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Cost-Benefit Analysis of Drinking Water Fluoridation in 12-year-old Children in the Biobío Region, Chile.

Análisis Costo-Beneficio de la Fluoración del Agua Potable en Niños de 12 años de la Región del Biobío, Chile.

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Abstract: Fluoridation has been shown to be an effective measure against caries in children. The present study evaluates the cost-benefit of the fluoridated water program for the reduction of dental caries in 12-year-old children in the Biobío Region, the only region in Chile that has not implemented this program. An economic cost-benefit evaluation was carried out, comparing two alternative interventions: non-fluoridated drinking water versus fluoridated drinking water. The prevalence of caries, direct and indirect costs of the treatments, the cost of implementing the programs and the benefits of both interventions were estimated. From this study it is concluded that the savings in oral health costs in 12-year-old children when using fluoridating drinking water in the Biobío region is significantly higher than the cost involved in implementing the water fluoridation program, resulting in total savings for the Chilean state of $129,861,645 (USD$ 152,833) as well as an estimated reduction of 15% in the history of caries in the study population.

Keywords: Child; fluoridation; drinking water; cost-benefit analysis; dental caries; health care costs.

Resumen: Se ha demostrado que la fluoración es una medida efectiva contra disminución de la caries en la población infantil. La presente investigación buscó evaluar cual es el costo-beneficio del programa del agua fluorada para la disminución de caries dental en niños de 12 años de la Región del Biobío, única región de Chile que no adhiere a este programa. Se realizó una evaluación económica de costo-beneficio, comparando dos intervenciones alternativas: agua potable no fluorada vs agua potable fluorada. Para tal fin se estimó la prevalencia de caries, costos directos e indirectos de los tratamientos, el costo de implementación de los programas y el beneficio de ambas intervenciones . De este estudio se concluye que el ahorro en costos de salud bucal en niños de 12 años al fluorar el agua potable en la región del Biobío, es significativamente mayor al costo que implica la implementación del programa de fluoración de aguas, lográndose un ahorro total para el Estado de $129.861.645 (USD $152.833) así como una estimación de reducción del 15% en la historia de caries en la población de estudio.

Palabra Clave: *Niño; fluoruración; agua potable; análisis costo-beneficio; caries dental; costos de la atención en salud.*

INTRODUCTION.

The World Health Organization (WHO) reports that dental caries is the most prevalent disease in the world, affecting people's health and well-being. Data shows that between 60 and 90% of schoolchildren worldwide have caries.[1] The Chilean Ministry of Health, after the evaluation of the National Oral Health Plan, has reported that between 62% and 85% of the school-age population suffer from caries.[2] As such, the national public policy has been focused on cost-effective preventive measures, as shown by the health objectives of the decade, whose goals for 2010-2020 consist of increasing the prevalence of free-of-caries 6-year-old children to 35% and reducing to 15% the average number of teeth damaged by caries in 12-year-olds in public educational establishments.[3]

Since 1983, the WHO has considered that the use of fluorides in public health programs is the most effective measure for the prevention of caries. Its data suggest that the increase in the concentration of fluorides in the water of central public supply systems would allow for reaching optimal concentrations to prevent tooth decay.[4] Multiple studies have been conducted to evaluate the therapeutic effects and the cost-benefits of the use of fluoride in drinking water for the prevention of caries. An example of this is the systematic review carried out by McDonagh *et al.*,[5] in the United Kingdom, which concluded that water fluoridation reduces the prevalence of dental caries by up to 15%.

Cohort studies carried out in Brazil have used the concept of "lifetime access to fluoridated water" (LAFW) and its relationship with the decrease in dental caries in adult patients in a given population.[6] In the same way, the same concept (LAFW) has been studied in Australia in young and middle-aged adult patients, concluding that there is a lower incidence of caries when access to fluoridated water was higher.[7] In the same context, studies such as those carried out in South Australia by Spencer *et al.*,[8] and Crocombe *et al.*,[9] confirm the effectiveness of exposure to fluoridated water in adults.

Using a cohort study design in it was shown that young adults between 22 and 35 years old in South Australia with relatively low access to fluoridated water throughout their lives (<75% LAFW) had substantially greater experiences of caries compared to those who had higher percentages of access to fluoridated water. Crocombe *et al.*,[9] through the "National Study of Adult Oral Health" (NSAOH), analyzed data on the effectiveness of water fluoridation in rural areas in subjects between 15 and 44 years old, and reported a negative relationship between exposure to fluorides and the decayed, missing or filled teeth index (DMFt).[9]

In New Zealand, studies carried out on the effect of fluoridated water show that children living in areas with fluoridated water have 40% fewer experiences with caries compared to the group of children living in non-fluoridated areas.[10]

In 2015, the "Cochrane Oral Health Group" (COHG) conducted a set of reviews, finding that the use of fluoride in water was effective in reducing caries by up to 35% in children with both permanent and temporary dentition. These results also suggest that 12% of people could suffer from cosmetic dental fluorosis in areas with concentrations equal to or greater than 0.7 mg/L of fluoride in the water.[11]

In Chile, the fluoridation of drinking water was adopted as one of the main strategies for the prevention and control of dental caries. A pilot plan was implemented in the city of Curicó in 1953,[12] and a national fluoride program for implementing drinking water supplies started in the 1980s.[13] At present, approximately 83% of the Chilean population is supplied by water systems whose fluoride concentration has been adjusted to optimal levels for the prevention of dental caries.

However, the Biobío Region is not part of this fluoridation program.[14] In this context, it is important to highlight that in the Biobío region the DMFt index has been reported to be higher than the national average (2.07 ± 2.26 *versus* 1.9 ± 2.2).[15] Despite all the benefits associated with the fluoridation of drinking water, there is no evidence to demonstrate the economic impact it can have on the Biobío region.

It is for this reason that the present study aims to evaluate the cost-benefit of the fluoridated water program for the reduction of dental caries in this region, determining the prevalence of caries history, estimating the costs of dental treatments in the population that receives and does not receive fluoridated water supply, evaluating the direct and indirect costs of the implementation of a fluoridation program and, finally, determining the benefits of said intervention for the population of 12-year-old children.

MATERIALS AND METHODS.

The study design consisted of an Economic Cost-Benefit Evaluation that adopted the social perspective. This approach considers direct and indirect costs because the decrease in caries history not only implies better oral health, but also a lower cost in dental care, fewer job losses, and less travel time, despite the expenses inherent to the implementation of the drinking water fluoridation program. The cost-benefit analysis yields the results of the intervention in monetary terms, that is, all the effects of a treatment or health technology are expressed in a common unit, which is money, and so the net value of the program can be determined. This method allows the comparison of two intervention alternatives: non-fluoridated drinking water versus fluoridated drinking water. Both alternatives will be compared according to the caries history (DMFt index) of the respective populations.

The study population consisted of all the 12-year-old children who are beneficiaries of the Public Health System (FONASA/National Health Fund) and who belong to the Biobío Region. This age range represents a strategic population target for the epidemiological surveillance of oral health, since it is the age at which deciduous tooth replacement ends, so dentists can project the oral needs of these subjects in their adolescent and adult stages.[16]

The size of the population was determined using the 2016-2017 Statistical Bulletin, an institutional document containing relevant data issued by FONASA.[16] This document contains the estimated number of beneficiaries per five-year age intervals. Due to this type of age-range distribution, the specific number of 12-year-old children was not directly available, as the reported age range was between 10 and 14 years.

To solve this problem, the database of the April 2017 census was analyzed, observing that the proportion of children aged 10, 11, 12, 13, and 14 years in the Biobío Region is practically the same among these ages (20%, 19.7%, 19.7%, 20.1% and 20.5%, respectively). When dividing the five-year period of this age range, according to the percentage described above for the Biobío Region, an estimated total of 23,014 12-year-old children were beneficiaries of FONASA, corresponding to 6.64% of the total regional population.

The Methodological Guide for the Economic Evaluation of Health Interventions in Chile,[18] provided by the Ministry of Health in 2013, recommends performing cost assessment through micro-costing or using secondary sources such as previous studies, in which costs have been estimated with validated methods for an economic evaluation. These secondary sources, called Cost Assessment Studies (CAS), are not available or do not exist for this intervention in the Chilean population for any age group. For this reason, the cost assessment of dental procedures was carried out following the recommendations of the aforementioned guide, obtaining the monetary values of these procedures from the Fees for Health Benefits of book II of DFL (Decree with Force of Law) No. 1 01/2005 issued by the Ministry of Health, which are granted by Institutional Care Modality (ICM), as of the year 2017.[19] Data related to human resources costs were obtained from the Municipality of Concepción by means of Law N° 20,285, known as the Law of Transparency of public services, which provides free access to data related to the state administration.[20]

The cost per working hour, the time the staff used to treat the patient per session, the cost for each consultation, and the number of consultations required on average per child were calculated for each health-care worker. This last point considered the 3 main consultations that include examination, dental scaling, and fluoride varnish.[21] In addition, on average 0.15 appointments are required for extractions, and 1.92 appointments for fillings. In other words, the DMFt index of this population indicates the need for 2.07 additional sessions to the 3 main consultations or appointments. This results in a total average number of 5.07 consultations per child in the context of non-fluoridated drinking water.

The cost of implementing the fluoridation program was obtained from the decree issued by the Ministry of Economy, Development and Reconstruction, (currently known as the Ministry of the Economy, Development and Tourism) Number 276, dated September 4, 2006, published on September 21, 2006.[22] This decree establishes rate formulas for the services of production and distribution of drinking water as well as the collection and disposal of sewage for the Empresa de Servicios Sanitarios del Bío Bío S.A. (Essbio S.A.).

It also establishes differences in the base rates. Given the characteristics of the drinking water networks, origin of the water and collection method, the region is categorized into two groups:

Group 1 (GI), which includes municipalities such as

Concepción, Coronel, Los Angeles, etc., and

Group 2 (GII), including municipalities such as Arauco, Quirihue, Mulchén, etc. The decree empowers the company to apply a surcharge per cubic meter consumed when the system includes a drinking water fluoridation program. It has been established that, for Group I, the surcharge will be $1.79 per cubic meter, and $ 4.03 per cubic meter for Group II.

The indirect cost calculation quantifies the amount of money that people must pay out of their own income in order to be part of the health intervention. Travel expenses and work absenteeism were considered. The data were collected through an adaptation and subsequent application of the survey used for the project "Evaluation of Cost Effectiveness of Support Modalities for Child Development of the Child Protection System of the 'Chile Grows with You' program", carried out in 2013 by Medwave Estudios Limitada and the CIGES Center (UFRO) for the Ministry of Social Development.[23]

Travel expenses refer to the cost the beneficiary incurs to travel from their home or workplace to the health care center. This cost is associated with the distance between both places and the number of previous trips that the child's companion must make prior to receiving care.

The main benefit of fluoridated drinking water is the reduction of tooth decay. According to the WHO, this difference would correspond to 15% less caries history compared to populations without fluoridated water.[24] To carry out a correct analysis of the study, the benefit must be accurately assessed. Consequently, it was established as the monetary savings obtained due to the implementation of the drinking water fluoridation program and the consequent reduction in the number of teeth that required treatment for caries.

This saving is mainly due to the lower number of procedures that FONASA must pay to the beneficiary's health center, the lower number of labor hours devoted to caring for the target population, and the costs saved in terms of using transport and absenteeism from work. According to the available evidence,[15] the history of caries in the 12-year-old population in the Biobío Region corresponds to a DMFt index of 2.07, which is slightly higher than the national average DMFt index of 1.9. This study shows that at 12 years of age, children have more teeth affected by caries (filled and missing) than active caries, both at national and regional scale.

However, this demonstrates that despite past dental experience, the emergence of new affected teeth continues with an average of 0.7 and 0.75 per child for the Biobío Region and for Chile, respectively. Knowing this information is essential to conduct the study, since it is the basis from which the treatment needs of the target population are estimated and, therefore, their costs.

Obtaining the total benefit or savings when implementing the fluoridation of drinking water in the Biobío Region will be understood as the sum of all the saved costs minus the costs that the implementation of this sanitary technology involves. The conversion from Chilean pesos to dollars corresponds to the annual average observed value of the dollar (1US$=648.9 CLP$) according to the records posted on the webpage of the Chilean Internal Revenue Service (SII).[25]

RESULTS.

a) Fees for dental procedures

Table 1 shows the estimated fees, in Chilean pesos (CLP) for dental treatment in 12-year-old children in the Biobío region (drinking water without fluoridation), in terms of the procedures covered and paid by FONASA to the health care centers. It is observed that in 2017 the National Health Fund allocated $42,200 for each 12-year-old child, and $971,189,189 for this entire target population.

The estimated costs of dental treatment in the population of children aged 12 with access to fluoridated drinking water can be observed in the second part of the table. A decrease in the need for extractions and fillings of 15% can be observed. In the context of fluoridated drinking water for the Biobío region, in 2017 the Chilean National Health Fund (FONASA) would have spent $39,051 for each 12-year-old child and $898,709,139 for this entire target population. Consequently, the Public Health System would have saved $3,150 per child and $72,480,050 for the total population of 12-year-old children.

b.) Costs related to Human Resources

Table 2 shows that the cost in human resources for the dental care of each 12-year-old child in the Biobío region was $25,730, and $592,138,670 for all the 12-year-old children in the region. The second part of the table shows the costs under the same parameters, except for the access to fluoridated drinking water and its consequent decrease in the number of consultations required by each child (4.75), by decreasing their DMFt index.

Tabla 1. Fees for Dental Procedures in 12-year-old children, Biobío Region, Chile, in the year 2017, with and without fluoridation of drinking water.

ICM* Code	Name of procedure	Amount required by child	Cost of procedure CLP$	Cost per person CLP$	Cost for the population (without fluoridation)
Total				**42,200**	**$971,189,189**
2701013	Oral examination	1	3,490	3,490	$80,318,860
2701003	Scaling and polishing of crowns	1	7,760	7,760	$178,588,640
2701017	Fluoride varnish application	1	10,180	10,180	$234,282,520
2701005	Simple extraction of permanent tooth	0.15	4,520	678	$15,603,492
2701010	Composite filling	1.919	10,470	20,092	$462,395,677

*It corresponds to the code assigned in the Fees Sheet 2017 for the Institutional Care Modality (ICM) (63). **Source:** FONASA

ICM* Code	Name of procedure	Amount required by child	Cost of procedure CLP $	Cost per person CLP$	Cost for the population (with fluoridation)
Total				**42,200**	**$898,709,139**
2701013	Oral examination	1.00	3,490	3,490	$80,318,860
2701003	Scaling and polishing of crowns	1.00	7,760	7,760	$178,588,640
2701017	Fluoride varnish application	1.00	10,180	10,180	$234,282,520
2701005	Simple extraction of permanent tooth	0.12	4,520	542	$12,482,794
2701010	Composite filling	1.63	10,470	17,078	$393,036,326

*It corresponds to the code assigned in the Fees Sheet 2017 for the Institutional Care Modality (ICM) (63). **Source:** FONASA

Tabla 2. Costs in Human Resources for treating 12-year-old children, Biobío Region, Chile, in the year 2017, with and without fluoridation of drinking water.

Staff	Gross monthly wage/salary	Cost per hour CLP$	Time required (per hour)	Cost per consultations CLP$	Number of consultations population	Cost per child CLP$	Cost for the (without fluoridation)
Total						**25,729**	**$592,138,670**
Administrative	$397,905	2,261	0.08	181	5.07	917	$21,103,612
Dental assistant	$457,038	2,597	0.5	1,298	5.07	6,583	$151,498,982
Dentist	$1,265,645	7,191	0.5	3,596	5.07	18,230	$419,536,077

Source: Municipality of Concepción.

Staff	Gross monthly wage/salary	Cost per hour CLP$	Time required (per hour)	Cost per consultations CLP$	Number of consultations population	Cost per child CLP$	Cost for the (without fluoridation)
Total						**24,029**	**$552,999,379**
Administrative	$397,905	$2,261	0.08	181	4.75	846	$19,458,337
Dental assistant	$457,038	$2,597	0.5	1,298	4.75	6,104	$140,482,635
Dentist	$1,265,645	$7,191	0.5	3,596	4.75	17,079	$393,058,407

Source: Municipality of Concepción.

Tabla 3. Costs of fluoridated drinking water consumed by 12-year-old children, Biobío Chile Region, according to System Group.

System Group	Cost per m^3 ($)	Annual consumption (m^3) per inhabitant	Annual cost per child ($)	Population (n)	Annual cost of population
Total					**$2.621.269**
GI	$1.79	42.19	$76	13,668	$1,032,209
GII	$4.03	42.19	$170	9,346	$1,589,060

Source: Ministry of Economy, Development and Tourism

Tabla 4. Total Annual Savings per 12-year-old Child in the Biobío Region, Chile 2017, b y fluoridating the drinking water network.

		Costs per Child		
	Parameter	Without fluoridated water CLP$	With fluori-dated water CLP$	Savings CLP$
Costs	Grand Total GI	82,293	76,612	5,681
	Grand Total GII	82,293	76,706	5,587
	Total	**42,200**	**39,051**	**3,149**
Procedures	Oral examination	3,490	3,490	0
	Scaling and polishing of crowns	7,760	7,760	0
	Fluoride varnish application	10,180	10,180	0
	Simple extraction of permanent tooth	678	542	136
	Composite filling	20,092	17,078	3,014
	Total$25,729	**24,029**	**1,701**	
Human Resources	Administrative	917	846	71
	Dental assistant	6,583	6,104	479
	Dentist	18,230	17,079	1,151
	Total	**14,363**	**13,457**	**907**
Indirect	Transport	5,217	4,888	329
	Work Absenteeism	9,146	8,569	577
Fluoridation Program	GI	0	76	-76
	GII	0	170	-170

Source: Fonasa, Municipality of Concepción, Users survey, Ministry of Economy, Development and Tourism.

Considering the proposed intervention, the population studied involves a human resource cost of $24,029 for each 12-year-old child, and of $552,999,379 for the total target population. It has been estimated that the savings in Human Resources would have been $1,701 for each child and $39,139,291 for the total population of 12-year-old children in the Biobío Region in 2017.

c. Costs for Drinking Water Fluoridation

According to the 2016 Health Sector Management Report,[26] the daily consumption of drinking water per inhabitant was 115.6 liters for clients of the company ESSBIO S.A. In other words, the annual consumption per inhabitant was 42.19 m^3.

As shown in Table 3, an additional cost per year of $1,032,209 is calculated in Group I, and $1,589,060 in Group II. The total cost of the drinking water fluoridation program for consumption by 12-year-old children in the Biobío Region would be $2,621,269.

Indirect Cost Analysis

Travel or transport costs were quantified by calculating the average expense incurred by the patient to go from their location to the care center. This average

Tabla 5. Total Annual Savings in the 12-year-old population in the Biobío Region, Chile 2017, by fluoridating the drinking water network.

	Parameter	Costs per Child Without fluoridated water CLP$	Costs per Child With fluoridated water CLP$	Savings CLP$
	Grand Total	**1,893,885,076**	**1,764,023,431**	**129,861,645**
	Total	**971,189,189**	**898,709,139**	**72,480,050**
Procedures	Oral examination	80,318,860	80,318,860	0
	Scaling and polishing of crowns	178,588,640	178,588,640	0
	Fluoride varnish application	234,282,520	234,282,520	0
	Simple extraction of permanent tooth	15,603,492	12,482,794	3,120,698
	Composite filling	462,395,677	393,036,325	69,359,352
	Total	**592,138,670**	**552,999,379**	**39,139,292**
Human Resources	Administrative	21,103,612	19,458,337	1,645,275
	Dental assistant	151,498,982	140,482,634	11,016,348
	Dentist	419,536,077	393,058,407	26,477,669
	Total	**330,557,216**	**309,693,645**	**20,863,572**
Indirect	Transport	120,064,728	112,486,679	7,578,050
	Work Absenteeism	210,492,488	197,206,966	13,285,522
	Total	**0**	**2,621,269**	**-2,621,269**
Fluoridation Program	Group I	0	1,032,209	-1,032,209
	Group II	0	1,589,060	-1,589,060

Source: Fonasa, Municipality of Concepción, Users survey, Ministry of Economy, Development and Tourism.

expense was multiplied by the number of consultations that each child requires (5.07), and in turn by the total population of 12-year-old children in the Biobío Region, Chile 2017 (n=23,014), resulting in an equivalent travel cost of $120,064,728 for the entire target population.

The same calculation was made for the population with access to fluoridated drinking water, in which the number of consultations decreases to 4.75. With a supply of fluoridated drinking water, the cost of transportation for all 12-year-old children in the region would be equivalent to $112,486,679. This results in a saving of $7,578,049 in transport due to a reduction in the need for treatment. The costs of work absenteeism were quantified by calculating the average loss in salary or wage of the patient's companion due to the need of attending dental consultations.

This average was multiplied by the number of consultations that each child requires (5.07), and in turn by the total population of 12-year-old children in the Biobío region in 2017 (n=23,014). A cost of work absenteeism equivalent to $210,492,489 was observed for the entire target population. The same calculation was made for the population with access to fluoridated drinking water, in which the number of consultations decreases to 4.75.

When valuing the cost of absenteeism, this is equivalent to $197,206,966 for the entire target population. A saving of $13,285,523 is observed in work absenteeism by having a supply of fluoridated drinking water.

Benefit Analysis

To determine the benefit or saving obtained by implementing the fluoridation program (at individual and population levels), the savings in dental procedures and treatment, savings in human resources, and savings in indirect costs (transport and work absenteeism) must be considered.

On the other hand, there are the costs of implementing the fluoridated drinking water supply, depending on Group I or II of the network systems. These savings are summarized in Table 4, which includes the costs with and without the implementation of the program.

By performing the analysis at the population level and considering exclusively the avoided costs (procedures, human resources and indirect), a saving of $132,482,914 is achieved, which corresponds to 7% of the total cost involved in treating all 12-year-old children of the Biobío region in the current context where drinking water is not fluoridated. When including the direct costs for the fluoridation process, this saving decreases to $129,861,645 ($2,621,269 less), corresponding to a 6.9% reduction in treatment costs after the implementation of this sanitary measure.

The specific analysis of each cost indicates the greatest savings are obtained at the expense of the reduction in procedures associated with the treatment of dental caries, avoiding the expense of $72,480,050, which represents 54.7% of the total saved. The rest of the savings is achieved by the lower number of working hours of the healthcare staff, and the decrease in indirect costs, which corresponds to 29.5% and 15.8%, respectively, as summarized in Table 5.

The cost-benefit analysis indicates that the reduction of 15% in the history of caries, associated with the implementation of a fluoridated drinking water program in 12-year-old children of the Biobío region, beneficiaries of FONASA, results in a savings of $5,681 per child for those who belong to Group I, and $5,587 for Group II, and a total saving of $129,861,645, when considering the entire study population.

DISCUSSION.

Despite the diversity in the magnitude of the results observed in the literature, many of the articles agree that fluoridation of drinking water is an intervention that provides savings over the cost of the resources necessary to implement it.[27] For this type of intervention, the saving ranges reported by other studies range from US$15.95[28] to US$60.78[29] per person annually.

Like other studies, the results of this research reveal that the savings in oral health costs for 12-year-old children by fluoridating the drinking water in the Biobío region is significantly higher than the cost of implementing the fluoridation program. The total savings achieved are CLP $129,861,645 (US $200,129), and CLP $5,681 (US $8.75) per child annually in Group I, and CLP $5,587 (US $8.61) per child in Group II annually. In this way, it could be stated that the fluoridation of drinking water is an economically viable project for the Biobío region. However, although the figures reflect significant savings in the total population of 12-year-old children, they only mean around 6% of the total cost of treatment in a context without fluoridated water. For this reason, it is thought that considering the low cost of the program *versus* the amount of savings it brings for the State, the latter should fully pay for the service of supplying fluoridated drinking water and not make it an additional expense for the population. Within the limitations of the study, a variable not considered was quantifying the loss of benefit (savings) due to patient absenteeism. It is recognized that missing medical care is a problem identified in practically all health services, causing a negative impact on costs and the use of resources, reducing productivity and efficiency.[30] Machado *et al*.,[31] concluded that, in their study population, 32.9% of the patients missed an appointment.

So, considering this figure, for the study population of 23,014 12-year-old children, it would mean 7,594 additional appointments or consultations. On the other hand, it is thought that the results of this study could have been even higher if the calculation had included recommendations based on evidence made available after the completion of the study. It has been recently reported that fluoridation programs can result in caries reduction rates that range from 25 to 40%.[32] Finally, it is important to highlight that despite the consistency of these results, the implementation of a drinking water fluoridation program like any other new sanitary technology is subject not only to technical aspects, but also to political and social factors.[33]

The measure studied has been debated in recent years and there is controversy in its implementation for reasons such as the difficulty in controlling the amount of fluoridated water intake (*e.g.*, athletes, workers, people with diabetes) or the increase in multiple sources of fluoride that are in contact with the body (such as dental products, food, etc.).[34]

This debate also took place in the Biobío region during the 1990s. Different views emerged from the community, private organizations, academics and trade unions, among others, regarding the decision of implementing this measure in the region.[35]

Consequently, it is believed that this study will be an important starting point to stimulate more in-depth research on the subject, especially at the regional level.

Conflict of interests: All authors declare no conflict of interest.
Ethics approval: This research complies with the ethical guidelines of the Declaration of Helsinki, Law No. 20,120 (2006) regarding scientific research on human beings, and Law No. 20,584 (2012) on the rights and duties of patients, protecting the rights and well-being of the study subjects. The data used in this study and the results and conclusions drawn from them correspond mainly to data obtained from the literature and the calculations described in this document.
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