Analysis of Fluorine Content in a Health Macro Region in the State of Pernambuco, Brazil *

Análisis del contenido de flúor en un macrorregión de salud en el estado de Pernambuco, Brasil

Análise de teores de flúor em uma Macrorregião de saúde do estado de Pernambuco, Brasil

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ABSTRACT

Background: Despite the fluoridation of public water supply being recognized as an excellent preventive measure for the control of dental caries, it is known that the state of Pernambuco does not carry out systematic monitoring of the fluoride levels in its waters. **Purpose:** The aim of this study is to describe and analyze fluoride (F) levels in the water sources and public water supply in municipalities of the first health macro-region of Pernambuco, with 50,000 inhabitants or more. **Methods:** This is a descriptive study that combines information from the Brazilian Institute of Geography and Statistics and the National Sanitation Information System with data from Companhia Pernambucana de Saneamento, the VIGIFLUOR project and the Water Quality Surveillance Information System for Human consumption. **Results:** The analysis of the data indicated the presence of natural F in insignificant or minimal contents in most of the studied municipalities. In addition, three levels of maximum benefit for caries prevention were found, but this concentration does not reach the population via public supply. **Conclusion:** The results demonstrate that the F levels of the public supply network of thirteen municipalities analyzed do not contribute to the protection of the population. This approach stresses the need for the water supply to the municipalities of the 1st macro-region of health to be fluoridated artificially; and may also be good, to assure the population access to quality treated and fluoridated water, that a surveillance mechanism be established through hetero-control programs. **Keywords:** dental caries; dental fluorosis; dentistry; fluoridation; oral health; Pernambuco, Brazil; public health; water quality; water supply

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RESUMEN

Antecedentes: A pesar de que la fluoración del agua de abastecimiento público sea reconocida como una excelente medida preventiva para el control de la caries dental, se sabe que el estado de Pernambuco no realiza monitoreo sistemático de los niveles de fluoruro en sus aguas. **Objetivo:** El objetivo de este estudio es describir y analizar los niveles de fluoruro (F) en las fuentes de agua y suministro público de agua en municipios del primer macrorregión de salud de Pernambuco, con 50.000 habitantes o más. **Métodos:** Este es un estudio descriptivo que combina información del Instituto Brasileño de Geografía y Estadística y el Sistema Nacional de Información de Saneamiento con datos de Compañía Pernambucana de Saneamiento, el proyecto VIGIFLUOR y el Sistema de Información de Vigilancia de la Calidad del Agua para el consumo Humano. **Resultados:** El análisis de los datos indicó la presencia de F natural en contenidos insignificantes o mínimos en la mayoría de los municipios estudiados. Además, se encontraron tres niveles de máximo beneficio para la prevención de caries, pero esta concentración no llega a la población vía abastecimiento público. **Conclusión:** Los resultados demuestran que los niveles F de la red pública de abastecimiento de los trece municipios analizados no contribuyen a la protección de la población. Este enfoque destaca la necesidad de que el suministro de agua a los municipios de la 1ª macrorregión de salud sea fluorado artificialmente; y también puede ser bueno, para asegurar a la población el acceso a agua tratada y fluorada de calidad, que se establezca un mecanismo de vigilancia a través de programas de heterocontrol.
Palabras clave: calidad del agua; caries dental; fluorosis dental; fluoración; odontología; Pernambuco; Brasil; salud bucal; salud pública; suministro de agua

RESUMO

Antecedentes: Apesar da fluoretação das águas de abastecimento público ser reconhecida como uma excelente medida preventiva para o controle da cárie dentária, sabe-se que o estado de Pernambuco não realiza um monitoramento sistemático dos níveis de fluoreto das suas águas. **Objetivo:** Esse estudo objetiva descrever e analisar teores de flúor (F) nos mananciais e águas de abastecimento público dos municípios da 1ª macrorregião de saúde de Pernambuco que tenham 50.000 habitantes ou mais. **Métodos**: Trata-se de um estudo descritivo que une as informações do Instituto Brasileiro de Geografia e Estatística e do Sistema Nacional de Informação sobre Saneamento com os dados da Companhia Pernambucana de Saneamento, do projeto VIGIFLUOR e do Sistema de Informação de Vigilância da Qualidade da Água para Consumo Humano. **Resultados:** A análise dos dados apontou a presença de F natural em teores insignificantes ou mínimos na maioria dos municípios estudados. Ademais, até foram encontrados níveis de benefício máximo para a prevenção da cárie em três mananciais, entretanto, tal concentração não alcança a população via abastecimento público. **Conclusões:** Os resultados demonstraram que os teores de F na rede de abastecimento público dos treze municípios analisados não contribuem para a proteção da população. Esse estudo enfatiza a necessidade de que a água de abastecimento dos municípios da 1ª macrorregião de saúde seja fluoretada artificialmente; podendo ainda, para de fato assegurar à população o acesso à água tratada e fluoretada de qualidade, que seja instituído mecanismos de vigilâncias através de programas de heterocontrole.
Palavras-chave: abastecimento de água; cárie dentária; fluoretação; fluorose dentária; odontologia; Pernambuco, Brasil; qualidade da água; saúde bucal; saúde pública

INTRODUCTION

Currently, in terms of oral health, dental caries remains the main health problem of the Brazilian population, according to the results of the last national epidemiological survey (1, 2). This pathology affects people of different age groups and socioeconomic levels unevenly, precisely because of the social differences that characterize these people and the context in which they are inserted (3).

Despite its persistent prevalence, caries rates have shown a significant reduction from the implementation of preventive measures and promotion in public health (4). Among these measures, the fluoridation of public water supply is considered the closest to the ideal with regard to disease control; since the benefits of its use can reach all people, without any distinction of economic, social or educational nature. In addition, water fluoridation is an important tool for achieving equity in oral health, as it mainly benefits population segments in the worst socioeconomic conditions, which often do not have access to other preventive methods and, therefore, are the who most need efficient fluoridation (5,6).

Fluoridation has been proven to be safe, effective and inexpensive, and is recommended by the World Health Organization (WHO) (7, 8). The effectiveness of this measure in the decline of caries is a

scientifically proven fact and widely accepted by specialists in public health and by the dental community (9). This process has been supported and encouraged by deliberations approved both at the Health and Oral Health Conferences, as well as by the Ministry of Health (MS) and by the main professional entities in Dentistry and Public Health (10).

In Brazil, increasing the coverage of the method and due compliance with Law nº 6.050/1974, which makes water fluoridation (FA) mandatory where there is a water treatment plant, were recommended in the three National Conferences on Oral Health (CNSB) held so far: 1st CNSB 1986, 2nd CNSB 1993 and 3rd CNSB 2004 (11). In such meetings, the strategic importance of FA was reiterated to face dental caries, which, undeniably, is a public health problem in the country (12).

From the point of view of health surveillance, it is imperative to ensure maximum benefit and minimum risk to consumers. This presupposes knowing and controlling the fluorine content of water used for consumption, making such information available to the population. The effects of fluoride on human health highlight the importance of its study, after all, both the addition of insufficient amounts and the addition of excessive amounts of fluoride are undesirable (13). Insufficient water fluoridation does not prevent caries, and excessive fluoride concentration can cause fluorosis (14, 15). To avoid these situations, permanent surveillance of the AF is essential, at the highest quality level, considering whether the fluoride present in the water is naturally present in it or if it was added in the treatment process (14).

Studies show that some regions of the country have natural sources of fluoride in their water supply, making it important to identify and map these areas (14,15). It is essential to know the natural levels of fluorine in springs before making them available for human consumption, preferably evaluating them prior to the implementation of artificial fluoridation systems (14).

In this sense, sanitation companies periodically carry out studies of water for human consumption, providing reports on their quality. However, according to studies carried out in the country, the information passed on by the companies is considered unreliable, which makes the analyzes carried out on the levels of fluoride inaccurate (16). Considering this fragility, the external control emerged, which is described as: "[...] the principle that any good or service that involves risk or represents a protective factor for public health requires, in addition to control by the producer, the control of State institutions over the process of its development, being its implantation means to effectively contribute to the improvement of the quality of artificial fluoridation" (17).

The VIGIFLUOR Project can be considered as one of the tools for external control of the levels of fluoride present in public water supply in the country. VIGIFLUOR was a multicenter study aimed at describing the surveillance and population coverage of fluoridation of public water supply in Brazilian municipalities with a population greater than or equal to 50,000 inhabitants. The project had the participation of researchers from different Brazilian states and had financial support from the National Council for Scientific and Technological Development (CNPq) (18).

Until now, the state of Pernambuco does not carry out systematic surveillance of fluoride levels in its waters and there are no scientific publications that discuss the levels of fluoride present in public water supplies in the state. Thus, the aim of this study was to describe and subsequently analyze fluoride levels in springs and public supply waters in municipalities with 50,000 inhabitants or more, located in the 1st health macro-region of the state of Pernambuco, comparing data provided by the Sanitation Company Pernambuco (COMPESA) with data obtained by VIGIFLUOR (18).

MATERIALS AND METHODS

This is a descriptive, observational and cross-sectional study. It was carried out based on the study of COMPESA data, primary data collected from the municipalities participating in the VIGIFLUOR PROJECT and data recorded in the Information System for Surveillance of Water Quality for Human Consumption (SISAGUA); These data indicated the levels of fluoride in water from sources for human

consumption and in the water supply network of municipalities in the 1st Health Macro Region of Pernambuco that have a population greater than 50,000 inhabitants. Furthermore, demographic data released by the Brazilian Institute of Geography and Statistics (IBGE) and the National Sanitation Information System (SNIS) related to access to treated water were also used.

The state of Pernambuco, through the Regionalization Master Plan (PDR) 2011, has its territory divided into four health macro-regions. Considering the availability of reports on fluoride levels from COMPESA and VIGIFLUOR, as well as the project by the State Coordination of Oral Health to implement the artificial fluoridation process, which points to the 1st Health Macro-Region as the first beneficiary, we chose to study it in the present study.

FIGURE 1

Map of the four macro-regions of the state of Pernambuco - Source: Secretary of Health of the state of PE. Regional master plan, 2011

With regard to the inclusion criteria, municipalities with regular water supply that had data available from both COMPESA and VIGIFLUOR were included, excluding those that do not fit these conditions. Therefore, the universe of this research comprises the municipalities belonging to the I, II, III and XII Regional Health Managements (GERES), members of the 1st Macro Region of the state of Pernambuco, provided that they had a population equal to or greater than 50,000 inhabitants in 2017 and respected the inclusion criteria. Thus, the following municipalities were part of the sample: Abreu e Lima; Cabo de Santo Agostinho; Camaragib; Carpina; Ipojuca; Jaboatão dos Guararapes; Dark skinned; Olinda; Palmares; Recife; São Lourenço da Mata and Vitória de Santo Antão.

Data collection for the VIGIFLUOR project was carried out by public servants linked to the Unified Health System (SUS), working in the health surveillance sector, who were previously calibrated. To carry out the collection, the establishment of two main water samples per treatment station (ETA) or alternative supply solution (SAA) existing in each municipality was adopted, these two samples being located in different units. There is also the collection of two more control samples, also located in different units, one for each main sample. The collection points for the main samples were preferably chosen at a point in the network closest to the water treatment unit and, in public units in the area of education or health, the collection point in the network that was farthest from the ETA was chosen.

Collection took place monthly (for three consecutive months), with all collections carried out on the same day of the month. After being collected, they were sent to the Biochemistry laboratory of the Piracicaba Dental School of the State University of Campinas (FOP-UNICAMP), so that the fluoride content could be measured using an electrometric method. From the levels obtained, a database was built in Microsoft Excel spreadsheets, managed by the researchers responsible for the study.

Secondary data, from COMPESA's reports, came from source control reports, which are executed and made available in digital format regularly by the Company. Having added such data to the research, data referring to the amount of natural fluoride detected in spring water. In turn, secondary data relating to demography and access to treated water come from research and surveys carried out, respectively, by IBGE and SNIS. Such values were obtained through a consultation of publicly accessible databases available on the Internet, during the study period.

The collected data were organized in Microsoft Excel spreadsheets and analyzed for fluoride levels. It is important to point out that the relationship between fluoride concentration and average variation of maximum daily air temperatures in each region was also considered. At the end of the described process, as shown in Table 1, the concentration of fluoride present in the water that offers maximum benefit for dental caries and minimum risk for fluorosis was identified for the locations selected by the research (whose average temperatures are between 26.3°C and 32.5°C). The analysis was carried out considering the new classification, proposed by the Collaborating Center of the Ministry of Health on Oral Health Surveillance of the University of São Paulo (CECOL/USP), for concentrations of F present in the public water supply, which was approved by the community by academics, specialists and professionals in the field (19).

It is also worth mentioning that this multicenter study is linked to the project "Coverage and surveillance of fluoridation of public water supply in Brazil", linked to the Collaborating Center of the Ministry of Health of the University of São Paulo (CECOL/USP). Due to this scenario, it was carried out in accordance with the Resolution of the National Health Council/CNS nº 466/12 and approved by the Research Ethics Committee of the Faculty of Public Health of the University of São Paulo under opinion nº. 2,517,890.

TABLE 1

Consensus on maximum benefit and minimum risk for fluoride contents in public water supply at mean annual temperatures between 26.3°C and 32.5°C.

Fluoride content in water (in ppm or mg F/L)	BENEFIT (prevent caries)	RISK (produce dental fluorosis)
0,00 a 0,44	Insignificant	Insignificant
0,45 a 0,54	Minimum	Low
0,55 a 0,84	**Maximum**	**Low**
0,85 a 1,14	Maximum	Moderate
1,15 a 1,44	Questionable	High
1,45 or more	Harm	Very high

Source: Vigifluor Project

RESULTS

Considering access to treated water, Table 2 shows that the municipalities of Carpina and Olinda are those with the highest proportion of urban population with access to treated water (95 %). On the other hand, at the lower end is the municipality of Ipojuca, which provides treated water to just over half of its population (57 %). Considering all the municipalities studied, 3,022,991 people have access to treated water, which corresponds to coverage of 81 % of the population of the 1st health macro-region in the state of Pernambuco.

TABLE 2

Population coverage and urban population with access to treated water in municipalities with more than 50,000 inhabitants in the 1st health macro-region, in the state of Pernambuco

County	Population[1]	Urban population served with water supply (inhabitant)[2]	Population with access to water supply (%)
Abreu e Lima	**99.364**	83.807	84
Cabo de Santo Agostinho	**204.653**	160.008	78
Camaragibe	**156.361**	118.949	76
Carpina	**82.685**	78.819	95
Ipojuca	**94.533**	54.348	57

Jaboatão dos Guararapes	**695.956**	512.606	74
Moreno	**62.119**	49.592	80
Olinda	**390.771**	370.589	95
Palmares	**62.832**	49.172	78
Recife	**1.633.697**	1.362.452	83
São Lourenço da Mata	**112.099**	78.690	70
Vitória de Santo Antão	**137.578**	103.959	76
TOTAL	**3.732.648**	3.022.991	81

In addition, it is still possible to observe in Table 3 that the minimum and maximum values of fluoride content found for each municipality, in COMPESA reports and in the VIGIFLUOR database, are not adequate and present a significant discrepancy between them.

TABLE 3
Minimum and maximum values of natural fluoride content in water sources and in the public water supply network for human consumption in the 1st Macro-Region of Health in the state of Pernambuco

County	COMPENSATE[1] (Fountains) F levels		VIGIFLUOR[2] (Supply network) F levels	
Abreu e Lima	0	0,27	0,03	0,09
Cabo de Santo Agostinho	0	0,48	0,03	0,08
Camaragibe	0	0,49	0,01	0,18
Carpina	0	0,17	0,07	0,20
Ipojuca	0	0,48	0,03	0,11
Jaboatão dos Guararapes	0	0,49	0,04	0,24
Moreno	0	0	0,07	0,14
Olinda	**0**	**0,86**	**0,01**	**0,17**
Palmares	**0**	**0,96**	**0,42**	**0,84**
Recife	**0**	**0,86**	**0,01**	**0,14**
São Lourenço da Mata	0	0,49	0,05	0,21
Vitória de Santo Antão	0	0,17	0,11	0,61

In most municipalities, fluoride levels are found that are considered insignificant or minimal for the desired effect of reducing dental caries. It is also emphasized that in Olinda, Palmares and Recife, levels of F considered to be of maximum benefit for the prevention of caries were found, but such levels are already at a level considered to be of moderate risk for the production of dental fluorosis (0.86 mg F/ L).

It is also noteworthy that, when evaluating the COMPESA data separately, all analyzed water samples are outside the range of best benefit for caries and lowest risk for fluorosis, considering the classification proposed by CECOL/USP (0.55 to 0, 84 mg F/L).

DISCUSSION

Before starting an analysis of the data already presented, it is important to understand the value of water fluoridation for society. Such relevance is due to the fact that fluoride modifies the processes of demineralization and remineralization of the tooth, decreasing, when present in the oral cavity in low and constant concentrations, mineral loss and, consequently, reducing the rate of caries progression. The addition of fluoride to public water supply is scientifically proven to be effective in preventing the disease, and is considered socially fair, as its scope is collective with the potential to improve the oral health of the entire population. Furthermore, the AF still shows itself as a measure of considerable impact in realities of socioeconomic disadvantage; these realities in which the context of dental caries favors the persistence of a picture of social segregation, characterized by the precarious conditions of existence to which part of the population is submitted (20).

Despite the fact that public water supply fluoridation in systems equipped with ETA has been mandatory in the country since 1974, the state of Pernambuco, through its sanitation company, does not carry out artificial fluoridation of its supply waters (11). This fact significantly affects the fight against caries in the state, as shown by the numbers measured by epidemiological surveys of oral health in Brazil. It was observed in the surveys, carried out between 2003 and 2010, an average decline of 8.6 % in the values of the CPOD index (decayed, missing teeth and/or obturator due to caries) in the capitals with fluoridated water compared to those without. fluoridated, with the latter registering an average increase of around 12.8 % (12). Investment in fluoridation as a preventive method is a priority, since the state has coverage of Oral Health Teams in Primary Care of 63.34 %, that is, theoretically, just over half of the dependent SUS population is covered by dentistry in the public sphere, which does not necessarily indicate timely and comprehensive access to dental services (21).

In view of this situation, it is worth noting that coverage of supply water does not mean regular access, a situation that is commonly critical in Pernambuco, which still lives at the mercy of irregular rainfall. In these situations, its population resorts to water trucks, water bottles, wells, cisterns and other forms unrelated to public supply, without any type of monitoring.

Furthermore, the data relating to access to public water supply, contained in Table 2 presented above, show the impact that fluoridation would bring if the municipalities received fluoridated water, since a significant number of residents would manage to be included by such a measure in their houses. Added to this situation is the fact that the scientific literature points out that the greater the access to fluoridated water, the smaller the magnitude and prevalence of oral caries in population terms (19). In addition, according to national studies, significant differences of 10 to 30 % are observed in DMFT rates in children and young people when comparing cities with and without fluoride addition to water for human consumption (1).

It is also observed, through Table 3, a significant discrepancy between the values measured by COMPESA and those found by VIGIFLUOR. This fact corroborates what is discussed in the literature: external control is essential to verify whether the results obtained in the internal control, carried out by the operators of sanitation companies, are adequate, as well as to detect the possibility of occurrence of technical or methodological problems (22).

Therefore, the results presented here demonstrate, at first sight, the occurrence of two undesirable extremes. After all, while part of the population assisted by COMPESA receives water with insignificant levels of fluoride for anti-caries action, another considerable portion may be consuming water with high levels of natural fluoride, putting themselves at risk of developing dental fluorosis. However, in a deeper analysis, comparing the COMPESA data with the values found by the VIGIFLUOR results, it is observed that, despite the considerable presence of natural fluoride in the sources of these municipalities, these values do not reach the population via the supply network public. It is important to emphasize that, despite not reaching the population that consumes water from the public supply network, the population may be consuming this water, since it is common for users to drill and use water from wells, mines and other sources without supervision. competent bodies (23).

The results collected by VIGIFLUOR demonstrate that the levels found in the samples obtained from the public supply network of ten municipalities analyzed do not contribute to the protection of the population that consumes water from the supply network. This assertion is justified by the fact that fluoride levels are below the ideal minimum (0.55 mg F/L), that is, in practice, there is no benefit in combating caries in these municipalities studied. Except for the municipality of Palmares, which has 0.84 mg F/L, considered within the optimum range, therefore benefiting from artificial fluoridation, which is subsidized by the National Health Foundation (24).

Considering the data collected from SISAGUA, it is clear that there is an important underutilization of the system: all the municipalities studied do not have records on the control and surveillance of the fluoride content in their waters. This finding is of paramount importance, since it means that municipalities are not routinely monitoring the levels of fluoride in their treated water supply networks. This attitude prevents municipalities that eventually have high levels of natural fluoride from detecting such a situation, presenting an imminent risk of fluorosis for the population that consumes water from springs, demonstrating the evident importance of the external control process.

CONCLUSIONS

The study finds the existence of varying concentrations of fluoride in springs and public supply waters in the municipalities of the 1st health macro-region of Pernambuco that have 50,000 inhabitants or more. Examples such as Palmares are noted, where the water offered is fluoridated, in contrast to other municipalities. Certain high levels of fluoride are also observed, which demonstrate the urgent need to implement control mechanisms so that fluoridation occurs in a safe manner, providing the maximum benefit to citizens.

RECOMMENDATIONS

In view of all that has been presented, it is extremely important to emphasize that there is still much to be studied on the topic discussed. Furthermore, due to the new information and the discussion brought about by this article, it is understood that, possibly, new questions will arise, which should be studied by the scientific community. Thus, it is suggested that, based on the analysis of the results and the discussion presented in this research, future studies be carried out, in order to expand academic knowledge with regard to real fluoridation.

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