

# Water Fluoridation and its External Control in the Municipality of Nova Friburgo, Rio de Janeiro - Brazil

## Fluoretação da Água e seu Heterocontrole no Município de Nova Friburgo, Rio de Janeiro - Brasil

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### Abstract

Water fluoridation, supported by the Brazilian Oral Health Policy, has been a challenge as a public measure to protect Oral Health, due to some current insufficiencies in public management for the implantation of this measure in most Brazilian cities. The present study aimed to monitor, the levels of fluoride in drinking water in Nova Friburgo - RJ-Brazil (NF), on a regular and a systematic manner for a 12 months period, as an external control measurement performed by a public university. Water samples were collected, in duplicate, from 26 localities throughout the city, on a monthly basis, on randomly established dates. The fluoride concentration in the water samples was measured by using an ion-specific electrode coupled to a potentiometer, according to standards supplied by Cecol/USP (2011). Data showed a large variation of fluoride concentration in water samples, ranging from minimum 0.00 ppmF and maximum 0.98 ppmF, with few samples into the interval between 0.65 and 0.94 ppmF, which had the best benefit to prevent dental caries. Fluoride concentration in public water in this city can be considered under the minimum required levels in most of the evaluated samples, even in those from the Water Treatment System (WTS), which has water fluoridation. Thus, water fluoridation and its external control should be established on a regular basis in Nova Friburgo-RJ, Brazil because they are relevant public measures to promote oral health.

**Keywords:** Fluoridation. Water Quality. Dental Caries.

### Resumo

*A fluoretação da água, apoiada pela Política Nacional de Saúde Bucal, tem sido um desafio no Brasil, devido a algumas insuficiências atuais na gestão pública para a implantação e controle desta medida. Este estudo objetivou vigiar, de forma periódica e sistemática, os níveis de fluoretos na água para consumo humano, em Nova Friburgo - RJ- Brasil (NF), por um período de 12 meses, como medida de heterocontrole, realizada por uma universidade pública. As amostras de água foram coletadas mensalmente, em duplicata, em 26 localidades em todo o município e em datas estabelecidas por sorteio. O método para medir a concentração de fluoretos nas amostras de água foi o eletrométrico, utilizando-se um potenciômetro digital com eletrodo específico para o íon flúor. A concentração de fluoretos nas amostras foi analisada de acordo com padrões fornecidos pelo Cecol/USP (2011). Os dados mostraram grande variação na concentração de fluoretos nas amostras, variando entre um mínimo de 0,00 ppmF e um máximo de 0,98 ppmF, com algumas dentro do intervalo de 0,65 e 0,94 ppmF, considerado o de melhor benefício para prevenir a cárie dentária. A concentração de fluoretos na água de abastecimento público do município foi considerada abaixo dos níveis mínimos exigidos, na maioria das amostras avaliadas, mesmo naquelas pertencentes às Estações de Tratamento de Água (ETA), cuja medida de fluoretação fora previamente implantada. Desta forma, a fluoretação da água e seu respectivo heterocontrole deveriam ser estabelecidos de forma contínua em NF, já que são medidas públicas relevantes para a promoção de saúde bucal.*

**Palavras-chave:** Fluoretação. Qualidade da Água. Cárie Dentária.

### 1 Introduction

In the last decades, epidemiological caries pattern has been clearly reduced in the developed countries<sup>1</sup>, as well as in those in process of development, such as Brazil<sup>2-5</sup>. National oral health surveys have shown a strong reduction in DMFT index for the 12-year-old group, from 6.67, in 1986, which was classified as very high, to 2.07, in 2010, a low caries prevalence rate<sup>3,5</sup>.

Public measures, including water fluoridation and dentifrices, reorientation and increase of investments in oral health approaches, after the SUS – the Brazilian Health System - implementation are believed to be relevant reasons for the caries decline in Brazil<sup>6,7</sup>.

However, on the other hand, caries index reduction has not occurred homogeneously throughout the country, as significant regional differences<sup>4,5</sup> have been observed, which are probably related both to inequality in water availability and other oral health care measures<sup>6,7</sup>.

Fluoridation has been recommended by WHO - World Health Organization since the 1950's and, in Brazil, it has been backed up by a Federal Law since the 1970's – Brazilian Federal Law number 6.050 of 1974. For this reason, water fluoridation must be compulsory in Brazil, wherever Water Treatment System -WTS is established<sup>8,9</sup>. The preventive efficacy of this method depends on the adequate fluoride level and its continuity. Therefore, State Institutions should

provide appropriated fluoride concentration and its control in water not only in terms of operational approaches in WTS, but also on sanitary vigilance, as this protective measure of oral health is a right of each Brazilian citizen<sup>10,11</sup>.

Although water fluoridation has been considered as an effective, economic and extensive measure for controlling dental caries<sup>6,11</sup>, there are many municipalities in Brazil that presented either no fluoridated water or inappropriate controlling procedures. According to the "ÁGUA BRASIL" - a System for Evaluation of the Water Quality, Health and Sanitation, Rio de Janeiro State has shown that 22.4% State Public Water Systems comprised fluoride in water in 2007<sup>12</sup>. In Nova Friburgo city, there is no consistent information on the presence and/or on the fluoride level control in public water so far. Thus, considering some shortcomings in oral health vigilance policy in Nova Friburgo-RJ, and supported by the National Oral Health Policy implemented in 2004<sup>13</sup>, a deep discussion on this relevant issue would be a suitable way to develop, in the near future, appropriate approaches to improve the availability of this recognized populational method for protecting and preventing dental caries<sup>6,11</sup>.

The present study aimed to monitor, on a regular and systematic manner, the fluoride levels in drinking water, in Nova Friburgo - RJ-Brazil (NF), for a period of 12 months, as an external control measurement performed by a public university. The importance of this issue, associated with the lack of information of fluoride levels in the city were the main reasons for the goal of this paper.

## 2 Material and Methods

This study was approved by the Ethics Committee of Fluminense Federal University (protocol #CMM/HUAP 272/10- CAAE 0217.0.258.000-10) and was performed in accordance with resolutions 196/96 from the National Health Council of the Brazilian Ministry of Health, and 179/93 of Dental Professional Code of Ethics from Brazilian Dental Council.

It was defined that water gathering spots would be under jurisdiction of public institutions, such as basic health units and municipal and state public schools in order to aid the access to the point of collection, avoiding possible sample losses. Likewise, informed consent, which consisted of enough information about the research and its objective, was presented to the central public authorities (Municipal and State Secretary of Education and Municipal Oral Health Coordination), as well as to all directors of basic health units and municipal and state public schools. After their evaluation, clearance was obtained for the beginning of the study.

Nova Friburgo is localized in the mountain region of Rio de Janeiro State, with a total area of 938.5 Km<sup>2</sup> (362.36sq mi) and a population of 182 016 inhabitants. This city is divided into 8 districts, namely: Nova Friburgo (1<sup>st</sup> District), Riograndina (2<sup>nd</sup> District), Campo do Coelho (3<sup>rd</sup> District), Amparo (4<sup>th</sup> District), Lumiar (5<sup>th</sup> District), Conselheiro

Paulino (6<sup>th</sup> District), São Pedro da Serra (7<sup>th</sup> District) and Mury (8<sup>th</sup> District). A total of 149,060 inhabitants are provided by water from Water Treatment Systems, corresponding to 81.89%<sup>14</sup>.

Water sample collection was carried out from December 2010 to November 2011. The objective of this procedure was to verify possible variations in fluoride concentrations in all of the fifteen water systems, with special focus on the 2 WTS in which had already been introduced water fluoridation (Debossan WTS and Rio Grande de Cima WTS) since 2010, as also in water from other sources, such as artesian wells. Considering the extension of Nova Friburgo, 26 points were selected, including all regions of the city<sup>10,15</sup>.

Hence, the sample was defined based on the localization of each WTS in the maps as well as on its extension and populational coverage in the distinct regions. Water samples were collected in all of the 8 districts; at least one sample near each WTS was collected and, for those 4 WTS with a large populational coverage of water supply, with more than 10,000 inhabitants, at least 3 samples were collected in different points of those systems. Other three samples consisted of water from different sources, such as artesian wells in rural areas, ie., not supplied by water from those systems<sup>10,15</sup>.

The only information about the fluoridation process in the city is from the Water Treatment Company, which has pointed out that fluoridated water was introduced in 2010 only in the two largest WTS, both of which with approximately 130,000 inhabitants, from the total of fifteen WTS. In this sense, it is important to emphasize that the population coverage of access to fluoridated water is 87.21%. No further information has been obtained about water from other sources.

Water samples were then collected, in duplicate, from 26 localities throughout the city, on a monthly basis, on randomly established dates, for a 12 months period. The researcher responsible for the sample collection was oriented to dispose of water from the tap for 30 seconds, wash the polyethylene bottles 3 times with the tap water, and after that, fill the bottle with an amount of 100 ml water. The identified bottles were kept in ambient temperature during transportation and stored at -2 °C for further laboratory analysis.

The fluoride concentration in the fluoridated water was measured by an ion-specific electrode (Orion 9609) coupled to a potentiometer<sup>15,16</sup>.

The recommended concentration of fluoride in public water depends on the annual mean temperature of each geographic region. As the city has an annual mean temperature of 17.9 °C (64.2 °F), the fluoride concentration in water should vary from 0.65 ppmF to 0.94 ppmF, according to Brazilian standards for localities with annual mean temperature under 26 °C (78.8 °F), which represents the maximum benefits to prevent caries and the lowest risk to fluorosis<sup>10</sup>.

Data were analyzed descriptively using Microsoft Office Excell 2007.

### 3 Results and Discussion

From the samples collected, 44 (7.28%) samples were discarded. The main reasons included transportation or freezing process, as well as the hurdles to arrive in the collection

points, especially after rainy days. Thus, 302 samples were analyzed, corresponding to fifteen WTS, during the 12 months of evaluation, presenting a large variation of fluoride concentrations, from 0.00 to 0.98 ppmF (Table 1).

**Table 1:** Fluoride concentration (ppmF) in water samples during the 12 months period. Nova Friburgo, RJ, 2010-2011.

| Month/Year | Minimum | Maximum | Mean | Standard deviation |
|------------|---------|---------|------|--------------------|
| Dec/2010   | 0.00    | 0.64    | 0.04 | 0.16               |
| Jan/2011   | 0.03    | 0.50    | 0.07 | 0.10               |
| Feb/2011   | 0.03    | 0.30    | 0.06 | 0.05               |
| Mar/2011   | 0.03    | 0.13    | 0.05 | 0.02               |
| Apr/2011   | 0.04    | 0.75    | 0.13 | 0.20               |
| May/2011   | 0.04    | 0.72    | 0.17 | 0.24               |
| Jun/2011   | 0.16    | 0.93    | 0.34 | 0.28               |
| Jul/2011   | 0.04    | 0.92    | 0.32 | 0.29               |
| Aug/2011   | 0.03    | 0.87    | 0.33 | 0.32               |
| Sep/2011   | 0.02    | 0.84    | 0.28 | 0.33               |
| Oct/2011   | 0.03    | 0.91    | 0.23 | 0.30               |
| Nov/2011   | 0.03    | 0.98    | 0.32 | 0.38               |

One hundred and seventy nine samples were from 2 WTS (Debossan and Rio Grande de Cima), where water has been fluoridated since 2010. From this total of fluoridated samples (n=179), only 48.60% (n=87) presented an adequate fluoride concentration (from 0.65 to 0.94 ppmF), which was considered to present the best

benefit to prevent dental caries and the lowest risk to produce dental fluorosis. Ninety-two samples (51.40%) were below the minimum fluoride levels (<0.65ppmF) and none of them was above the maximum acceptable fluoride level (>0.94 ppmF). All samples from artesian wells were not fluoridated (Table 2).

**Table 2:** Classification of the samples from the WTS submitted to fluoridation, according to the fluoride concentration during the 12 months-period. Nova Friburgo. RJ. 2010-2011.

| Month/Year   | Below the minimum level (<0.65 ppmF) n(%) | Adequate level (0.65-0.94 ppmF) n(%) | Above the maximum acceptable level (>0.94 ppmF) n (%) | Total (%)    |
|--------------|---|--------------------------------------|---|--------------|
| Dez/2010     | 14 (100.00)                               | 00 (0.00)                            | 00 (0.00)   | 14(100.00)   |
| Jan/2011     | 14 (100.00)                               | 00 (0.00)                            | 00 (0.00)   | 14(100.00)   |
| Feb/2011     | 14 (100.00)                               | 00 (0.00)                            | 00 (0.00)   | 14(100.00)   |
| Mar/2011     | 14 (100.00)                               | 00 (0.00)                            | 00 (0.00)   | 14(100.00)   |
| Apr/2011     | 10 (71.43)                                | 04 (28.57)                           | 00 (0.00)   | 14(100.00)   |
| May/2011     | 10 (62.50)                                | 06 (37.50)                           | 00 (0.00)   | 16(100.00)   |
| Jun/2011     | 04 (25.00)                                | 12 (75.00)                           | 00 (0.00)   | 16(100.00)   |
| Jul/2011     | 04 (25.00)                                | 12 (75.00)                           | 00 (0.00)   | 16(100.00)   |
| Aug/2011     | 01 (6.77)                                 | 14 (93.33)                           | 00 (0.00)   | 15 (100.00)  |
| Sep/2011     | 00 (0.00)                                 | 14 (100.00)                          | 00 (0.00)   | 14(100.00)   |
| Oct/2011     | 06 (37.50)                                | 10 (62.50)                           | 00 (0.00)   | 16(100.00)   |
| Nov/2011     | 01 (6.25)                                 | 15 (93.75)                           | 00 (0.00)   | 16(100.00)   |
| <b>Total</b> | 92 (51.40)                                | 87 (48.60)                           | 00 (0.00)   | 179 (100.00) |

For the last past decades, a decrease in the prevalence of dental caries has been observed, especially in children and adolescent groups, and some reasons have been pointed out for this epidemiological phenomenon, as the presence of fluoride

in different sources, including some foods, water, dentifrices, and teas, in addition to other preventive methods used in dentistry<sup>6,11,17,18</sup>. The World Health Organization - WHO, the Center for Disease Control and Prevention (CDC) recommend

water fluoridation as one of the main public health measures for controlling diseases in the population. For this reason, water fluoridation and external controls of fluoridated water have been included as one of the relevant approaches of the National Oral Health Policy<sup>6,11,13,19</sup>.

Data from the National Survey<sup>3</sup> have shown that 115 of the 225 Brazilian cities presented fluoridated water, comprising 46%, with better results found in the South and Southeast regions. Besides, there has been an expansion of cities with fluoridated water, reaching 7 million of Brazilians in 2010<sup>5</sup>. This fact shows that the Government has invested in this measure for controlling caries disease, as it is considered to have a better cost-benefit effect when compared to other practices related in dentistry<sup>6,11</sup>.

The water fluoridation benefits have been demonstrated through comparison studies on regions/cities with or without fluoridated water. In general, these studies have shown lower levels of dental caries for the fluoridated regions, in terms of DMFT reduction and/or number of caries-free individuals<sup>3,17</sup>.

However, it seems that there has been a tendency for higher water fluoridation in cities with better socioeconomic indicators<sup>6,7</sup>. This fact may be confirmed, for example, by comparing, through the National Surveys<sup>3,5</sup> the water fluoridation situation and the prevalence of caries in 12 year-old groups, from the North and Northeast regions to the South and Southeast geographic regions of Brazil. Caries are less prevalent in the South and Southeast, and in cities having fluoridated water, with higher numbers in the North/Northeast regions<sup>3</sup>. This is no surprise, since the North/Northeast regions are way below socioeconomic acceptable levels, as, for instance, a large number of families without any access to basic sanitary measures. Therefore, it is up to the government to progressively guarantee some reductions focused to the unfair and avoidable causes for the population falling ill<sup>6,7</sup>.

Preventive efficacy of water fluoridation depends on the security of the fluoride adequate level during the implementation for the WTS, as well as its continuity and control throughout the time and through sanitary vigilance measures as well. Hence, these measures represent fundamental importance for the caries reduction in the population, as water fluoridation interruption, either temporarily or definitively, would break off the success of this effort<sup>11,20-23</sup>.

Regarding the external controls, they should be brought about by other Institutions, such as Universities, as they are not involved directly in water treatment application. This procedure might guarantee credibility and quality to reach water fluoridation advantages and purposes. However, external controls of water fluoridation have not been carried out consistently in many Brazilian cities, even in the South and Southeast regions, which are considered to present a more substantial availability of fluoridated water<sup>11,20-26</sup>.

Several studies have been performed to evaluate fluoride presence and concentrations in treated water in distinct states and cities of the country. Their results have shown inadequate

fluoride concentrations, with some fluctuations based on both different periods of time and diverse points of the same territory<sup>16,20-22, 24, 25</sup>.

Concerning Nova Friburgo-RJ-Brazil, the majority of fluoride levels in water samples showed results below the acceptable or recommended levels, even in the samples from those 2 WTS, in which the preventive measure had already been implemented. Accordingly, this shows that the introduction and control of fluoride levels has not been properly performed by the Water Treatment Company. Therefore, due to the urgent need to disclose these results, authors have contacted municipal authorities, such as the oral health coordinator and the regional council of dentistry, in 2012, in order to inform them about the low availability of fluoride in water, and to stand for a more effective oral health sanitary vigilance system in the city. The University commits to continually conducting the control of fluoride levels in water and providing proper information to both municipal authorities and community.

In this regard, efforts have also been made to encourage and mobilize those partnerships, aiming to study the epidemiological pattern of oral diseases. Epidemiological research has been undertaken by researchers at the University since 2011. Previous results, still unpublished, show that, despite the prevalence of dental caries are low in 12 years-old groups (DMFT = 1.90), there is a clear polarization of its distribution. These data reinforce the need to adopt fluoridation as a measure that might contribute to inequalities reduction in oral health.

The present study did not initially focus on the official implementation of an external control system of fluoridated public water in the city of Nova Friburgo-RJ-Brazil, but aimed to investigate fluoride presence and concentrations in drinking water, for a period of 12 months. It could be justified by the fact that there is no evaluation of fluoride levels in water by municipal officials or any other institution, thus programs should be established to promote and mobilize competent authorities for the appropriate decision making procedures, as water fluoridation has been supported by Federal Law since the seventies.

In virtue of these findings, it is possible to verify that the University has a very important role to perform together with the Municipal Oral Health Office to produce monthly indicators of fluoride concentrations in water consumption and to make water fluoridation and its external control more realistic in the city.

#### 4 Conclusion

Lastly, fluoride concentration in public water in the city of the present study can be considered below the minimum required levels, in most of the evaluated samples, so much as in those belonged to the 2 largest populational coverage WTS, which had already adopted this protective measure to dental caries control. Thus, water fluoridation and its external control

should be implemented in Nova Friburgo-RJ-Brazil, through an effective sanitary vigilance, as fluoridation is a relevant public measure to promote oral health.

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