Status of the Epidemiological Surveillance Systems for Salt and Water Fluoridation Programs in Latin America and the Caribbean*

Estado de los sistemas de vigilancia epidemiológica en los programas de fluorización de sal y agua en Latinoamérica y el Caribe

Status dos sistemas de vigilância epidemiológica para programas de fluoretação de sal e água na América Latina e no Caribe

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ABSTRACT

Background: Epidemiological Surveillance Systems are part of public policies to evaluate the impact of prevention interventions or the occurrence of related health events. In Dental Public Health has been valuable the surveillance systems to follow the fluoridation programs, the prevalence of caries or the

fluorosis cases. ***Purpose:*** Identify and summarize published information regard the status of fluoridation programs and their epidemiological surveillance systems in Latin America and the Caribbean region. ***Methods:*** In this narrative literature review, articles searches in Medline and LILACS, in four languages, was carried out. ***Results:*** The authors included the analysis of 291 references published by government entities, international agencies, academic institutions and other sources, and summarizing the synthesis of all findings in two tracking matrices to contribute with new knowledge for policy making and program improvement through monitory systems. The results showed 11 active programs, 18 in uncertain status, and one country projecting a future program. Only six countries that started their fluoridation programs in the mid-eighties in the twentieth century have structured or strengthened a surveillance system for their fluoridation programs. ***Conclusions:*** The authors recommend a new stage of international accompaniment by several agencies to resume fluoridation programs in countries where structural, economic, or political factors affected the implementation or continuation of fluoridation programs in the 21st century.

Keywords

dental caries; fluoridated milk; fluoridation programs; fluorosis; preventive programs; Latin America and the Caribbean; salt fluoridation; water fluoridation

Thematic fields

dentistry; epidemiological surveillance; health policies; oral health; oral health policy; oral public health; public health

RESUMEN

Antecedentes: Los sistemas de vigilancia epidemiológica forman parte de las políticas públicas para evaluar el impacto de intervenciones preventivas o la ocurrencia de eventos relacionados con la salud. En salud pública dental los sistemas de vigilancia para seguir programas de fluorización, prevalencia de caries o casos de fluorosis han sido valiosos. ***Objetivo:*** Identificar y resumir la información publicada sobre el estado de los sistemas de vigilancia epidemiológica en los programas de fluorización en América Latina y el Caribe. ***Métodos:*** En esta revisión narrativa de la literatura se efectuaron búsquedas de artículos en las bases Medline y LILACS en cuatro idiomas. ***Resultados:*** Los autores incluyeron el análisis de 291 referencias publicadas por entidades gubernamentales, agencias internacionales, instituciones académicas y otras fuentes, y resumieron la síntesis de todos los hallazgos en dos matrices de seguimiento para contribuir con nuevo conocimiento para la formulación de políticas y la mejora de programas a través de sistemas de monitoreo. Los resultados mostraron 11 programas activos, 18 en estado incierto y un país proyectando un programa futuro. Solo seis países que comenzaron sus programas de fluorización a mediados de los años ochenta en el siglo veinte han estructurado o fortalecido un sistema de vigilancia para sus programas de fluorización. ***Conclusiones:*** Los autores recomiendan una nueva etapa de acompañamiento internacional por parte de varias agencias para reanudar los programas de fluorización en países donde los factores estructurales, económicos o políticos afectaron la implementación o la continuación de los programas de fluorización en el siglo XXI.

Palabras clave

América Latina y el Caribe; caries dental; fluorización del agua; fluorización de la sal; fluorosis; leche fluorada; programas de fluorización; programas preventivos

Áreas temáticas

odontología; políticas de salud; políticas de salud oral; salud pública; salud oral; salud pública oral; vigilancia epidemiológica

ABSTRATO

Antecedentes: Os Sistemas de Vigilância Epidemiológica fazem parte das políticas públicas para avaliar o impacto das intervenções de prevenção ou a ocorrência de eventos relacionados à saúde. Na saúde pública odontológica tem-se valido os sistemas de vigilância para acompanhar os programas de fluoretação, a prevalência de cárie ou os casos de fluorose. ***Objetivo***: Identificar e resumir informações publicadas sobre a situação dos programas de fluoretação e seus sistemas de vigilância epidemiológica na região da América Latina e Caribe. ***Métodos***: Nesta revisão de literatura narrativa, foram realizadas buscas de artigos em Medline e LILACS, em quatro idiomas. ***Resultados***: Os autores incluíram a análise de 291 referências publicadas por entidades governamentais, agências internacionais, instituições acadêmicas e outras fontes, e resumindo a síntese de todos os resultados em duas matrizes de rastreamento para contribuir com novos conhecimentos para formulação de políticas e melhoria de programas através de sistemas monitorados. Os resultados mostraram 11 programas ativos, 18 em status incerto e um país projetando um programa futuro. Apenas seis países que iniciaram seus programas de fluoração em meados dos anos 80 no século XX estruturaram ou reforçaram um sistema de vigilância para seus programas de fluoretação. ***Conclusões***: Os autores recomendam uma nova etapa de acompanhamento internacional por várias agências para retomar os programas de fluoração em

países onde fatores estruturais, econômicos ou políticos afetaram a implementação ou continuação de programas de fluoretação no século XXI.

Palavras-chave

América Latina e Caribe; cáries dentárias; fluoretação da água; fluoretação do sal; fluorose; leite fluoretado; programas de fluoretação; programas preventivos

Campos temáticos

odontologia; políticas de saúde; política de saúde bucal; saúde pública odontológica; saúde bucal; saúde pública; vigilância epidemiológica

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INTRODUCTION

In 1994, an initial strategy to implement caries prevention programs in the Region of the Americas by the Pan American Health Organization (PAHO) was delivered to all Latin American and Caribbean countries (1). One of the main purposes was to socialize the results of prior trial studies or programs developed in the Region which tested the effectiveness of water and salt fluoridation

programs. The second purpose was to provide initial technical support to implement or to strengthen national fluoridation programs in Latin America and the Caribbean where the prevalence of caries affects the majority of the infant and adult population in the region (2).

The Local Health Authorities in the majority of Latin-American and Caribbean countries were able to begin or to strengthen fluoridation programs in the Americas by the leadership of the PAHO and sponsored by several international organizations, as the Kellogg Foundation, World Bank and United Nations Children's Fund (UNICEF) (1, 2). Nonetheless, after some years of activities and publications, the dissemination of new general reports sharing experiences of all the countries involved in these initiatives stopped several years ago (1, 2). It has been evident the lack of an updated published document containing a tracking record about the activities developed by each country in Latin America and the Caribbean to continue the fluoridation programs established in the 20th century, and the possible implementation of surveillance systems to monitor these programs. This gap of information inspired the authors about the need to develop this nonsystematic narrative literature review study to contribute with new knowledge for policy making and program improvement through monitory systems.

The promotion of water fluoridation in Latin America began in 1954, during the Fourth Inter-American Congress of Sanitary Engineering held in Brazil, and after in 1956, at the V Inter-American Congress of Sanitary Engineering held in Peru (3). In Both meetings, the majority of members voted a regional recommendation for the fluoridation of water as a means of reducing tooth decay. Currently, since 1953 Chile and Brazil began a pilot of water fluoridation program in one city at the beginning, extending the national coverage in 1958 (4) and 1974 (5) respectively. Argentina has been implementing water

fluoridation programs since 1969, reaching the program in 17 from 23 regions of the country, and Brazil promoted the national water fluoridation program in all its states since 1974 (3).

The beginning of salt fluoridation programs in Latin America had as reference study a landmark approach developed in 1965 by PAHO with the collaboration of the University of Antioquia, the United States Public Health Service, and the National Institute of Dental and Craniofacial Research (1). The study was developed in two Colombian communities with the distribution of fluoridated salt to the study group, as part of a trial to determine the effect of salt fluoridation in the prevention of dental caries, as compared with water fluoridation's trials (1, 2, 6). After this study, the "First International Symposium on Salt Fluoridation" took place in 1977 in Colombia, with the participation of European and American advisors on the topic, promoting the advantages of the fluoridation programs in Latin-American Countries (7).

Currently, salt fluoridation programs offer the best alternative for European and Latin-American countries, because they provide greater coverage at lower cost (7). According to some studies, the per capita cost of salt fluoridation is very low, within €0.02 and €0.05 per year or one hundredth of a dollar cent (6). In Germany, with a salt fluoride program established since 1991 covering almost 70 % of its population, the cost of adding fluoride in salt has been calculated around €200,000 per year (US $230,000), and only affecting the increase of the 500 g salt packet market price in 5 or 10 cents in euro or dollars (6, 8, 9).

In contrast, the cost of water fluoridation programs has depended on the size of the community and the amount of fluoride added to the water supply (7). Reviewing some studies, the median cost

per person per year ranged from US $2.70 among 19 systems serving tows with 5,000 inhabitants in small cities to US$ 0.40 among 35 systems serving ≥ of 20,000 people (8, 9, 10). Leaders in water fluoridation have affirmed over the past decades the advantages of this strategy showing that the $23 per year cost of maintaining a child in a sealant program could be improved with the annual per capita cost of a water fluoridation program. Five communities of United States have reported values with ranges from US$0.06 in Denver, Colorado to US$0.80 in rural West Virginia achieving US$1,981 dollars per capita cost per year (9, 11, 12).

Regional agencies and governments achieved a consensus in 2005 about the five major components to develop a successful fluoridation program including a pertinent cost-benefit analysis and the development of periodic national oral health studies to assess DMFT and exposure to fluoride. Other components included in the consensus were biological and chemical monitoring of all fluorides, quality control to salt-industry and water supply companies, and epidemiological surveillance systems for fluoridation programs to determine the effectiveness of national fluoridation programs (12).

Following the recommendations defined at the 2005 Consensus, several Latin-American and Caribbean countries have implemented regular oral health surveys, providing useful information that now is part of a regional and global oral health information systems, to show data on oral health status, monitoring disease patterns and trends over time about a specific oral health program implemented by the policy-makers or oral health planners (13, 14). These collections and analysis of data based on common procedures have been part of an epidemiological survey methodology and surveillance in oral health System established by the World Health Organization in 1967 and

called WHO Global Oral Health Data Bank (13-15), and which currently is virtually updated through WHO Oral Health Country/Area Profile Programme (CAPP) since 1996 (15). Data comparisons over time have shown a decline in dental caries experience of the child population in the region since the implementation of fluoridation programs (13-17).

The present paper outlines all the published information by government entities, specialized agencies, or academic institutions about the existence of Epidemiological Surveillance Systems for fluoridation programs in 32 countries part of the Latin-American and the Caribbean regions, and the description of the status of these systems, highlighting the most critical findings in each country, based on their collection and analysis of data (15).

MATERIALS AND METHODS

Type of Study

This is a non-systematic narrative literature review study, with the main purpose to summarize evidence using a qualitative method to collect and interpret information and reports on the topic. The authors did not choose to develop a systematic review because the research question was focused on a measure in public health influencing 40 countries in the Americas, to collect qualitative data and involving several sources of information beyond of relevant databases. This qualitative approach allows the authors to build a protocol-based in the search method and data analysis.

Hypothesis

The authors developed this study under the hypothesis that there was dispersed published evidence

in Latin America and the Caribbean region about the implementation of fluoridation programs and epidemiological surveillance systems on these programs, but that information should be collected and synthesized in a qualitative narrative review to contribute with new knowledge for policy making and program improvement through monitory systems.

Research Question

Based on the Hypothesis the authors framed the research question and secondary question using the PICO framework:

Central Question: The Latin American and Caribbean countries have continued to develop fluoridation programs?

Secondary Question: The Latin American and Caribbean countries have implemented epidemiological surveillance systems on these fluoridation programs?

P –Problem: Lack of information about the status of fluoridation programs in Latin America and the Caribbean region.

I- Intervention: Collect the information about 40 countries in the Americas from different sources including relevant databases and other published information by government entities, international agencies, academic institutions and other sources.

C – Comparison: No collection of information and persistence in the lack of evidence on the topic

O – Outcome: Increase the evidence of fluoridation programs in Latin America and the Caribbean and the implementation of Epidemiological Surveillance on these programs.

Search Method

The authors planned a search strategy by identifying the major elements of the research question and

secondary question, translating some terms to the official language used by the selected 40 countries included in the study.

The first search step of the study was to find all related information in article databases defined in the methodology and the second search step was to find additional information using a search engine to include documents from international agencies, governmental entities, and academic institutions about the topics contents in the central and secondary questions.

Major elements or terms of search: fluoridation programs, salt fluoridation, water fluoridation, fluoridated water, fluoridated salt, epidemiological surveillance.
Second elements to cross all the major terms: names of the countries included in the study.
Core article databases used by the authors: Medline/PubMed, LILACS, and WHO-Extranet.
Core search engine used to find other type of publications on the topics of search: Google.
Main languages included within the search: Spanish, English, Portuguese and French.

Universe and Sample

Universe: the identified universe to be approached in this study were all articles, documents, and published reports about fluoridation programs in Latin America and the Caribbean and the evidence of implemented epidemiological surveillance systems in all these programs.
Definition of the sample: the authors worked in this study without any prior inventory of documents, crossing the terms of search defined in the research questions with the name of each country included in the study. It was evident since the beginning of the study that the authors will face a lack of uniformity in the sources and in the type of publications to be collected.

Inclusion and Exclusion Criteria

Inclusion criteria: the authors included all the Latin-American and Caribbean countries to be analyzed in this study according to the central and secondary research questions.

Exclusions: the authors only excluded references with repeated information previously included in the findings, or all those references without credible information from a reliable source.

Limitations: several countries have difficulties offering access to their virtual records or some of them, have not yet converted their information of many activities into virtual records, and it was not available in online platforms.

Data Analysis and Synthesis

The data extraction, data synthesis and quality of the collected data were conducted by an own protocol-based defined among the authors to this study, taking advantage of the number of researchers in the study and managing the lack of uniformity in the sources and type of publications. The main steps defined within the protocol-based defined to this study were:

1. Each author was assigned ten countries for the review and analysis of their fluoridation program and the implementation of an epidemiological surveillance system in that program.
2. Each author was focused to make a simple description of the findings, providing an overview of each program, antecedents, and a brief political context influencing the decisions in public policies that could affect the existence or not of fluoridation programs.
3. Other authors were able to share links and references from countries other than those initially assigned to contribute to the process of data selection and analysis.
4. After, the other three authors reviewed the synthesis of their peer, evaluating the included

information, suggesting the search of more information about the missing aspects not yet included and tracking the updates of each recommendation.

5. This revision process was developed for each country included in the study. If there was no evidence of an important aspect to be included, it was recorded within the synthesis of the country.
6. The authors' synthetized the majority of information in two tracking matrices summarizing the findings.

FINDINGS AND DISCUSSION

After the start or implementation of several fluoridation programs in Latin-American and the Caribbean countries with the support of PAHO, Kellogg Foundation, World Bank and UNICEF, it was evident the lack of an updated publication synthetizing the achievements, difficulties and recommendations to improve these initiatives in both regions of the Americas (1, 2). This gap of information inspired the authors to develop this nonsystematic narrative literature review study to contribute with new knowledge for policy making and program improvement through monitory systems.

The authors reviewed and analyzed more of 538 documents from official governmental reports, scientific articles, thesis, annual summaries from government entities, academic dissertations, health national programs, environmental reports, community water fluoridation reports, reports from water supply companies and salt industry, summary of achievements from national oral health divisions, and highlights from oral health national plans. It was evident the lack of uniformity in the sources and type of publications to be collected, but finally the authors selected 291 references from trusted sources

eliminating repeated information or data from unidentified sources.

The authors found that Mexico, all the Central American and South American countries, with exception of Argentina, Brazil, Chile, and several Caribbean countries had started, maintaining, or are about to launch salt fluoridation programs at the end of the twentieth century (1, 7, 11, 17-19) (Table 1). Eight of these Countries have prior histories with water fluoridation programs and one with salt fluoridation program before the implementation of the current program (Table 2), but these programs finished by economic, political, logistic factors (20, 21). All these fluoridation programs have had sponsored by several international organizations, especially by the PAHO, Kellogg Foundation, World Bank, and UNICEF.

The results from these 40 countries showed 11 active programs, 28 in uncertain status and one country projecting a future program (Table 1). Only six countries that started their fluoridation programs in the mid-eighties in the twentieth century have structured or strengthened a surveillance system for their fluoridation programs (Table 1). In addition to the salt or water fluoridation, three countries implemented milk, topic or mouthwashes programs (Table 2).

Several countries had difficulties offering access to their virtual records, and the context embroiled in this review could have some gaps in their fluoridation background and current status because their lack of virtual records. Twenty countries appear to be overcoming their difficulties in salt production and the addition of nutrients such as fluoride, through the importation of salt, but none of these countries show any regulation or standards for salt importers.

The salt fluoridation schemes are reaching more than two hundred million between Mexico, Costa Rica, Colombia, Peru, Jamaica and Cuba, and the water fluoridation more of two hundred million between Chile, Argentina, and Brazil (1, 3, 7, 19, 20). The scope of the current water and salt fluoridation programs would be around 60 % of the total population between both regions, taking into account that the average population of Latin American and the Caribbean was reaching the 680 million inhabitants in 2017 (15). Below the most important findings by country and region:

Mexico

Mexico began its first salt fluoridation program in 1981 selecting two initial states, to then achieve national coverage of the program by 1995, reaching 120 million of its population (6, 22). A federal rule NOM-040-SSA1 was issued in 1993 by the Health Secretary, regulating the basic standards for salt produces, defining the fluoride (F) concentration in 250 ±50 parts per million (ppm) (23). In 2005, the General Direction of Epidemiology at the Federal Health Secretary began the Epidemiological Surveillance System for Oral Pathologies (SIVEPAB), with a network of 450 sentinel units in 32 federative entities to collect the information, which provide the elements for decision making and to base the actions of prevention and health promotion (24).

The SIVEPAB is not part of the Unique Information System, unique system of information for epidemiological surveillance of the nation (SUIVE), but this system is not part of the national surveillance system. Therefore, some authors consider that its scope is still limited although SIVEPAB has more of ten years ago of implementation (25, 26).

In the Third National Survey of Oral Health in 2015, it was included the dental fluorosis as one of

the surveillance topics. The national average of fluorosis was 2.9%, except for three zones reporting a high prevalence of fluorosis over 9 %, such as Aguascalientes, Zacatecas, and Durango with 8,941 cases reported with dental fluorosis with ages between 15-29 years old, from a total of 312,963 screened patients (24). The DMFT index in the state of México according to CAAP in 1988 was 4.4 in children and adolescents, when salt fluoridation was fully implemented in this region, and according to the latest report in 2010 in the same WHO bank, the DMFT index was 1.1 (15). The SIVESPAB national data reported in their last bulletin in 2016, that seven of each ten children and adolescents have dental caries (24, 27, 28).

After the consolidation of results from the Third National Survey of Oral Health in 2015, and according to a federal reevaluation of several studies developed by local authorities in partnership with academic institutions between 1995 and 2009 (24, 28-33), the National Salt Fluoridation Strategy was updated recommending the measure of a first analysis of fluorides concentration in drinking water. According to the findings, the SIVEPAB system will divide the country into three regions where the first region will include those geographical areas with high reports of fluorosis where only iodized salt will be available. The second geographic area with lower reports of fluorosis where approached with iodized-fluoridated salt and the third region with mixed reports, where managed with two types of salt (24, 27, 28).

Guatemala

In 1985, Guatemala developed the National Oral Health Survey in schoolchildren from 5 to 17 years old. The 1985 Survey showed a 97% of prevalence in dental caries, with a DMFT index of 10.1 and the existence of mild, moderate, and severe dental fluorosis in the communities of El

Progreso, Zapaca, and the Izabal (34, 35). For that moment, it was estimated that 40,000 persons were exposed to high levels of fluoride in drinking water and within the recommendations from the PAHO and local authorities were to implement the salt fluoridation national program, mouth rinse programs in all schools and continue evaluating 8 endemic zones with higher content of fluoride in their drinking water (35, 36).

In 1988, the City of Guatemala, in partnership with the Ministry of Public Health and Social Assistance, the Municipal Company Authority (EMPAGUA) and the Guatemalan Social Security Institute decided the implementation of a first fluoridation program in drinking water in the capital city (37). In 1998, the amount of fluoride in the water supplies from samples collected in schools located in the distribution network of EMPAGUA, were very low (0.29mg / l to 0.466 mg / l). The costs and insufficient impact of this prevention program caused the cancelation of this strategy (38).

In 1991, an epidemiological survey in dental caries and oral hygiene was developing in urban areas showing that 63 % of the schoolchildren had dental caries, and a decreased DMFT index of 7 in a similar population approached in the previous survey. The results were linked with the implementation of month rinse programs but showed the persistent need to implement a national salt fluoridation program (34, 39).

In 1991, the National Committee of Oral Health (CONASABU) was the governmental body defined to be in charge to develop the national program of salt fluoridation by the National Decree 755-88m of 1991, which was modified with a new government agreement 29-2004 updating the initial decree issued in 1991 (40). The United Nations Children's Fund (UNICEF) was actively involved supporting

the beginnings, including the implementation of the National Committee of Fortified Foods (CONAFOR) by the legislative decree 44-92 of 1992 (41), funding the training and standardization of protocols for salt producers during two years. In 1995 was developed a survey of salt consumption with adequate results to continue the national program (42). During 1994-1996, the government mapped the fluoride content in water, with the expectancy to implement a surveillance program to monitoring communities with higher levels of fluoride in drinking water (43).

The latest epidemiological study in dental caries and dental fluorosis developed in Guatemala during 1999-2002, reported that every Guatemalan schoolgirl at age 12 presents a DMFT index of 5.68 (44). The results positioned the country at global level as one with the higher needs to improve fluoridation and preventive programs to improve the oral health in younger populations and adults (21). The findings also detected the existence of moderate and severe dental fluorosis in the communities of Guatemala, Huehuetenango, Zapaca, and the Izabal (44).

Following the Epidemiological survey, the CONASABU published a report in 2015, to show the status of the salt fluoridation program, according to the latest Government Agreement 29 of 2004 based on the updated rule for the inclusion of fluoride and iodine micronutrients in salt (21). This research had as main objective to establish the concentration of fluoride and iodine in the salt of human consumption available in the markets of the Republic of Guatemala. The report showed that 97.5% of the analyzed samples do not contain any trace of fluorine (21).

Centro American Countries of the Kellogg Project: Belize, Honduras, Nicaragua, and Panama

The Alma Ata Declaration on primary health care was adopted in 1978, including a global benchmark in oral health defined by the World Health Organization (WHO), where all countries should reach the milestone of having a DMFT index below three at schoolchildren populations by the year 2000 (45). This milestone was accompanied by the regional strategy led by PAHO and sponsored by Kellogg Foundation to implement or reinforce fluoridation programs (1, 46).

The results by country at the beginning of the twenty-first century showed that only some Central American countries achieved that purpose as Belize, Costa Rica, Nicaragua, and El Salvador. In South America, the goal was reached by Suriname, Peru, Colombia, Uruguay, Venezuela, and Brazil. The DMFT index above 4 remained in Bolivia, the Dominican Republic, and Chile to the beginning of the 21st Century (1, 46, 47).

During 1996 and 1997, the PAHO with the sponsorship of Kellogg Foundation, began the implementation of salt fluoridation programs in Bolivia, the Dominican Republic, Honduras, Nicaragua, Panama, Venezuela, Belize, and Paraguay (1, 2, 46).

In 2000, the PAHO published a report to the Kellogg Foundation, about the status on the implementation of salt fluoridation programs in these countries with the foundation' sponsorship (1, 47). The report included the initial evaluations of the fluoridation programs, as a base for a structured epidemiological surveillance system that was expected to be implemented during the first decade of Twenty-first century in each country part of the Kellogg Foundation' sponsorship (1, 46, 47).

The initial results and the subsequent follow-up in their salt fluoridation programs during the

twenty-first century in all countries part of the Kellogg Foundation' sponsorship showed mixed results in coverage, quality, evaluation and subsequent influence on the DMFT index (46-52):

Belize

This country began the program in 1997 analyzing the status of the salt industry, oral health care services and cost-benefit study about the viability of the program. They continued with a study of fluoride concentration in drinking water and a National Oral Health Survey approaching DMFT and dental fluorosis. (46-48). According to the CAAP, the DMFT was decreased from 6 in 1989 to 0.7 in 1999, but it's not clear the impact of the salt fluoridation program on this decreased index when the program had less of three years of implementation in 1999 (15).

In 2007, the Bureaus' technical committee for foods and food-related products, published an updated national rule to define that salt labeled “fluoridated salt” contains a minimum of 175 milligrams of fluoride and a maximum of 225 milligrams of fluoride per kilogram of salt (49). The most recent document from the Ministry of Health about the plan of action to reduce non-communicable diseases in Belize, it was not found any strategy or update about the salt fluoridation program or any other approach to reduce dental caries in the country (50).

Honduras

This country started the program in 1996 analyzing the status of the salt industry, oral health care services and cost-benefit study about the viability of the program. They continued with an examination of fluoride concentration in drinking water and a National Oral Health Survey approaching DMFT and dental fluorosis (51). The health authorities complemented the prior

activities with the second part of actions developing a study of fluoride supplements and toothpaste; and the first assessment of fluoride excretion in urine. Finally, the authorities defined an initial task force designing the initial recommendations on fluoride concentration in salt for the country, as baseline of the country surveillance systems for fluoride (46, 47).

In 2011, was created the National Advisory Council of Micronutrients, which would be in charge of the National Plan of Micronutrients, including all rules, related to the salt fluoridation standards (52).

The most recent document from the Secretary of State about the National Health Plan 2021, does not address any topic related to oral health, epidemiological surveillance or a national salt fluoridation program (53). An official bulleting from the Presidency of Honduras at the beginning of 2017 included a president' statement about the initial negotiations with the National Federation of Ranchers and Farmers (FENAHG). The salt producers were involved about the implementation of new national rules to include iodine and fluoride in the Salt nationally produced, and the subsidies to be granted to the salt-producers, reflecting that the program implemented in 1996 was not active in 2017 (54).

Nicaragua

This country began the program in 1996 analyzing the status of the salt industry, oral health care services and cost-benefit study about the viability of the program. They continued with an examination of fluoride concentration in drinking water finding two communities of Central Zelaya with high levels of fluoride above 2.0 ppm in drinking water (55) and a National Oral Health Survey approaching DMFT and dental fluorosis (46). The Health authorities complemented

the prior activities, with the second part of actions developing a study of fluoride supplements and toothpaste, and the first assessment of fluoride excretion in urine. Finally, the authorities defined an initial task force designing the initial recommendations on fluoride concentration in salt for the country, as baseline of the country surveillance systems for fluoride (1, 46).

In 2007, the National Assembly of Nicaragua, approved a national law about the fluoridation and ionization of salt, specifying that the fluoridated salt should not be commercialized in areas where there is natural fluoride in water for human consumption, with levels higher than 0.7 mg/kg, according to the Epidemiological Map of Risk for Fluorine Deficiency Disorders (56). A related resolution with the Law 638 of 2007 was published in 2008 (57) and a national technical rule in 2009 (58), defining that fluoride concentration in salt should be 200–225 mg/kg (57, 58). In 2012, Nicaragua, Honduras, El Salvador, Costa Rica, and Guatemala signed a Central American agreement to standardize and regulate the addition of micronutrients in products as salt (59), but an additional technical rule specifying parameters in fluoridated and iodized salt still in construction, according to the online database of the Centro American and Dominican Republic Council of Health Ministries (COMISCA) (60).

The latest multi-year plan of health developed between 2011 and 2015 in Nicaragua, does not have any reference to an annexed oral health plan for the country, or an epidemiological approach on the national salt fluoridation action (61). Only one study has been published about fluoride concentrations in salt marketed in Nicaragua, having as results that most salt samples analyzed by the researchers violated the requirements of the national legislation, and the main recommendation to implement a surveillance system for the salt fluoridation program in Nicaragua (62).

Panama

This country began the salt fluoridation program in 1996 after having had a water fluoridation programs for more of 20 years in urban areas and around the canal zone (63). Initially, the health authorities analyzed the oral health care services, the status of the salt industry and cost-benefit study about the viability of the program. Posteriorly, they led a dental caries and fluorosis study in 1997 finding a DMFT of 3.64 and a review of fluoride concentration in drinking water (46, 63). The health authorities complemented their prior activities with an examination of fluoride supplements and toothpaste, a first assessment of fluoride excretion in urine and an initial task force meeting defining the initial recommendations on fluoride concentration in salt for the country (1, 46).

In 1998, was published a national executive order in Panama to regulate the fluoridation of salt (64), but later in 2001 a new regulation was implemented returning the water fluoridation program in the country and to be managed by the Institute of Aqueducts and Sewerage (IDAAN) including an assigned budget of 2 million of balboas (65).

The National Policy of Health 2010-2015 published in 2010 defined nine national policies including the policy 3 to improve the access and quality of health services, where the plan of oral health was including, promoting communities free of dental caries for vulnerable populations, like children, pregnant women, people with disabilities and indigenous communities. The water fluoridation strategy or the evaluation of this program was not included within the document, and some related documents noted the need to resume the program after IDAAN suspended the measure in 2010 because of financial difficulties (66).

Costa Rica

Costa Rica began a water fluoridation program in 1975 until 1980, but this strategy was only adopted in metropolitan areas of the country (67). The health authorities lived severe technical, economical and logistics difficulties because different entities managed the national water distribution network, and in rural areas, the population still used well water (68). Authorities defined the national program in fluoridation after the National Survey in Nutrition developed in 1966 detected a high incidence of dental caries, reporting a DMFT index between 3,1 to 11 in rural areas, and 1,7 to 7,4 in urban areas (67, 68).

In 1983 the Oral Health Department at the Ministry of Health defined to begin the studies to evaluate the feasibility to implement a national salt fluoridation program, taking advantage on the salt iodized program that was already running in the country by the leadership of the Costa Rican Institute of Research and Teaching in nutrition and Health (INCIENSA) (68).

The salt fluoridation program was reached in 1987, taking as reference the successful programs developed in Europe and Jamaica at the Caribbean region in 1985 (9, 18). The national rule to regulate the salt fluoridation program was published in 1989 defining the dry method and sodium fluoride to be used by the seven salt producers, with an initial concentration 250 ± 25 mg of F per 1 kg and reducing it in 1994 to 150–200 mg of F per 1 kg of Fluoride in Salt (69).

A subsequent modification of the national rule based on the epidemiological studies to evaluate the concentration of fluoride in potable water was issued in 1992. This rule limits the scope of the

salt market in the geographical volcanic zone of Cartago, especially in the localities of Tierra Blanca and Llano Grande, where the water is still detected with fluoride 0.8 mg FAI (Free Androgen Index) in the rainy season and 1.4 mg FAI in the dry season. (70).

Costa Rica's salt fluoridation program was initially placed under the leadership of the Ministry of Health, in coordination with the Costa Rican Social Security Fund (CCSS), and the Costa Rican Institute for Research in Nutrition and Health (INCIENSA) (67). Subsequently, INCIENSA assumed in 1994 the full responsibility for the project, which was financed in part with a grant from the Kellogg Foundation (68). The country always has had a national office for the program, and a visible chief is leading all strategies defined by INCIENSA (68).

The country has been committed taking care of the National Salt Fluoridation Program since the beginnings of the strategy: In 1988, a year after the salt fluoridation program was launched, a second national study was conducted to contrast the first national study of oral health conducted in 1984 (46). The health authorities only found a DMFT reduction of 0.7 in children of 12 years old (9.1 in 1984 vs. 8.4 in 1988) (1). In June and October 1987 and again in 1988, studies of fluoride in urine were conducted in 16–22 years old population, detecting an increase in fluoride in urine, associated with the consumption of fluoridated salt (67, 68).

In 1992, a national study of 12-year-old school children yielded an average DMFT of 4.9, a reduction of 40 % compared to the average DMFT in 1988 (68). In 1996, as part of the national nutrition study, data on the state of the dentition of children 7–12 years old indicated that the average DMFT for 12-year-old was 4.9, which is comparable to the value obtained in 1992 (47).

Preliminary data from the latest epidemiological evaluation of caries and the first national evaluation of enamel fluorosis carried out in 1999 showed an average DMFT of 2.5 at 12 years of age, confirming the downward trend of the prevalence and severity of caries in Costa Rica (69).

Costa Rica's salt fluoridation program includes an educational campaign in communities with natural fluoride promoting awareness of the availability of non-fluoridated salt (1, 69, 70). An important aspect of Costa Rica's program for salt fluoridation was the designation of a sentinel site to monitor caries and enamel fluorosis (1, 67, 71).

Epidemiological studies continue developing every four years on 12-year-old schoolchildren, and periodic reports have been published, updating on several aspects of the epidemiological surveillance, especially studies related to chemical and biological monitoring (67. 68, 70, 71, 72, 73). Quality control has been carried out by the salt plants locally and centrally at INCIENSA, with periodic data recording and monthly evaluations. Quality control shows that Costa Rican salt is consumed within four months of being produced (67, 72).

El Salvador

In 1997, a regional plan with strategies for caries prevention was approved by PAHO and all members' countries (74). This mandate was adopted by the health authorities of El Salvador, planning and developing the second first Epidemiological study of caries and dental fluorosis in school children of 6, 7-8, 12 and 15 years of public education centers. The results showed a DMFT index of 1.4 in younger populations, comparing the index from a previous study in 1989 where the DMFT was 5.1 (75). Initially, El Salvador agreed to develop a prevention program through

fluoridation of salt and made initial efforts in the implementation of the program, trying to take advance about the implemented national salt iodized program which started a first stage in 1967 until 1977, and was reactivated in 1993 (76-78) and updated in 2018 (79).

Different factors affected the implementation of the salt fluoridation program as the affirmation from some actors in the health system that linked the decreased DMFT between 1989 to 2000 as a product of local dental initiatives and not for large preventive programs and the increase of dental workforce in the country (75). Another factor noted was that during the last 20 years the majority of salt producers in the country were not legal according to the official standards. Therefore, it would be difficult for them to be part of a national program with specific parameters to follow (80).

All evidence found by the authors of this study showed that El Salvador began some efforts to initiate a salt fluoridation program between 1997 to 2002, including the development of a survey about the fluoride concentration in potable water (81) and finding a potential of 12% of the country population at risk of fluorosis in 5 localities (Usulután, La Union, La Libertad, Sonsonate and San Salvador).

Nonetheless, the documents found about this country, showed a legal framework focused on the idea to implement a water fluoridation program, as it was included in the National Health Code of 1998 in the Article 51, part of section 4 focused on Oral Health stating "the government will propose the laws to obtain the fluoridation of potable water on the national territory" (82).

Any institutionalized epidemiological surveillance in oral health or salt fluoridation was not found by the authors of this study, screening all possible documents after the last regional report where El

Salvador was included as part of the countries that were beginning a salt fluoridation program (1).

The strategy about "Dental Services for Children of 5 Years Old" defined in the latest National Oral Health Plan published in 2008, or the National Policy in Health 2015-2019 does not contain any activity related to a salt fluoridation program (83, 84), or the latest epidemiological study in oral health (85), as well as the national nutrition plan issued in 2010 (86, 87).

Colombia

Colombia launched the first water fluoridation program in 1953 beginning the strategy in the small city of Girardot (Cundinamarca) and later implemented this measure in main cities such as Cali, Bogotá, Medellín, and Manizales (7, 88). Posteriorly in 1969, the Ministry of Health adopted this preventive measure as a national strategy, but it had low national coverage given the low availability of potable water at that time, and only benefiting around 40% of the population in large urban centers (89-91).

In 1963, Colombia was selected by the Medical Research Committee of PAHO to study the impact of the salt fluoridation as a large prevention measure of dental caries (7, 89, 92-94). After the end of this study in 1972, a stable mixture of fluoride in the salt was established for future approaches in the country and at a regional level (7, 89).

The Oral Morbidity Study developed in 1977-1980, found that 97.6 % of Colombians presented a history of dental caries, reinforcing the international recommendation to establish a national salt fluoridation program to cover all regions and populations, especially children and teenagers (7, 89, 95).

An initial national rule was approved in 1984 to regulate the addition of fluoride in salt, including the minimum standards to define the process to be implemented by salt producers and to be regulated by the government agencies (96). In 1994 and 1996, new decrees established the fluoridation of the salt in contents between 180 and 220 ppm, the issuance of the sanitary registry, and the "sanitary conditions of production, packing and marketing to the control of salt for human consumption " (97, 98).

Complementary with the legal framework, several government institutions worked to increase the spectrum of available information to define better policies to implement the salt fluoridation program in Colombia. Within the outstanding efforts was the longitudinal study finalized in 1988 by The National Institute of Health in Colombia (INS) providing a first inventory of natural fluoride content in water for public consumption where four cities in the Department of Huila (Gigante, Hobo, Rivera y Suaza) showed fluoride concentrations in water above 0,5 ppm (7, 99).

Another effort was the publication by the Colombian Institute of Surveillance and Control (INVIMA) of a manual on analytical technics to evaluate the quality of fluoride and iodine salt to be sold by salt producers in Colombia (7, 100, 101). It was also remarkable the exploratory study about dental fluorosis, fluoruria (fluoride deficiency), and dental caries by the Ministry of Health between 1988 and 1989 and published in 1990 (102, 103).

In 1998, the Third National Study of Oral Health (ENSAB III) reported a prevalence of 11.5% of fluorosis and a reduction of the DMFT index in 2.3 at 12 years old (89, 104). Posteriorly, a sentinel

study in 2001-2002 was developed to analyze the fluoride concentrations in water and salt by the excretion of fluoride in urine, finding ten cities at the Department of Huila with high fluoride concentration in water, ratifying the need to define competencies for controls in the exposition of fluorine in specific municipalities and populations. The cities under surveillance after the sentinel study were Aipe, Algeciras, Campoalegre, Hobo, Neiva, Pitalito, La Plata, Garzón, San Agustín and Palermo (105, 106).

Since 2012, sentinel surveillance of fluoride exposure has been routinely including the biological monitoring of dental fluorosis and the chemical monitoring of the presence of fluoride in the water by the Surveillance System for Water Quality (SIVICAP) and salt by the National System of Public Health (SIVIGILA) managed by INVIMA (107).

This epidemiological surveillance has made possible to finalize several reports and the enforcement of its monitoring and regulation function, as the latest report where 3 municipalities (Turmequé in Boyacá, Orocué in Casanare and Tablón de Gómez in Nariño) had had higher fluoride concentration in the salt market during 2012 – 2015 (108, 109).

Other studies developed by universities and research institutions to measure the fluorine ion stability, the prevalence of dental fluorosis, fluoruria, risk factors, and dental caries promoted a great feedback to the Epidemiological Surveillance System for the salt fluoridation program in Colombia at the end of the 20th century and the first decade of the 21st century (7, 110-129). Some of these researches were focused to evaluate the stability of the cooking salt (111), fluorosis in children and adolescents (112, 115-127), measurement of the fluorine ion in the cooking salt (113,

129), urinary fluoride excretion (114), and fluoride concentrations in aqueduct waters (110, 128).

The epidemiological surveillance system (SIVIGILA) is under the leadership of the National Institute of Health in Colombia (INS) and the Colombian Institute of Surveillance and Control (INVIMA). Although it does not have national coverage, has made it possible to identify the needs of strengthening of installed capacity in the regional public health laboratories, and other priority surveillance activities, to improve the oral health and overall health of the Colombian Population (7, 107-109).

Ecuador

Ecuador initiated the national salt fluoridation program with the PAHO assistance and World Bank sponsorship in 2001, after having had a water fluoridation program in several urban municipalities since 1974 under the constitutional support of a supreme decree that built the basis to establish a national program of fluoridation (130). The water fluoridation program was only carried out in a few cities of Ecuador until 1986, and its implementation in the rest of the country became difficult due to the low coverage of potable water systems. According to data from the Ecuadorian Institute of Sanitarian Works, only 59.7 % of the Ecuadorian population had access to potable water in urban areas and only 27.7% in rural areas (131-133).

In 1986, the health authorities decided to develop several baseline studies to implement a National Salt Fluoridation Program, funded by international agencies as PAHO and the World Bank (131, 134). The findings about the DMFT index in 1988 were included within the Epidemiological Study of Oral Health in Schoolchildren, where the DMFT index had a notable variation according to the age. Between 7 to 12 years the DMFT index was 0.7 to 4.94, indicating that Ecuadorian

schoolchildren beginning high school would be having 5 teeth affected with any dental event (135).

Posteriorly, the financial feasibility study in 1994 by the Ministry of Health with the support of PAHO, defined the schoolchildren as the primary target population to receive the benefits of a national salt fluoridation program in Ecuador. According to the economic projections, based on the cost of a dental visit defined in US$3, the impact of a salt fluoridation program with a national scope could have as the average saving US$204 per each dollar invested. The projected initial investment for Ecuador to develop the plan was US$100,000 per year based on the projected population in 1994 (136). In 1996, the DMFT index continued with the tendency showed in the previous epidemiological study of oral health (135), where schoolchildren have a DMFT index between 2.93 in the early years to 4.62 for teenagers of 15 years old (137).

The results from the national study of the natural content of fluorine in waters for human consumption of Ecuador's supplies published in 1996 showed that the country had six communities at the provinces of Cotopaxi, Chimborazo, and Tungurahua with high fluoride concentrations in water between 1.4 and 2.5 ppm. The Ministry of Health excluded the three regions from the national salt fluoridation program to decrease the risk of dental fluorosis in these communities (133).

Several studies have been developed after this study not for government entities, but for academic institutions to measure the fluoride concentration in drinking water. One of these studies found a high prevalence of dental fluorosis in rural parishes of Cuenca District (81 %) among 7-13-year-old children but detecting lower fluoride content in potable water (0,0-0,39 ppm) (138).

Other study evaluated the fluoride concentration in Tumbaco's Valley. This study found higher concentrations of fluoride in drinking water and a lower concentration in packets of salt and bottles of water (139). Other studies have been conducted on how to inhibit the fluoride ion in potable water (140), an update of oral health morbidity developed in 1988 (135) and 1996 (137), and one about fluoride exposure from other sources in 1996 (141), between other topics needed to update an epidemiological surveillance in a fluoridation program.

Peru

Peru had some government attempts to add fluoride in potable water at the end of 1957 with pilot experiences in small urban areas as Lima and Chimbote, located in the northern province of Lima (142). The country continued the attempts to implement a national fluoridated water program in 1973 with a massive pilot in the capital city of Lima, but this pilot only launched for 5 months, having logistical, technical and management problems in the central plant of water treatment "La Atarjea" located in the capital district of Lima (143).

The beginning of the salt fluoridation program in Peru goes back to the year 1982 when the Ministry of Health (MINSA) developed an initial study to evaluate the feasibility to establish a national salt fluoridation program in Peru with the international support of PAHO (144, 145). Posteriorly, in 1984 the President of the Republic and the Ministry of Health signed a supreme decree where the salt producer companies were forced to add fluorine, in addition to iodine (146). It was recommended in the same supreme decree that EMSAL state company would assume the monopoly of salt distribution at a national level (144, 146). In 1985 the salt fluoridation technical standards were approved, indicating the addition of 200 ppm of sodium fluoride +/- 10 % per

kilogram, starting the distribution of fluoridated salt for the Peruvian population (147). In 2006, a new update in the rule was approved to adjust the fluoridation program according to the international consensus on the topic (148).

In 1986, through another Supreme Decree, the National Oral Health Program and the National Oral Health Commission were created, composed by the most representative institutions in Peruvian Dentistry, to promote, among other things, the dissemination of the salt consumption fortified with iodine and fluorine (149).

Peru received in 1987 an initial financial support from the Kellogg Foundation for US$495,000 to support the implementation of its national fluoridation program (143). In 1988, a Ministerial Resolution declared the application and development throughout the country of the Massive National Program of Dental Caries Prevention through the use of fluoridated salt a priority and a public necessity (143).

The Pan American Health Organization (PAHO) and The Kellogg Foundation recommended carrying out two baselines and two complementary studies as part of the implementation of the program. The country should establish the status of dental caries and fluorosis in the country, the basal levels of fluorides in the potable water, the levels of fluoride excretion in urine in schoolchildren and the evaluation of other fluorides sources in the country with these four studies (144, 145).

The first national epidemiological study of dental caries carried out at the beginning of the program in 1990, excluding fluorosis and presenting methodological weaknesses, as the insufficient sample for age 12 years (143, 150, 151). The other three studies were not carried out, and it was one of

the reasons for the cancellation of approved funds by the Kellogg Foundation (143, 151).

Contemporaneously, in 1994 the state company EMSAL S.A. was sold transforming its name to Química del Pacífico Company, becoming as the primary salt producer with more than 60% of the national market, and facilitating the monitoring of the measures established for the national authorities (143). Nerveless, some reports show that Peru still having problems to regulate the existence and evaluation of salt producer companies, and the National Database of Sanitary Registration at the General Direction of Environment Health (DIGESA) has 17 legal companies and a large number of companies that do not meet the legal requirements (143, 145).

Peru has developed parallels programs at the same time as the salt fluoridation program implementation. A fluoridated milk program started in 1999 until 2004, and it was linked with a national strategy focused to 6-year-old children and called "a glass of milk" in a district of Trujillo City, funded by Borrow Dental Milk Foundation (152). The Milk was supplemented with 0.25 mg of fluoride and was prepared and distributed in the district's "mothers clubs" (143).

The last application cohort of topical fluorides in Peru, was developed for 24 years (1984-2008), with previous experiences from 1964, where a Fluorine phosphate acidified to 1.23% in gel form was used on the surfaces of the teeth in four different times of the life of the child (3,7,10 and 13 years old). This scheme, was developed as a complement to the mouthwashes program (153) and as part of the Lima Metropolitan Oral Health Program by the MINSA leadership, oriented to children of public schools and applied by dentists from the public health system and sometimes, by school teachers (152, 153).

Beginning the 21st century, Peru started a new stage of actions and studies to strengthen the National Salt fluoridation Program. The Ministry of Health (MINSA) through the General Direction of Epidemiology (DGE) in 2000 and 2001, conducted the second national epidemiological study of prevalence in dental caries, dental fluorosis and urgency treatment in schoolchildren from 6 to 8 years, 10, 12 and 15 years old (154). The results showed a national 10.1% of dental fluorosis prevalence and a decreased DMFT index of 5.59 in schoolchildren compared with the DMFT index of 7 in 1990 in the same population (144, 150, 154, 155).

Simultaneously, the Ministry of Health carried out between 2000 and 2001 a national chemical monitoring of water for human consumption, showing the presence of higher fluoride concentrations in five departments and 10 cities above the international standard (1.00 mg/l): Lambayeque (Chiclayo, La Victoria, Pacora, Picsi, Ferreñafe, Olmos), Lima (Canta, Los Olivos), Áncash, Huancavelica (Pasos-Tayacaja) and Andahuaylas (144, 156). This study had as primary result new national regulation for the use of systemic and topical fluorides in risk areas by the concentration of fluorine in water (157) and the standards for potable water establishing Maximum fluoride values (1.00 mg F-L-1 (158).

Complementary, Peru has a Health Technical Standard for the addition of fluorides in toothpastes, mouthwashes and others products used in oral hygiene since 2001, which establishes ranges of fluorine concentration expressed in parts per million (ppm), which must be included in the labeling of the immediate and intermediate containers of the creams, gels and mouthwash (159). The technical norm also includes how dental creams, suitable for children under six years, must have

a concentration of fluoride from 250 to 550 ppm. In older children six years and adults should contain concentrations of fluorides greater than 1100 ppm (157, 159).

Academic institutions have developed essential studies to complement the government surveillance efforts on the salt fluoridation program (142, 145, 160-171). The spectrum has been focused on fluoride concentration in drinking water (142, 160-163), fluoride concentration in salt (145, 160, 161-165, 168), dental fluorosis (163, 164, 166), prevalence and incidence of dental caries (163, 164, 166, 170), salt mapping in the market (165) and knowledge and acceptance of the program (145, 167, 169, 171).

The salt fluoridation program in Peru is active, but an updated epidemiological surveillance on this preventive program was not found in the review. Some activities and indicators have been developed across the years, but a current chain of coordinated actions to evaluate the effectiveness of the measure is not running, or it has not been published (172, 173).

South American Countries of the Kellogg Project: Venezuela, Bolivia, and Paraguay

During 1996 and 1997, the PAHO with the sponsorship of Kellogg Foundation, began the implementation of salt fluoridation programs in Bolivia, Dominican Republic, Honduras, Nicaragua, Panama, Venezuela, Belize, and Paraguay (1, 2, 46).

In 2000, the PAHO published a report to the Kellogg Foundation, about the status on the implementation of salt fluoridation programs in these countries with the foundation' sponsorship

(1, 47). The report included the initial evaluations of the fluoridation programs, as a base for a structured epidemiological surveillance system that was expected to be implemented during the first decade of twenty-first century in each country part of the Kellogg Foundation' sponsorship (1, 46, 47).

The initial results and the subsequent follow-up in their salt fluoridation programs during the Twenty-first century in all countries part of the Kellogg Foundation' sponsorship showed mixed results in coverage, quality, evaluation and subsequent influence on the DMFT index (46-52).

Venezuela

Venezuela began the implementation of a salt fluoridation program in 1993 when the government signed a National Executive Law defining the strategy to include iodine and fluoride in the salt for human consumption (174). The same year, the health authorities created the National Commission of Iodization and Fluoridation of Salt (CONIFLUSAL), having as principal functions to coordinate all actions of implementation and evaluation of a national program, and the coordination of responsibilities between the stakeholders, including the salt producers (175).

Nonetheless, Venezuela had not a recent history of baseline studies to begin a national preventive program and it was imperative to know the status of prevalence in dental caries, fluorosis or fluoride concentration in drinking water (176). The country developed an epidemiological study of dental caries in 1964 (177), a survey of dental prevalence in Ciudad Bolívar previous to the water fluoridation program in that locality in 1971 (178), and a study for the Integral Planning of Dentistry (E-PIO) developed in 1967-1972 by the division of Division of Oral Health at the Ministry of Health (179).

Venezuela had some previous efforts to implement water fluoridation programs since 1952 in the city of Guarane (State of Portuguesa) and 1972 in Ciudad Bolivar (formally called Angostura in the State of Bolivar) (180). In Contrast, some localities were detected with dental fluorosis in 17 endemic districts (Lagunillas, San Timoteo, Tropezon, Tomeporo de Agua, Bocono, Ceuta, Guillen, San Carlos, San Joaquin, Mariana, El Palito, Morón, Urama, Marín, Cocorote, El Guarataro and Cerro Los Cachos – La Guaira) located in the states of Zulia, Carabobo, Yaracuy and the Federal District, linking with the excess of natural fluorides in drinking water (176, 180, 181). All these localities were connected with geographical zones with drinking waters containing high levels of fluorine naturally as in Lagunillas in the state of Zulia (176, 181, 182). In 1958, it was calculated that to implement a water fluoridation program in the capital city of Caracas, which used about 300,000 cubic meters of water daily for that epoch, 500 kilograms of sodium silicofluoride would be required and cost about 400,000 bolivars annually (180).

In 1996, Venezuela was funded by the Kellogg Foundation to analyze the status of the salt industry, the coverage of oral health care services, and the cost-benefit study about the viability of the program. They continued with an examination of fluoride concentration in drinking water and a National Oral Health Survey approaching DMFT and dental fluorosis (46). The Health authorities also completed the second part of actions developing a study of fluoride supplements and toothpaste, the first assessment of fluoride excretion in urine. Finally, the authorities defined an initial task force designing the initial recommendations on fluoride concentration in salt for the country, as baseline of the country surveillance systems for fluoride (46, 176). The DMFT reported in the CAPP System in 1997 was 2.1, compared with 3.6 in 1986 (15).

In 1999, Venezuela began a new political stage redefining the budget assigned to public policies, including public health. In 2005, Venezuela's salt industry was considered to be mature and described as one of the best examples of the region, because it had a good network of 3 crude salt producers, 14 processors and distributors, high levels of efficiency and with consistently high product quality (183). Large processors were Sal Bahia, and Tecnosal, medium and small processors were Alesca, Molisoca, and Indulsalca, with an average capacity among all of 450,000 ton per year (183).

After the initial stage of the program stated in 1993 and implemented in 1996, the country has not had a new round of baseline studies by official entities (184). The authors did not find evidence of a surveillance system, subsystem for a fluoridation program or for oral health morbidity. Some reports affirm that the country is having problems to produce its primary national salt consumption, for which reason it has resorted to salt imports in recent years, but this has not been enough to cover the domestic use of the country (185).

The virtual access to academic institutions or research centers in Venezuela to follow new publications related with the salt fluoridation program was difficult for the authors, only being able to include five studies developed in the states of Carabobo, Vargas, and Zulia (186-190). The focused on the fluoride content of commercial salt brands showed that the majority of brands had a concentration of 60 to 90 ppm of fluorine (188). In the studies focused on prevalence of dental fluorosis the findings were worrying because the different populations approached had 51.7%, 79.04%, 75.6% and 98.6% of dental fluorosis with 22.5% in severe stages (186-190), 97.5 % of children between 3 and 5 years used toothpaste for brushing with fluoride concentrations between

1000 and 1100 ppm (186), and the association between fluorosis and source of drinking water was significant (proportionality ratio 26.1) (187).

Regarding the origin of water, the researchers observed in the State of Zulia, town of Baralt, that 51.7% of children and adolescents consumed groundwater and 23.6% come from aqueducts (189). Concerning the state of teething was noted that 24.4% of the evaluated children had healthy teeth, 57.9% were free of caries, which 26.9% of them have between one and two decayed teeth (189). The concentration of fluoride in drinking water was 1.58 ppm, having a direct relationship between its level with the incidence of fluorosis in temporal dentition (190).

Bolivia

Bolivia initiated its efforts to establish the salt fluoridation national program in 1994 developing several feasibility studies in collaboration with PAHO (191, 192), receiving several funds from Kellogg Foundation and World Bank assistance and the local support by Rotary Club Tunari of the city of Cochabamba (46, 193).

Several studies were carried out in Bolivia that allowed knowing the situation of oral health (192), the concentration of fluoride in water as indispensable elements and a survey of the status of the salt companies to initiate the fluoridation program (193). Other studies were conducted to measure the fluoride concentration in dental toothpaste and fluoruria (194) and the feasibility of the program (1,46).

The feasibility study showed that the potential national coverage with fluoridated salt defined the annual salt consumption per inhabitant was approximately 3.65 kg (10g per day per person),

estimating the consumption for 7.2 million inhabitants to 1994 and the production cost on 15,000 tons in about US$ 1.57 per ton or US$ 0.0016 per kg (1, 185). The oral morbidity study showed a lower DMFT of 4.7 compared with 7.6 of DMFT in 1981 (15). The study evaluated the fluoride concentration in the country showed that five regions of the country (Beni, Chuquisaca, La Paz, Potosi, Santa Cruz) had higher or equal concentrations to 0.9 mg/l. The provinces with higher concentrations and required epidemiological surveillance were: Andres Ibanez, Cordillera, Florida, and Manuel Caballero (1, 46, 194).

A national resolution was published by the National Secretary of Health in 1996, declaring the salt fluoridation as a national priority and defining the minimum standards to develop the program (195). During the first stage of the program implementation (1996-2002), the national health authorities subsidized the delivery of 10 packages of salt per month to every family with infants per month, to promote the consumption of fluoride salt in vulnerable populations (193). There is no evidence of any study evaluating the effectiveness of this annexed strategy with the salt fluoridation program (192, 193).

In 2002, the salt fluoridation program in Bolivia presented several problems and the partnership between the government and salt producers, and only one company was following the rule to add fluoride in salt, but with a concentration below the dose recommended by PAHO (193). To 2014, only six salt producers had implemented the rule and are located in the Capital City of La Paz and the same year was validated the law of Epidemiological Surveillance of Transmittable Diseases by Foods to implement it at the national level. This rule included the option to evaluate the fluoride concentration in salt (196), but there is no evidence of a surveillance strategy to assess the quality

of fluoride salt in the country, or new epidemiological studies to evaluate the national salt fluoridation program in Bolivia (197).

In 2010, the government published the Oral Health National Rules, only including the concept of the salt fluoridation program as part of the prevention and promotion conferences to be delivered to communities linked with public hospitals to improve their oral health literacy about the benefits of the fluoride salt in the dairy consumption (198). The report in 2010 included different DMFT index in its provinces, as 3.96 in Carraco Tropical, Capinota 1.83, Chapare 5.58 and Tapari 2.10. The report continues showing a high prevalence of dental caries as the tendency reported in 2006 where the national DMFT index was 6.68 (199) and the observed DMFT from 2 to 4 in some academic studies (200).

Paraguay

The first history of fluoridation in Paraguay begins with some efforts in water fluoridation at the beginning of 1959 at the capital city of Asuncion, Paraguay (201). This effort started at the same time that the capital city enjoyed a public water system, inaugurating a modern plant with an installation capable of including fluoride within the drinking water (180).

Some reports of dental fluorosis were reported during the following years in Asuncion, whereby the water fluoridation strategy was canceled after different concerns expressed by dental professionals (202, 203). Misinterpretations or misconceptions about fluoridated salt and its link with increased salt consumption were a constant among health professionals in Paraguay (202).

In 1997, Paraguay was included within the countries granted by the Kellogg Foundation to develop

baseline studies before to implement a national salt fluoridation program (1). According to the report by countries delivered to the sponsors, the country achieved to develop the studies related to the status of the salt industry, cost and benefits of the program, DMFT and dental fluorosis survey, oral health services, and fluoride concentration in drinking water (46). Only ten years after, in 2007 the Ministry of Health approved a resolution to develop a new Oral Health Survey in 2008 (204).

The reported DMFT was 5.08 in 1996 followed by a new dental survey in 1999 where was 3.83 (1, 205). Previous morbidity studies in 1983 and 1987 showed 5.90 and 4.02 of DMFT, but it was not clear the used methodology for these years (205). The reported four regions in 1999 with high levels of fluoride in drinking water were Paraguari, San Pedro, Alto Parana, and Concepcion, and the samples were collected with the collaboration of the National Service of Environmental Sanitation (SENASA) (205, 206).

The collected samples to determine the fluoride concentration in drinking water in a national study developed in 2008 were analyzed in the laboratories of Ministry of Health, and the results indicated that only one sample from Ciudad del Este had more of 1.0 mg/l (206). However, a study developed in 2011 reported that fifty percent of the studied children presented some degree of dental fluorosis, and the category most frequently observed was moderated (1/3 of the sample) and the localities that showed more cases of dental fluorosis was Loreto and Yatayty del Norte (207). Additionally, in 2018, a joint effort between the Ministry of Health, the Multidisciplinary Technologic Research Center (CEMIT) and the National University of Asuncion (UNA), found high levels of fluoride in drinking water at the Guaira Region (203).

The results in 2008 were not comparable with prior surveys, but the reported DMFT index was 1,96 in the region I and 4,87 in the region VIII (206). In 2008, the findings related to enamel fluorosis indicated that the fluorosis index calculated was low 0.17 and this condition was not a Public Health concern (206).

Even though initial efforts were made to implement the Salt Fluoridation Program in Paraguay, this strategy did not succeed, and still not included in the legal framework of the country (208). Currently, there is no information about the current state of the salt fluoridation in the country or about the problems that the authorities faced not to achieve its implementation (206).

Brazil

Brazil started the fluoridation of public waters in October 1953 in the city of Baixo Guandu, State of Espirito Santo by the Special Services of Public Health (SESP) (209). This city had a high average temperature, whereby only 0.8 ppm of sodium fluosilicate was added to the waters after an analysis of the hydric sources that showed the fluorine concentration was low with an average of 0.15 ppm (180). In 1956, the government developed a feasibility study where they found that cost of water fluoridation program was estimated at 3.10 cruzeiros or around two cents of American dollars per inhabitant per year (180).

After Baixo Guandu, the water fluoridation program was implemented between 1957-1959 in the cities of Palmares (Pernambuco), Marilia (Sao Paulo), Curitiba (Paraná), Taquara (Rio de Janeiro), Guaiba, Santa Maria and Montenegro (Rio Grande do Sul), cities with similar temperatures than Baixo Guandu. In 1958, followed studies were conducted evidencing a DMFT reduction around 21-2 8% compared

with a prior study in 1953 developed before the implementation of the program (180, 210).

In 1974, Brazil approved a law determining the addition of fluoride in potable water in the localities that had treatment stations (211). In 2004, the government issued a national ordinance establishing the procedures and responsibilities relating to the control and monitoring of water quality for human consumption, the standards of potability and determining the maximum permissible (VMP) of 1.5 parts per million (ppm) for fluoride (212). Posteriorly in 2011, the Ministry of Health issued a resolution establishing the minimum standards and the mechanisms of surveillance and quality control to delivery potable water in all cities of the country (213) and defining the maximum level to add the fluoride ion in 1,5 milligrams per liter of water (mg/l) (214). The program has been established as a priority for the Oral Health Nacional Policy to prevent dental caries, requiring an epidemiological system on the program to evaluate the effectivity (214, 215).

Only 63 % of the Brazilian cities in 2005 fluoridated their public water supply and covering 100 million people or 53.0 % of the Brazilian population. The local or federal governments are not in charge of the network of water treatment plants, and this context has generated a difficulty trying to obtain data about the fluoride concentration used by the private companies in the water treatment plants (214, 215). However, several studies developed by Academic institutions from 1992 to 2011 warn fluctuation of fluoride levels in the waters of reinforcing the need for the implementation of the of surveillance systems (216-220). In 2005 researchers from the Federal University of Rio Grande and the Lutheran University of Brazil, evaluated the control of fluoride in public water supply in the Brazilian capitals. The researchers found that the fluoride levels in the waters were not added correctly, and only 30% of the network carried out the steps of collection, analysis, and

publishing of fluoride parameter to report to the nascent Water Quality Surveillance for human consumption (VIGIAGUA) (216).

The Environmental Health Surveillance Program related to water quality for human consumption (VIGIAGUA), member of the National Subsystem of Environmental Health Surveillance was implemented in the year 2004 (221). In support of this surveillance program, the Information System of Water Quality for Consumption Human (SISIGUA) was created in 2003, which includes specific fields for recording fluoride analyzes (222).

The expansion of new 206 water fluoridation systems since 2003 in eight states have been implemented based in the Oral Health Policy of the Ministry of Health called “Brasil Sorridente” or Smiling Brazil (216). The National Oral Health Policy or "Brasil Sorridente" was established in 2003 to guarantee actions for the promotion, prevention, and recovery of the oral health of the Brazilian population. Additionally, this oral health policy defined to expand the access to free dental treatment through the Unified Health System (SUS) and having as main lines of action the reorganization of primary care in oral health, expansion of the specialized attention, health in school program, national plan for people with disabilities, professional and scientific qualification and fluoridation of public supply waters (223).

Complementary, the country has a national regulation to define the maximum total fluoride that a tube of toothpaste may contain (0.15 %, 1,500 ppm F) but not the minimum concentration of soluble fluoride products in cosmetic products as dental toothpastes (224). Therefore, according to several researchers from the Campinas State University promoting the need to regulate fluoride

toothpaste and review the efficacy of those products for caries control (225). The authors found no evidence of salt for human consumption with fluorides addition in Brazilian territory.

Several researchers in the country continue to ask the authorities for better monitoring and control of fluoride levels in water supply, bearing in mind that water intake increases in areas with high temperatures and Brazil still being a tropical country with high temperatures (214).

Argentina

Argentina started its first water fluoridation program in September 1957 in the metropolitan area of Buenos Aires, under the legal framework signed by the local government. They authorized an initial investment of 8 million Argentine pesos for the necessary equipment for water fluoridation and the acquisition of fluosilicic acid for its economy because the estimated cost was one centavo for each cubic meter of water (180). For 1959 the financial difficulties and bureaucratic resistance forced the metropolitan authorities to postpone the plan, until 1974, when the representative board of the city signed a resolution to implement the water fluoridated water program in the city (3).

The second effort to implement a fluoridation program in Argentina was launched by the Ministry of Health in the Province of Buenos Aires, first in the capital city of La Plata and after, in two small neighboring towns, Ensenada and Berisso, beginning in April 1958 (160). The initial plan had as scope two industrial cities with working-class populations, but the program was not inaugurated for the same reasons explained in the first attempt (3).

The third effort was initially approved by the government of the Province of Santa Fe in January

1959, and after ratified in January 1960, to provide public water fluoridation for the cities of Rosario and Santa Fe (160). One million pesos were approved for the initial works, and the requirement to have the assistance of the National Administration of the Waterworks. Only ten years later, in 1969, the Province of Santa Fe and its City of Santa Fe, began the official fluoridated water program, becoming to be one of the first cities in Latin America to make this measure effective and specify a yearning of the health authorities and the entire community (3). The program in Santa Fe lived several interruptions from 1969 to 1994, until the program was included in a national oral health prevention program (3).

In 1975, a first national law was enacted under the leadership of the Department of Oral Health of the Health Promotion and Protection Division, providing the basic standards as the addition of sodium silicofluoride in all water treatment plants of the country to implement this public policy of prevention in partnership with the National Public Water Fluoridated Program (226). In 2007 the National Code of Food included the Chapter XX related to the potable water, including a specific article regulating the concentration of fluoride to be added according to the average temperature in each city (227).

The national fluoridation program in Argentina has suffered several interruptions since 1975, the majority for bureaucratic and financial reasons (228). For several years, the program was interrupted in the whole nation from 1990 to 1994 because of the hyperinflation crisis (3, 228, 229). In 1994, the province of Santa Fe and other provinces resumed the program, as part of the National Dental Caries Prevention Program lead by the Ministry of Health of the Nation, including more cities as Rosario, Villa Gobernador Gálvez, Granadero Baigorria, Reconquista and restarted

it in the city of Santa Fe (3, 228, 230).

Again in 2007, the provision of salts in the whole nation by the Ministry of Health of the Nation was suspended, until 2011, when the Federal Board of Health (COFESA), allowed restoring the provision of fluoride to all provinces, which is in charge of the nation which imports it from frontier countries (228,230).

Currently, the country is living a new economic crisis that could affect the integrity of several programs, including the water fluoridation program. On the one hand, the latest National Oral Health Program 2018-2030 was approved in 2017, which does not contain any link with the water fluoridation program or a project to develop baseline programs as part of a surveillance system to evaluate the water fluoridation program (231).

On the other hand, in September 2018 the national government degraded the Ministry of Health to be a secretary annexed to the Ministry of Social Development, losing much of its budget, activities, functions, information system, virtual access to official web pages, and currently is not clear if the country will live another interruption of the water fluoridation program as it happened in previous times (232).

Uruguay

In October 1958, the Departmental Advisory Committee of the city of Montevideo asked the mayor of the city of Buenos Aires for advice on water fluoridation that might be used in the installation of a system in Montevideo (180). The Argentine Ministry of Public Health sent all the pertinent details to Uruguay, but the costs were not able to be assumed by the Government of Uruguay (180).

The local authorities continue searching options to implement a national preventive program to decrease dental caries, until 1990, when the National Executive issued a decree establishing the National Salt Fluoridation Program. The Decree included the basic standards to develop the program, including the minimum content at 250 mg/kg F to be followed by local salt producers, who made most of the initial investment for the program (1, 233).

In 2001, the Ministry of Health approved a special ordinance to create a new advisory task force to work on different options to improve the salt fluoridation program at the national level. This advisory team could support about the possible rules for fluoride salt imported from bordering countries and enhance the understanding by the public and dental professional about the benefits of the program to the Uruguayan population (234). In 1998, the national government approved the minimum requests for salt importers (235).

The National Oral Health Plan was published in 2008 and within the strategic guidelines as a national strategy "to define the strategic lines linked to the promotion and prevention of oral health at national level, especially, the status of the salt fluoridation program and to establish an epidemiological surveillance in the salt fluoridation program" (236). The plan had quite similarities with the one issued in 1997 (237) but is not evidence that the country has implemented a surveillance system on the salt fluoridation program or has developed some morbidity studies to measure the impact of this preventive program in the country, or, any update in the legal framework (238-240).

Chile

The history of the water fluoridation program dates back to 1953 in the city of Curico, a small town near Santiago and a fluoride concentration in water of 1 mg/l was used (180). Curico was chosen as a pilot city to intervene and San Fernando as a control city, to develop the baseline studies to test the effectivity of the pilot (241). The results of this pilot showed a 48 % of DMFT reduction in the pilot city, empowering Talca, Punta Arenas, and Población Dávila to begin the feasibility studies to implement the program too (242).

The Dental Department of the Chilean National Health Service decided to begin a national fluoridation plan which was expanded in 1958 to 73 communities, covering 58 % of the country, using international funds, and excluding the northern provinces where the water contains from 0.2 to 0.8 ppm of fluoride in water (243). In 1973 the country lived a coup following an extended period of social and political tension, and in 1977 the national fluoridation program was suspended due to the lack of resources to be obtained by the National Health Service, calculated annually in 329 million Chilean pesos and faced several barriers by local authorities to import and to have enough fluoride stock to continue the program (180, 242, 243).

The National Potable Water Fluoridation Program has been implemented progressively in a second stage since 1985, in areas where the level of natural fluorides in water is less than 0.5 mg/l (244). Currently, 72 % of the total population and 83 % of the urban areas has access to fluoridated drinking water (245). In 1985, a water fluoridation pilot in the Valparaiso Region started with national resources. After a favorable evaluation in 1996, the metropolitan region and other regions began to be gradually fluoridated (246).

A study of oral health in children aged 6 to 8 years and adolescents of 12 years was carried out during the years 1996 and 1997 in parallel with the beginning of the expansion of the water fluoridation program (247, 248). The study included all the regions of the country except for Valparaiso, whose study was carried out in 1999 (248). These studies were developed through an agreement of the Department of Dentistry of the Ministry of Health with the Faculty of Dentistry of the University of Chile and are part of the Epidemiological Surveillance Program of caries and fluorosis (249).

For the implementation of the program, the Ministry of Health defined the optimum concentration of fluoride in water for each region, based on national epidemiological studies and environmental temperature, to achieve the objectives of caries prevention, minimizing risks (244). The surveillance of fluorides in water contemplates the daily measurement of fluoride concentrations in fifteen of the sixteen regions of the country in which this measure is implemented, with the exception of the Bio-Bío region, selected as control group by the authorities in their different efforts to implement the program at national level (245). This Surveillance is under the standardization and control of the National Superintendence of Sanitary Services in Chile (SISS), which summarizes the chemical analyzes sent by various sanitary laboratories in the country (245, 250). One of the latest reports of Fluoride concentration in water at the national level by the SISS showed adequate levels of fluoride in drinking water in all intervened regions (243).

The academic institutions have been involved in this program contributing with studies to support the surveillance and analysis of this public policy in the country. In 2016, a new study was carried out to evaluate caries damage in a population under 13 years of age and its relationship with the concentration of fluoride in drinking water, using information from national oral health diagnoses

in children aged 2, 4, 6 and 12 years in 2007, 2009 and 2010. The results showed the positive impact of fluoridated water decreasing the prevalence of dental caries in younger populations, similar results of a study in 2010 (251-253).

Complementary, Chile has included other programs to increase the consumption of fluoride in selected populations that live in rural areas or have difficulties of potable water access. The government legally established the National Complementary Feeding Programme (PNAC) in 1987 with a national coverage achieving 90 % of the target population (253-254). Under this program, every Chilean child could receive 2 kg of free powdered cows' milk per month from birth until age two years. After that age and until six years, the child could be eligible for 1 kg of milk–cereal product per month (254).

From 1994 to 1999, the Institute of Nutrition and Food Technology of the University of Chile began a trial in Codegua and La Punta, two rural communities to establish a program to assess the feasibility of using PNAC products as a vehicle for disodium monofluorophosphate, with bioavailability to be derived in fluoride at milk were undertaken (254). Results obtained after four years of milk fluoridation indicated that it was possible to reduce the prevalence and severity of dental caries in the primary dentition, especially in those children either born after the start of the program or aged around one year when it started. The authors recommended the extension of milk fluoridation to other rural and semi-rural areas in Chile where water fluoridation was not technically feasible (255-256).

The Guianas

French Guiana is since 1981 the only territory of the mainland Americas that is still part of a

European country when Belize became independent. The projected population in this country for 2018 was 283,000 where around 10% still without access to drinking water (257). The country confronts continuous endemic situations where waterborne diseases as Typhoid fever, cholera and dysentery are widespread, alerting the French High Council for Public Health has been issued, about the conditions for improving water supply in Guyana (258).

Efforts to improve the access of drinking water have been realized during the last years (259, 260), but is not evidence that the implementation of any water or salt fluoridation program has been included, updated or resumed within the improvements of the treatment's plants in different cities and villages of the country (258-260).

Guyana has a population of 778,000 and Suriname 563,000 (261), and according to with a PAHO report, the two countries were planning to import fluoridated salt scheduled at the end of 2001, since the two countries have not had installed infrastructure to produce their salt al local level (47). The plan to import fluoridated salt was defined by the two countries, as a strategy to support the preventive actions to decrease dental caries in vulnerable populations (1).

In 2014 during the Caribbean Oral Health Initiative Summit, the implementation of a salt fluoridation program was included as one of Guyana's future priorities to achieve within the Oral Health Program in the country but in the internal market, the families have access to buy imported salt with or without iodized or fluoride salt (262). Meanwhile, the latest assigned budget in oral health and public health programs approved by the Suriname government did not include any financial plan in a salt fluoridation program or quality surveillance strategy on imported salt with

added components as fluorine (263). No evidence was found about a legal framework in any of these countries about minimal requests for importers about fluoride or iodized salt.

English Speaking Caribbean Countries

In 1990, according to the World Health Organization publication, the only country in the English-speaking Caribbean sub-region that was enriching the salt for human consumption was Jamaica (264). All these countries have consolidated various alliances or partnerships to improve their commercial activities or public policies, working together with regional agreements (265-267).

The Caribbean Community (CARICOM) is an organization of Caribbean nations and dependencies whose main objective is to promote economic integration and cooperation among its members, to ensure that the benefits of integration are equitably shared, and to coordinate foreign policy (265). The CARICOM Community includes Anguilla, Antigua, and Barbuda, Barbados, British Virgin Islands, Bahamas, Cayman Islands, Dominica, Grenada, Guyana, Jamaica, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad & Tobago. The Jamaican fluoridated salt is available to all Caribbean Community countries and territories through a regional trade agreement (266).

The Oral Health Goals for the Caribbean published by the Eastern Caribbean Countries (ECC) office at the PAHO in 2007 defined 4 Strategic Goals within which no reference was made about the implementation, strengthening or follow-up of salt fluoridation programs in the Caribbean region. The countries part of this Eastern Caribbean Countries (OECC) Office, which was established in September 2006 are: Anguilla, Antigua and Barbuda, Barbados, British Virgin

Islands, Dominica, Montserrat, Grenada, Saint Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines, French Guiana, Guadeloupe and Martinique (267).

In 2005, The PAHO published a document reporting the planning or initial feasibility of several programs at the Caribbean region, but it was not possible to find evidence about the implementation or evaluation of salt or water Fluoridation programs in any of the 15 English speaking Caribbean countries part of CARICOM or OECC, with the exception of Jamaica, country that has established a Salt Fluoridation Program since 1987 (183).

Jamaica

The Salt fluoridation program started in Jamaica at the beginning of 1987, after the Ministry of Health and the Parliament of Jamaica worked for the preceded three years to define the legal framework to implement the program. Additionally, the legal framework adopted the recommendations from the Regional CARICOM resolution issued in 1977 by the Caribbean Ministers responsible for health about the use of potassium fluoride in salt fluoridation programs at a concentration of 250 mg/kg (265). The approved rule was issued in 1986 based on previous urinary excretion, fluoride in water concentration, household salt consumption and oral morbidity studies with technical assistance from the Pan American Health Organization (PAHO) (268).

Previously, Jamaica tried to implement a water fluoridation program in Kingston, when the capital city was the only city in the country with a regulated water system in the 1970s, although fluoridation equipment was purchased, the system was never implemented due to operational costs, and only one salt producer had the national authorization to be active in the country (269).

In 1984, a survey of oral health reported a lower fluoride in water, the average of household salt consumption and a high incidence of dental caries in children above 6.7 at age 12 years using DMFT index (183). Eight years later, a national oral health survey was conducted comparing the results with a previous study developed in 1984, showing a significant decrease in dental caries, a lower dental fluorosis, confirming the reductions in oral morbidity and having as differential factor the salt fluoridation program implemented in 1987 (270).

Jamaica only has one salt refinery, which was involved since 1985 in the possible implementation of the program, and previously was in charge of the iodized salt since 1962 (47). Alkali Inc. usually buys raw sea salt from nearby islands and after the refinery export the processed fortified salt with iodine and fluoride to all Caribbean countries (145). Equally, the fluoride toothpaste had been available in Jamaica since 1972 as a preventive measure, but different studies linked the reduction of the dental caries prevalence I the country with the implementation of fluoridated salt (1, 271, 272).

In 2006, a study approached to evaluate caries and fluorosis experience in Jamaica among 789 children in two different age groups in St. Elizabeth, a city identified in 1999 with a high prevalence of dental fluorosis. The results indicated a notable reduction of dental caries for 6-year-olds compared to 1999 results. Fluorosis prevalence was high in 6-year-olds, and it was recommended a surveillance program to evaluate the use of fluorides from multiple sources (271).

In 2008, a study was launched to evaluate the urinary fluoride concentration in children of two urban and two rural areas of Jamaica, following the parameters based on WHO guidelines. Almost

all children within the study reported consumption of fluoridated salt and the use of toothpaste with fluoride concentration from 600 to 1000 ppm F.

The results showed a sub-optimal exposure of fluoride, whereas concentrations would suggest an optimal or slightly higher intake. The recommendations of the researchers were focused on to minimize the risk of dental fluorosis offering in the local market dentifrices with 500 ppm F (272).

It was not possible to find documents, reports or studies by local authorities after 1999, to show an implemented national surveillance strategy to evaluate or improve the Salt fluoridation program in the country.

Caribbean Country of the Kellogg Project: Dominican Republic

Dominican Republic was the only selected country in the Caribbean region by PAHO and Kellogg Foundation in 1996 to support the advanced implementation of Salt Fluoridation programs (1, 46). The 2000 PAHO report also called "The Kellogg Project," related to the Dominican Republic included the evaluations by the local authorities to improve the salt fluoridation program, and the real stage on the structuration of epidemiological surveillance system with the Kellogg Foundation' sponsorship (46, 47).

The country included within the baseline studies the status of the salt industry, the morbidity in oral health (273), the costs of oral health services (274), and the fluoride concentration in drinking water (275). Additionally, the health authorities included the assessment of fluoride excretion in urine, the study of fluoride supplements and toothpaste, the development of technology in the salt

industry, and the structuration of country surveillance systems for fluorides (47).

The country has had iodized salt since 1996 under the legal framework approved in 1995, but the country reported the importation of salt from Venezuela, Ecuador, Colombia y Jamaica, due to a limited infrastructure for salt production in the country (47).

The country had a salt industry located in the Province of Barahona, in the south of the Dominican Republic. According to local authorities, the country could produce enough salt to supply the country, but the inefficient management by the local mining industry derived in a legal resolution to close this branch. In 2015, the constitutional court decided to close all salt mines in this province and open the salt importation from neighbor countries that could be considered less expensive than national production (276, 277).

No evidence of surveillance activities from the National Health Services (SNS) or linked institutions to control the quality of the imported Salt, or about a national legal rule to request the fortification of micronutrients as iodide and fluoride in the imported salt or following studies after the studies developed in 1997.

Haiti

In 2005, it was reported that the population in Haiti had not access to fluoridated salt but iodized salt, without any legal framework to request minimum standards to control or evaluate the food addition of micronutrients (47). Lymphatic filariasis (LF) is present in 118 of 140 communes of Haiti, making 84% of the country a potential risk zone. Adding iodine via fortified food-grade salt in highly endemic region

is an effective method to halt LF transmission, and since 2006, the Haiti Salt Program has been producing and distributing iodized salt marketed as "Bon Sel Dayiti+," which translates as "The Good Salt of Haiti" and the pricing is competitive with unrefined local raw salt (278).

In 2015, it was inaugurated a new Haitian salt processing plant in the locality of Delmas in the Port-au-Prince metropolitan area. This plant was implemented to produce clean and iodized salt in an effort to eliminate lymphatic filariasis and iodine deficiency disorders in Haiti through fortified salt, and to achieve iodine standards, because Haiti was the only country in the western hemisphere without it to 2015, according to the NDHP salt project director Jim Reimer (278, 279). It was a two-year project implemented by Cargill Salt from Minnesota and manufactured by Southwest and Associates from Kansas (279).

This new salt processing plant was a result of a great partnership between the Haitian Ministry of Public Health and the Population (MSPP), the University of Notre Dame Haiti Program (NDHP), and the Congregation of Holy Cross It was no evidence or updated information about a plan to add fluoride in this "Bon Sel Dayiti+" or "The Good Salt of Haiti" (280).

The status of oral health in Haiti is limited and complicated. The country has not a dental representation at the Ministry of Health, and the average of new graduates in dental schools is 25 per year, reducing access to dental care services. Dental services are severely limited by cost and coverage because the majority of Dentists are located in the capital city of Port-au-Prince, and rural areas suffer a significant shortage of dental professionals, existing only "extraction sites" or facilities failing to meet basic standards (281).

It was not evidence of national oral health surveys developed by the Haiti health authorities during the last 20 years. Nevertheless, a dental caries survey was conducted in 1999 using Basic Oral Health Survey (BOHS) showing as main results that permanent dentition caries in youth population was a minimal health problem, compared with other Caribbean countries, but the majority of children with DMFT above 1 did not have access to dental services (282). Complementary, Haiti has several academic studies approaching the concentration of fluorides in hydric natural resources (283, 284).

The first study in 1999 evaluated the concentration of fluorides in the hydric resources showing high levels of fluorides in the Southcentral Hydric Region, but not in the Metropolitan Region of Port-au-Prince. These suggested to take advance about a large number of inhabitants in the capital city (almost 10% of the total country population) to develop a water fluoridation pilot by the Metropolitan Autonomous Central of Potable water (CAMEP) (283).

Another Study in 2003 assessed the risks generated by chronic exposure to high fluoride concentration in drinking water from alluvial aquifers in four localities: Luly, Williamson, Titanyen, and Lafiteau. The researchers found high environmental risks according to the collected samples, recommending the increase of water samples for future studies to confirm these initial results (284).

Cuba

In 1958, Cuba launched a study on the fluorine content from 209 sources of water supply in 6 of its 15 provinces, and the results showed that the fluoride concentration was less than 0.3 mg/l in

more than 90 % of the sources. The maximum concentration of 0.4 mg/l was found in two towns in the province of Havana, two in Las Villas and four in Camagüey (285).

Ten years later, in 1968 the National Urban and Rural Hygiene Group continued and expanded this research, mainly in public supply sources. The study covered all the provinces and all sources finding similar results from the previous review, where the fluorine content in most sources was lower except for highest concentrations of fluorine found in the localities of Camagüey, Holguín, and Guantánamo (286).

After a feasibility analysis, the government started the water fluoridation program in 1973 in "La Salud" village in Havana Province benefiting around 5,300 inhabitants (287). Following this trial, from 1975 to 1978 the Cuban government in conjunction with ONU and UNICEF expanded the water fluoridation program in 10 villages of the Habana, Pinar del Río and Villa Clara provinces and the Capital City of Habana reaching more than 200,000 inhabitants (287). A third stage was projected to cover 60 % of the urban population in the island between 1981-2000, but the option to reach rural communities with a salt fluoridation program changed the initial plans (285).

After several gaps, the projected salt fluoridation program was resumed in 1996, when the Ministry of Health (MINSAP) requested the feasibility studies by the National Stomatology Department to implement the National Fluoridation Program for Human Consumption Salt, with the PAHO support.

In 1997 the country developed the baseline studies about the costs of the program, the fluoride concentration in drinking water, the morbidity in oral health and the structuration of country surveillance

systems for fluorides. The program of fluoridation of salt for human consumption in Cuba was initiated in 2002, and its distribution began in the Eastern provinces and the City of Havana (288).

At the same time, Cuba carried out since 1968 the first massive preventive actions with the execution of the mouthwashes ("buchitos") of sodium fluoride to all primary school children. They started with the provinces of Villa Clara and Havana, and it was extended to the whole country, to be applied later in secondary education and more recently in pre-university and technological institutions (289). Some researchers have linked this “buchitos” mouth rinsing national program with positive incomes in the DMFT index of children and adolescents, after the cessation of water fluoridation in 1990. The percentage of caries-free children was increased from 26.3 % in 1973 to 61.6 % in 1982 and extraordinarily maintained in 55.2% to 1997 (290).

A publication in 2004 showed similar results from the study of 2000, about the evolution of the state of oral health with a decreased DMFT index tendency at 12 years of age after any fluoridation strategy implemented in the country (19, 290). All these results were based on studies developed before the implementation of a salt fluoridation program but justifying the application of any program to increase the impact on vulnerable populations, especially children and youth. A new transition of power in the government began in Cuba in 2006, and the authors were able to find only a protocol defined to perform all steps and stages defined to run a surveillance system in a fluoridation program by the health authorities, but the authors of the present study were not able to find any update information about DMFT index in several populations after the implementation of salt fluoridation program in 2002 or any feedback about the Surveillance system (19, 291).

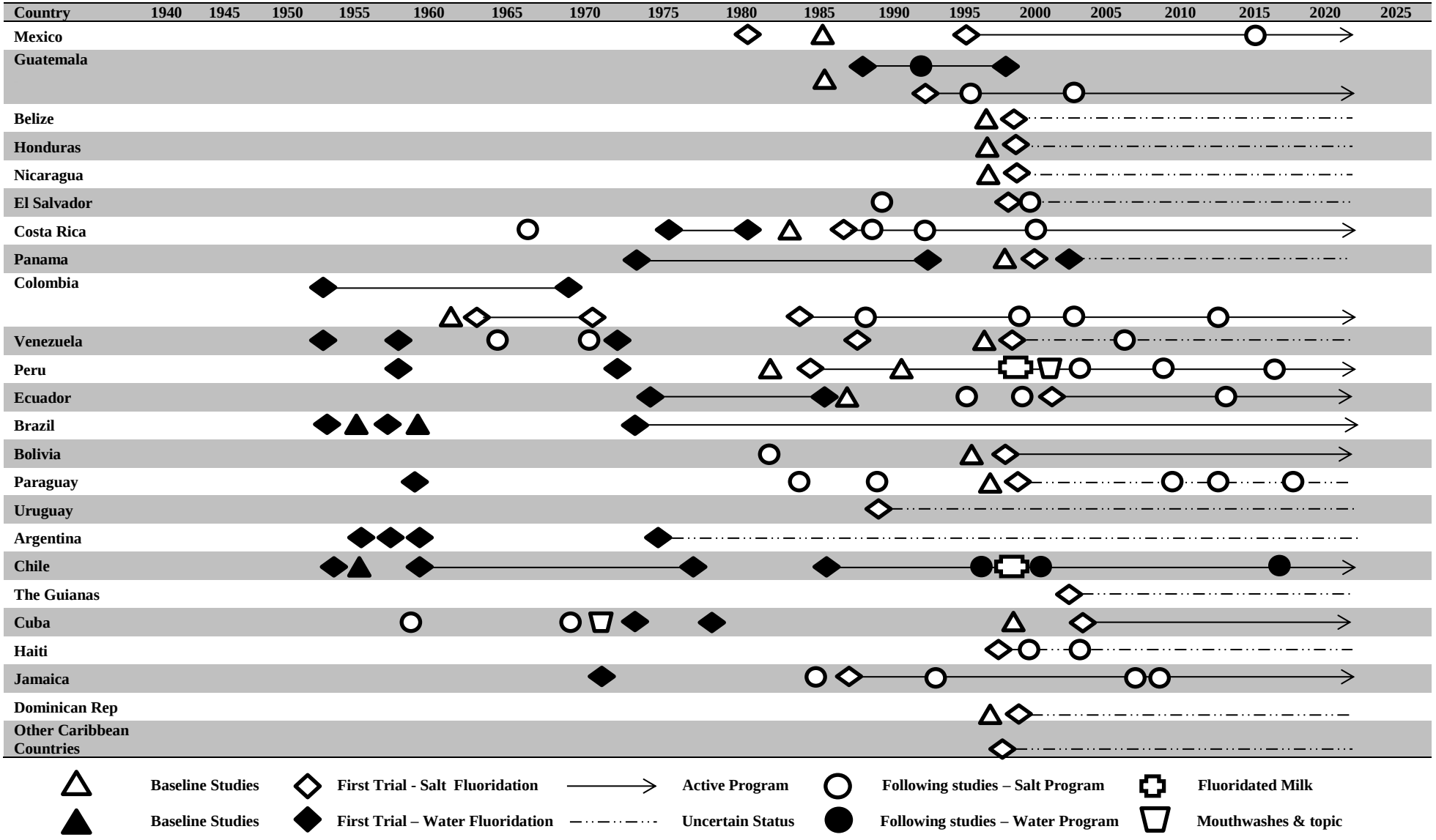
TABLE 1
STATUS OF THE FLUORIDATION PROGRAMS IN LATIN-AMERICAN AND CARIBBEAN COUNTRIES, 2018

Country	Fluoridation			Status 2018	Legal Framework	Surveillance System							
							Epidemiological Approaches				Quality Approaches		Information
	Water	Salt	Other			Baseline studies	Endemic areas studies (fluorine in water)	Oral health morbidity (DMFT & fluorosis) studies	Fluoride excretion in urine studies	Other fluoride sources studies	Quality control of water supply additions	Quality control to salt-industry products	Surveillance system information with easy access
Mexico	-	Yes	-	Active	1993	Yes	Yes	2015	Yes	Yes	N/A	Yes	SIVEPAB
Guatemala	*	Yes	-	Active	1991	Yes	Yes	2002	Yes	Not found	N/A	Yes	-
Belize	-	Yes	-	Uncertain	2007	Yes	Not found	Not found	Not found	Not found	N/A	Not found	-
Honduras	-	Yes	-	Uncertain	2011	Yes	Not found	Not found	Not found	Not found	N/A	Not found	-
Nicaragua	-	Yes	-	Uncertain	2007	Yes	Not found	Not found	Not found	Not found	N/A	Not found	-
El Salvador	-	Yes	-	Uncertain	1998	Yes	Not found	Not found	Not found	Not found	N/A	Not found	-
Costa Rica	-	Yes	-	Active	1989	Yes	Yes	Yes	Yes	Yes	N/A	Yes	Active
Panama	Yes	*	-	Uncertain	2001	Yes	Not found	Not found	Not found	Not found	Not found	N/A	-
Colombia	*	Yes	-	Active	1984	Yes	Yes	Yes	Yes	Yes	N/A	Yes	SIVIGILA
Venezuela	*	Yes Or Imported	-	Uncertain	1993	Yes	Not found	Not found	Not found	Not found	N/A	Not found	-
Peru	*	Yes	Milk Topic	Active	1984	Yes	Yes	Yes	Not found	Yes	N/A	Not found	-
Ecuador	*	Yes	-	Active	2001	Yes	Yes	Not found	Not found	Not found	N/A	Not found	-
Brazil	Yes	-	-	Active	1974	Yes	Yes	Yes	Not found	Yes	Yes	N/A	SISIGUA
Bolivia	-	Yes	-	Active	1996	Yes	Not found	Not found	Not found	Not found	N/A	Not found	-
Paraguay	*	Yes	-	Uncertain	Not found	Yes	Yes	Yes	Not found	Not found	N/A	Not found	-
Uruguay	-	Yes	-	Uncertain	1990	Not found	Not found	Not found	Not found	Not found	N/A	Not found	-
Argentina	Yes	-	-	Uncertain	1975	Not found	Not found	Not found	Not found	Not found	N/A	Not found	-
Chile	Yes	-	Milk	Active	1985	Yes	Yes	Yes	Not found	Yes	Yes	N/A	Active
Guyana	-	Imported	-	Projected	Not found	Not found	Not found	Not found	Not found	Not found	N/A	Not found	-
Suriname	-	Imported	-	Uncertain	Not found	Not found	Not found	Not found	Not found	Not found	N/A	Not found	-
French Gy	-	Imported	-	Uncertain	Not found	Not found	Not found	Not found	Not found	Not found	N/A	Not found	-
Cuba	*	Yes	Topic	Active	2002	Yes	Yes	Yes	Not found	Not found	N/A	Yes	Active
Haiti	-	-	-	Uncertain	Not found	Not found	YES	YES	Not found	Not found	N/A	Not found	-
Jamaica	*	Yes	-	Active	1986	Yes	Yes	Yes	Not found	Yes	N/A	Not found	-
Dominican Republic	-	Yes or imported		Uncertain	Not found	YES	Not found	Not found	Not found	Not found	N/A	Not found	-
Caribbean Countries	-	Imported	-	Uncertain	Not found	Not found	Not found	Not found	Not found	Not found	Not found	Not found	-

*Previous trial or program

TABLE 2

TIMELINE OF THE FLUORIDATION PROGRAMS IN LATIN AMERICAN AND CARIBBEAN COUNTRIES



CONCLUSIONS

The fluoridation programs across the Latin America and Caribbean regions have a long history that began more of sixty years ago with several trials in Colombia, Venezuela, Brazil and Chile. Nevertheless, the National Fluoridation Programs in the majority of Latin America and Caribbean had a great momentum during the las decade of the twentieth century, especially by the technical and economic support from international agencies as PAHO, World Bank, UNICEF and Kellogg Foundation.

Currently, the efforts developed by the majority of Central American and Caribbean countries to continue the fluoridation programs at the 21st century are in an uncertain status, with the exception of Cuba, Mexico and Costa Rica. South American countries have better advances on the implementation of these programs but the majorities, with exception of Colombia, Chile and Brazil have not updated records about the fluoridation programs, or an implemented surveillance system to follow the minimum indicators to know if the program is working property.

National preventive programs as water or salt fluoridation approaches are part of public health policies that need to be evaluated and improved by an Epidemiological Surveillance System. The Surveillance Systems for fluoridation programs need to have a group of multi-professional activities that allow the policy makers to periodically adjust all the measures related to concentration, distribution, scope, special approach in endemic zones, baseline studies, and follow-up studies, between others.

Despite the fact that the vast majority of the Latin American countries have a legal framework to continue developing their fluoridation programs, several factors related to economic, logistic and political reasons, have affected the follow up and evaluation of these programs, or the resume of others.

The political factors are those that most affect the programs that may have been designed or implemented in public health. Countries that started interesting salt fluoridation programs as Venezuela, Nicaragua and Bolivia, have uncertain status of these programs, promoting more other programs related to nutrition and access to food but leaving aside programs of prevention and monitoring of chronic diseases such as dental caries. It was difficult to find updated documents related to oral health programs or records of oral health status from the last 15 years in these countries.

Similarly, countries as Argentina, Uruguay, Chile and Panama, suffered political coups for several decades, influencing the budget assigned to national health programs, including fluoridation programs, and in most of the cases, these countries stopped their programs for several years or decreased their scope during those times.

Logistic factors also influence the implementation of these public health programs. Some countries started one program fluoridating water as Cuba, and after changed the measure fluoridating cooking salt to decrease costs and scope. In contrast, countries as Panama, started fluoridating salt for several years, but currently, they are promoting the fluoridation of water to increase the scope of the measure at national level.

Nevertheless, economic factors are not excluded from these dynamics. Currently, countries living economic difficulties as Argentina, El Salvador, Honduras and the majority of the Caribbean countries do not have evidence of being implementing a fluoridation program if they ever had one or if they are evaluating its impact through a surveillance system. These economic difficulties can also affect the lack of published or updated information about these fluoridation programs. This situation was evident in more of half of the consulted countries, and the access of official webpages was difficult or not possible in several of these countries as Venezuela, Nicaragua, Bolivia, Argentina, Cuba, and Caribbean Countries.

RECOMMENDATIONS

Mexico, Costa Rica, Cuba, Colombia in salt fluoridation and Brazil and Chile in water fluoridation have the better development of these fluoridation programs in Latin America and Caribbean, and it could be a point of reference to resume the programs in other countries with the support of international foundations and agencies.

The authors recommend a new stage of international accompaniment by several agencies and foundations to resume fluoridation programs in countries where structural, economic or political factors affected the implementation or continuation of fluoridation programs in the twenty-first century.

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