.1±0.3% and 0.4±0.1%, respectively, percentages lower than those obtained in the study carried out in the same region in the 1990s by Freitas *et al.* (2002), who highlighted that the presence of color and turbidity directly compromised the organoleptic characteristics of the water and, therefore, consumer satisfaction and product suitability.

A total of 2005 (13.5%) water samples analyzed were in disagreement with the legislation for fluoride. This fact was also observed in the study by Freitas *et al.* (2002), but with a much higher percentage of unsatisfactory results (47.8%). It is interesting to note that the parameter of fluoride showed a decrease in the percentage of unsatisfactory samples from 16.5% in 2016 to 11.9% in 2019. This decrease was obtained due to the efforts of cities to adjust the amount of fluorine added after the water treatment. After the declaration of the pandemic in 2020, the percentage of samples showing fluoride outside the recommended range rose again.

Table 1. Analytical results, in numbers of samples (and percentage) per year of the five parameters surveyed.

Parameters	Analytical results[a]	2016 n (%)	2017 n (%)	2018 n (%)	2019 n (%)	2020 n (%)	Total (mean% ± SD)	*p*[c]
Apparent color	Satisfactory	758 (98.6%)	2943 (99.2%)	3741 (99.1%)	4430 (99.0%)	4427 (98.5%)	16299 (98.9 ±0.3%)	0.014
	Unsatisfactory	11 (1.4%)	23 (0.8%)	33 (0.9%)	44 (1.0%)	67 (1.5%)	178 (1.1 ± 0.3%)	
Turbidity	Satisfactory	765 (99.5%)	2955 (99.6%)	3758 (99.6%)	4198 (99.5%)	4478 (99.6%)	16154 (99.6 ± 0.1%)	0.843
	Unsatisfactory	4 (0.5%)	11 (0.4%)	16 (0.4%)	21 (0.5%)	16 (0.4%)	68 (0.4 ± 0.1%)	
Fluoride	Satisfactory	632 (83.5%)	2484 (83.9%)	3310 (87.7%)	3592 (88.1%)	2803 (86.1%)	12821 (85.8 ± 2.1%)	<0.001
	Unsatisfactory	125 (16.5%)	478 (16.1%)	464 (12.3%)	484 (11.9%)	454 (13.9%)	2005 (13.5 ± 2.1%)	
Total Coliform[b]	Absence	736 (95.5%)	2836 (95.8%)	3629 (95.9%)	4277 (95.4%)	4285 (95.2%)	15763 (95.6 ± 0,3%)	0.541
	Presence	35 (4.5%)	125 (4.2%)	154 (4.1%)	205 (4.6%)	216 (4.8%)	735 (4.4 ± 0,3%)	
Escherichia coli	Satisfactory	765 (99.4%)	2946 (99.5%)	3773 (99.7%)	4465 (99.6%)	4479 (99.5%)	16428 (99.6 ± 0,1%)	0.352
	Unsatisfactory	5 (0.6%)	15 (0.5%)	10 (0.3%)	16 (0.4%)	21 (0.5%)	67 (0.4 ± 0,1%)	
Total samples (mean)		**767**	**2963**	**3778**	**4346**	**4249**	**16104**	

[a]Results based on the legislations Brasil (2011) (2016 and 2017), and Brasil (2017) (2018 to 2020); results for fluoride based on the legislation SES-SP (São Paulo, 1995).

[b]In public water supply samples, the total coliform parameter is just an indicator of the treatment carried out.

[c]Chi-square test.

Total coliforms and *E. coli* were observed in 735 (4.4±0.3%) and 67 (0.4±0.1%) samples, respectively. The result was in agreement with the study carried out by Palmeira *et al.* (2019), which considered that, in general, the occurrence of these bacteria in treated water reflected the hygienic conditions of the raw waters, the efficiency of the treatment process, and the integrity of the distribution system.

The total coliforms in the water does not necessarily represent the probable presence of pathogenic bacteria, protozoa, and/ or pathogenic virus, since this group includes microorganisms that naturally occur in the ground or the vegetation (Alves *et al.*, 2017). The total coliform test is used for routine examination of public water supplies and the objective is to determine the efficiency of treatment plant operations and the integrity of the distribution system (APHA *et al.*, 2012).

Already *E. coli*, with some exceptions, generally does not survive well outside of the intestinal tract, its presence in environmental samples, food, or water usually indicates recent faecal contamination. The presence of *E. coli* in the water does not directly indicate pathogenic microorganisms in the sample, but it does indicate that there is an increased risk of the presence of other bacteria and viruses of fecal origin, such as *Salmonella spp*. or hepatitis A virus. For this reason, *E. coli* is considered a more specific indicator of faecal contamination than total coliforms (Odonkor and Ampofo, 2013). Therefore, in the legislation there is a certain tolerance for the total coliforms, but not for the *E. coli*.

Fioravanti *et al.* (2020) and Tolentino *et al.* (2019) evaluated the physicochemical and microbiological characteristics of samples of alternative water solutions from wells (non-municipal water systems) and observed the presence of apparent color in 8% and 20%, and turbidity in 11% and 4.4%, respectively, of the samples analyzed, values above the percentages determined in the current study. This difference demonstrated the effectiveness of the water treatment systems adopted in the cities of the region.

Although the presence of color is related to consumer rejection, most people can detect color above 15 true color units (TCU) in a glass of water (WHO, 2022). The study by Tolentino *et al.* (2019) observed that a significant percentage of samples with color and turbidity also showed the presence of bacteria from the coliform group, a fact explained by the values for turbidity, caused by sufficiently large suspensions of particles which can harbor microorganisms, resulting in inefficient chlorination of the water. Fioravanti *et al.* (2020) observed the presence of microorganisms, 29% of total coliforms and 9% of *E. coli*, in the total number of samples analyzed, and concluded that the results found interfered with the quality of the water offered in schools, being associated with a lack of investment in the infrastructure of the wells and the lack of water chlorination.

Table 2 presents the results found in the current study and studies carried out by other groups in the Southeast region of Brazil. The total number of samples taken in the current study is higher than the numbers taken in the other studies, evidence of the commitment of the cities and laboratories involved in the control of the water supplied to residents in the Campinas region in recent years.

For the apparent color (A.C.) and turbidity (Turb.) parameters, only data for the following regions of São Paulo state were presented: Campinas, Santos, Bauru and Ribeirão Preto. A difference between the data for Santos, which is located on the coast, and the other regions, is evident. Compared with Ribeirão Preto and Bauru, the data for the apparent color parameter in the current study (Campinas) presented a higher percentage of unsatisfactory samples, whereas for turbidity the results for the three regions were similar.

Table 2. Comparison between the current study and other studies carried out in the Southeast region of Brazil.

Article	Year	Study Region	Total Samples	Parameters: % Unsatisfactory samples						
				A. C.[1]	Turb.[2]	Fluoride			T.C.[4]	*E.coli*
						% Unsat.[3]	< 0.6	> 0.8		
Current study	2016 to 2020	Campinas (SP)	16500	1.1	0.4	13.5	6.6	6.4	4.5	0.4
Freitas *et al.* (2002)	1991 to 1999	Campinas (SP)	8174	5.3	3.2	59.4	47.8	8.4		
Passos *et al.* (2012)	2007 to 2008	Santos (SP)	3094	11.8	3.7		6.0	1.0	13.9	4.7
Tavares *et al.* (2015)	2010 to 2014	Santos (SP)	9175	11.9	4.7	3.9				1.2
Romani *et al.* (2018)	2007 to 2016	Bauru (SP)	8887			31.1	22.7	8.4		
Palmeira *et al.* (2019)	2016	Bauru (SP)	2897	0.4	0.5	24.7	14.9	9.7	4.3	0.4
Dovidauskas *et al.* (2017a; 2017b)	2015 to 2016	Ribeirão Preto (SP)	4347	0.4	0.3	39.8	30.2	9.6	5.9	0.7
Faria *et al.* (2021)	2013	Rio de Janeiro (RJ)	5322						34.1	14.9
Mendonça *et al.* (2021)	2014	Espirito Santo (ES)	692			29.4	23.6	5.8		
	2017		713			14.0	13.0	1.0		

[1]A.C.: apparent color; [2]Turb.: turbidity, [3]Unsat.: unsatisfactory fluoride, outside the 0.6 to 0.8 ppm range established by SES-SP (1995); [4]T.C.: total coliforms.

For all studies presented in Table 2, the highest percentage of unsatisfactory samples is due to the fact that fluorine is outside the established range, especially being below the minimum of <0.6 ppm. This pattern is due to the fact that most Brazilian waters do not have fluorine naturally, being necessary to add it to the water distributed to the population, and also to the difficulties that water treatment plants have in controlling the fluoridation process. Inadequate dosage or overdose of fluoride can put public health at risk in terms of preventing tooth decay or expose the population to the risk of fluorosis, respectively, emphasizing the importance of water monitoring (Palmeira *et al.*, 2019; Romani *et al.*, 2018).

Some developed countries are removing the fluoridation system from their supply. This served as a justification for certain authors, and even for lay people to consider the method outdated and dangerous for populations. However, with regard to oral health, the Brazilian reality cannot be compared with that of developed countries, and the fluoridation of public water supplies is a safe, effective and inexpensive method that has helped humanity to control and prevent caries (Garbin *et al.*, 2017). The findings of Mendoça *et al.* (2021) reinforce the importance of maintaining public policies that guarantee the correct monitoring and maintenance of the quality of fluoridation.

The percentage of total coliforms (T.C.) and *E. coli* found in the current study are the same or below the values found in the other studies shown in Table 2, especially the data found by Faria *et al.* (2021). In general, the occurrence of total coliforms and *E. coli* in treated water reflects the hygienic conditions of the raw waters, the flaws in the treatment and/or, especially, problems with the integrity of the distribution system (Tavares *et al.*, 2015; Palmeira *et al.*, 2019). According to Brazilian legislation (Brasil, 2017), the detection of total coliforms and *E. coli* in the sample must be evaluated so that corrective actions can be taken by those responsible for the supply system and they must inform the public health authority about the measures adopted. These actions were not reported to the laboratory.

4. CONCLUSIONS

The results of this study show a prevalence of satisfactory samples in relation to the analyzed parameters; the results in greater disagreement were related to the fluoride content and the presence of total coliforms, indicating failures in fluoridation and problems in the water distribution system. Monitoring and surveillance of the quality of water supply is an important preventive measure to minimize the risks of health problems.

This study can guide future actions, informing the adoption of preventive and corrective measures, such as the need to invest in the training of health surveillance teams to carry out field analyses (chlorine and pH), training/investments to improve the water fluoridation and chlorination process, as well as investment in the distribution system to minimize the presence of microorganisms.

5. REFERENCES

ALVES, W.; SILVA, T. I.; MARROM, D. A. S.; SANTOS, T. M. S.; SANTOS, H. R. S. Avaliação da qualidade da água do abastecimento público do Município de Juazeiro do Norte, CE. **Revista Desafios**, v. 4, n. 2, p. 112–119, 2017. https://doi.org/10.20873/uft.23593652.2017v 4n2p112

ANVERSA, L.; ARANTES STANCARI, R. C.; GARBELOTTI, M.; DA SILVA RUIZ, L.; PEREIRA, V. B. R.; NOGUEIRA NASCENTES, G. A. *et al.* Pseudomonas aeruginosa in public water supply. **Water Practice and Technology**, v. 14, n. 3, p. 732–737, 2019. https://doi.org/10.2166/wpt.2019.057

APHA; AWWA; WEF. **Standard Methods for the examination of water and wastewater**. 22nd ed. Washington, 2012. 1496 p.

BRASIL. Departamento de Saúde Ambiental, do Trabalhador e Vigilância das Emergências em Saúde Pública. **Indicadores institucionais do Programa Nacional de Vigilância da Qualidade da Água para consumo humano – 2019.** Brasília, DF, 2020.

BRASIL. Departamento de Vigilância em Saúde Ambiental e Saúde do Trabalhador. **Diretriz Nacional do Plano de Amostragem da Vigilância da Qualidade da Água para Consumo Humano**. Brasília, DF, 2016.

BRASIL. Ministério da Saúde. Portaria GM/MS nº 888, de 04 de maio de 2021. Altera o Anexo XX da Portaria de Consolidação GM/MS nº 5, de 28 de setembro de 2017, para dispor sobre os procedimentos de controle e de vigilância da qualidade da água para consumo humano e seu padrão de potabilidade. **Diário Oficial [da] União**: seção 1, Brasília, DF, n. 85, p. 127, 07 de maio 2021.

BRASIL. Ministério da Saúde. Portaria de Consolidação nº 5, de 28 de setembro de 2017. Consolidação das normas sobre as ações e os serviços de saúde do Sistema Único de Saúde. **Diário Oficial [da] União**: seção 1, Brasília, DF, n. 190, supl., 3 de out. de 2017.

BRASIL. Ministério da Saúde. Portaria GM/MS nº 518, de 25 de março de 2004. Estabelece os procedimentos e responsabilidades relativos ao controle e vigilância da qualidade da água para consumo humano e seu padrão de potabilidade, e dá outras providências. **Diário Oficial [da] União**: seção 1, Brasília, DF, n. 59, p. 266-270, 26 de mar. 2004.

BRASIL. Ministério da Saúde. Portaria n. 2.914, de 12 de dezembro de 2011. Dispõe sobre os procedimentos de controle e de vigilância da qualidade da água para consumo humano e seu padrão de potabilidade. **Diário Oficial [da] União**: seção 1, Brasília, DF, p. 39, 14 de dez. de 2011.

BRASIL. **Portal Brasileiro de Dados Abertos**. 2022. Available: https://dados.gov.br/dataset/sisagua-tratamento-de-agua. Access: May 16, 2022.

DOVIDAUSKAS, S.; OKADA, I. A.; IHA, M. H.; CAVALLINI, A. G.; OKADA, M. M.; BRIGANTI, R. DE C. *et al.* Mapeamento da qualidade da água de abastecimento público no nordeste do estado de São Paulo (Brasil). **Health Surveillance under Debate: Society, Science & Technology**, v. 5, n. 2, p. 53-63, 2017a. https://doi.org/10.22239/2317-269x.00862

DOVIDAUSKAS, S.; OKADA, I. A.; IHA, M. H.; CAVALLINI, A. G.; OKADA, M. M.; BRIGANTI, R. DE C. Quality Assessment of fluoridation of public water supply in 88 municipalities in the Northeast region of the state of São Paulo (Brazil). **Health Surveillance under Debate: Society, Science & Technology**, v. 5, n. 3, p. 14-23, 2017b. https://doi.org/10.22239/2317-269X.00926

FARIA, C. P.; ALMENDRA, R.; DIAS, G. S.; SANTANA, P.; SOUSA, M. C.; FREITAS, M. B. Evaluation of the drinking water quality surveillance system in the metropolitan region of Rio de Janeiro. **Journal of Water and Health**, v. 19, n. 1, p. 306-321, 2021. https://doi.org/10.2166/wh.2021.217

FIORAVANTI, M. I. A.; PEREIRA, P. H. L.; MARCIANO, M. A. M.; SANCHES, V. L.; FERREIRA, C. D. F.; MAZON, E. M.D. Monitoring and evaluation of alternative collective solution for water supply for public schools in Itatiba, SP. **Health Surveillance under Debate: Society, Science & Technology**, v. 8, n. 2, p. 122-133, 2020. https://doi.org/10.22239/2317-269x.01460

FREITAS, V. P. S.; BRIGIDO, B. M.; BADOLATO, M. I.; ALABURDA, J. Padrão físico-químico da água de abastecimento público da região de Campinas. **Revista do Instituto Adolfo Lutz**, v. 61, n. 1, p. 51-58, 2002.

GARBIN, C. A. S.; SANTOS, L. F. P. DOS; GARBIN, A. J. I.; MOIMAZ, S. A. S.; SALIBA, O. Fluoretação da água de abastecimento público: abordagem bioética, legal e política. **Revista Bioética**, v. 25, n. 2, p. 328–337, 2017. https://doi.org/10.1590/1983-80422017252193

IBGE. **População de Cidades e Estados**. 2022. Available https://www.ibge.gov.br/cidades-e-estados/sp. Access: May 06, 2022.

MENDONÇA, A.; MARTINELLI, K. G.; ESPOSTI, C. D. D.; BELOTTI, L.; PACHECO, K. T. S. Surveillance of public water supply fluoridation and municipal indicators: an analysis in the state of Espirito Santo, Brazil. **Revista Ambiente & Água**, v. 16, n. 3, 2021. https://doi.org/10.4136/ambi-agua.2693

ODONKOR, S. T.; AMPOFO, J. K. Escherichia coli as an indicator of bacteriological quality of water: an overview. **Microbiology Research**, v. 4, n. 1, p. e2, 2013. https://doi.org/10.4081/mr.2013.e2

PALMEIRA, A. R. O. A.; DA SILVA, V. A. T. H.; DIAS JÚNIOR, F. L.; STANCARI, R. C. A.; NASCENTES, G. A. N.; ANVERSA, L. Physicochemical and microbiological quality of the public water supply in 38 cities from the midwest region of the State of São Paulo, Brazil. **Water Environment Research**, v. 1, n. 8, p. 1/8, 2019. https://doi.org/10.1002/wer.1124

PASSOS, E. C.; MELLO, A. R. P.; SOUSA, C. V.; GONZALEZ, E.; JORGE, L. I. F.; SILVA, M. L. P. *et al.* Avaliação microbiológica e físico-química da qualidade das águas para consumo humano realizada na região metropolitana da Baixada Santista, no período de 2007 a 2008. **Boletim do Instituto Adolfo Lutz**, v. 22, n. 1, p. 22-24, 2012.

ROMANI, C. D.; STANCARI, R. C. A.; NASCENTES, G. A. N.; ANVERSA, L. Public water supply fluoridation: 10 years of monitoring in 38 municipalities of Centro-Oeste Paulista, São Paulo, Brazil. **Health Surveillance under Debate: Society, Science & Technology**, v. 6, n. 4, p. 47-55, 2018. https://doi.org/10.22239/2317-269x.01169

SCALIZE, P. S.; PINHEIRO, R. V. N.; RUGGERI JUNIOR, H. C.; ALBUQUERQUE, A.; LOBÓN, G. S.; ARRUDA, P. N. Heterocontrole da fluoretação da água de abastecimento público em cidades do estado de Goiás, Brasil. **Ciência & Saúde Coletiva**, v. 23, n. 11, p. 3849–3860, 2018. https://doi.org/10.1590/1413-812320182311.24712016

SÃO PAULO. Secretaria de Estado de Saúde. Resolução SS-45, de 31 de janeiro de 1992. Institui o Programa de Vigilância da Qualidade da Agua para Consumo Humano-PROÁGUA e aprova diretrizes para sua implantação no âmbito da Secretaria de Saúde. **Diário Oficial [do] Estado**, São Paulo, 31 jan. 1992.

SÃO PAULO. Secretaria de Estado de Saúde. Resolução SS-250, de 15 de agosto de 1995. Define teores de concentração do íon fluoreto nas águas para consumo humano, fornecidas por sistemas públicos de abastecimento. **Diário Oficial [do] Estado**, Seção I; São Paulo, 16 ago. 1995.

TAVARES, M.; VIEIRA, A. H.; ALONSO, A. C. B.; MELLO, A. R. P.; SOUSA, C. V.; GONZALEZ, E. *et al.* Avaliação da qualidade microbiológica e físico-química da água para consumo humano na Região Metropolitana da Baixada Santista, Estado de São Paulo, no período de 2010-2014. **Boletim do Instituto Adolfo Lutz**, v. 25, n. 2, p. 10-13, 2015.

TOLENTINO, F. M.; DE ALMEIDA, I. A. Z. C.; DOS SANTOS, C. C. M.; TEIXEIRA, I. S. C.; E SILVA, S. I. L.; NOGUEIRA, M. C. L. *et al.* Phenotypic and genotypic profile of the antimicrobial resistance of bacterial isolates and evaluation of physical and chemical potability indicators in groundwater in Brazil. **International Journal of Environmental Health Research**, 2019. https://doi.org/10.1080/09603123.2019.1640354

WHO. **Guidelines for drinking-water quality**: fourth edition incorporating the first and second addenda. Geneva, 2022. Available in: https://www.who.int/publications/i/item/9789241549950. Access: May 10, 2022.