SALT FLUORIDATION TO PREVENT DENTAL CARIES IN ARMENIA

Master of Public Health Integrating Experience Project
Utilizing Community Service Grant Proposal Framework

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Executive Summary

Dental caries is considered a public health problem for many developed and developing countries. There are a huge number of affected school-aged children and adults, where the prevalence can reach from 60 to 90%. In some countries, the prevalence of dental caries can reach 100%. Dental care expenditure is a significant financial burden for many developed countries where 5-10% of public health expenditures relates to oral health. The most affected group in the community is the low and middle-income population. The social impact associated with dental caries is very high; "more than 51 million school hours are lost every year to dental-related illness". The mean DMFT index in 2000 for children aged 12 years was 4-5 on average and for adults aged 35 years the DMFT index was approximately 14 in Armenia. According to the World Health Organization (WHO), oral diseases prevention and hygiene improvement should be integrated with chronic diseases prevention and control programs (19). "The policy of the WHO Global Oral Health Program emphasizes that oral health is integral and essential to general health, and that oral health is a determinant factor for quality of life". Thus, there is a need to develop and implement community based preventive programs to promote and improve the oral health of the population in Armenia. Fluoride is a natural element found in the earth and in different amounts in all sources of water and has caries protective effect. Fluoridated salt has the same caries protective effect as fluoridated water. Salt fluoridation, in comparison with water fluoridation, costs from 10 to 100 times less than water fluoridation. When salt fluoridation is used, it does not change the price of salt. The most appropriate method to provide fluoride to the population in Armenia is with fluoridated salt. Armenia has a local salt plant and it would be easy to implement the fluoridation program. Salt fluoridation is sustainable long-term intervention, which requires strong collaborations between internal and external institutions.

Specific Aims/Objectives:

The aim of this project is reduction of dental caries prevalence among the Armenian population by organizing production and distribution of fluoridated salt in Armenia and makes it available and affordable for the general population. In addition to increase awareness of the population about the health benefit of consuming fluoridated salt.

The specific objective of this project is to reduce the DMFT index (decayed, missed, filled teeth) of dental caries in Armenia through salt fluoridation by40% in seven years among the 6-15 year old population (1-2) and to ensure at least 90% of households' consume fluoridated salt.

The DMFT index is used to determine severity of dental caries. This index was adopted and approved by WHO (World Health Organization) (3). The DMFT index shows the sum of decayed, missing (because of caries or its complications), and filled teeth among the observed population divided by the number of observed persons (12).

Introduction

Literature review

Dental caries, cavity, or tooth decay is defined as a "chemical dissolution of the tooth mineral resulting from metabolic events taking place in the dental biofilm covering the affected area" (4). Dental caries is considered a public health problem for many developed and developing countries (5). There are a huge number of affected school-aged children and adults, where the prevalence can reach from 60 to 90%. In some countries, the prevalence of dental caries can reach 100% (6).

Based on reports of the United States Surgeon General, dental caries is several times more common as a chronic disease than asthma and hay fever among children (7). According to the same report, dental caries has tremendous social impact in children such as school hours lost due to dental diseases (7). Approximately 50% of 5-9 year old children and 78% of 17-year-old children have at least one decayed tooth or experienced at least one dental treatment in the United States (8).

Another study, conducted among preschool-children in China in 2007, identified 55% prevalence of dental caries (9).

The situation in Armenia is approximately the same as in many countries. According to the study conducted by the American University of Armenia the prevalence of dental caries was 86% among a 12 year old population (see table 1)and the mean DMFT was 2.84(10). Another AUA research study in Armenia reported in 2000 that the mean DMFT for children aged 12 years was 4-5 on average and for adults aged 35 years the DMFT index was approximately 14 (11).

Several risk factors may be necessary to develop dental caries. Some risk factors can be identified as local, which act at the tooth surface directly (saliva, biofilm, diet, fluoride) and some of them can be identified as personal (behavior, attitude, knowledge, education, socio-economic status (SES), and income) (4). Prevalence of dental caries among children with low socioeconomic status is two times higher than among children with middle and high socioeconomic status (8). According to a study conducted in Australia, there are strong associations between SES, utilization of dental care, health behavior and risk to develop dental caries among young adults (13**).** The study shows that poor oral hygiene and level of sugar consumption has an important impact on developing dental caries (14).

Poor oral health condition may have an adverse effect for children's nutrition, growth, and development (7). In addition, dental caries may lead to such serious health problems as

pain (toothache), dentofacial abnormality, inflammatory complications, and spreading infection through blood (7). One of the most frequent complications of untreated dental caries is the toothache. According to a study by Slade, toothache prevalence varies from 5% to 33% among children and adolescents in different countries (15). Toothache has an impact on the health of person in terms of difficulties in playing, sleeping, eating and school activities (15).Besides psychological and functional consequences, toothache has social impact as well (16). The social impact associated with dental caries is very high; "more than 51 million school hours are lost every year to dental-related illness" (7). Oral diseases, such as periodontal diseases and dental caries, may increase risk to develop such diseases as atherosclerosis, rheumatoid arthritis, and diabetes. In addition, maternal poor oral condition may have an impact on infant's predisposition to be vulnerable to develop dental caries during their lifetime (17). Early childhood caries (ECC) may have an association with childhood mortality because of dental caries and interventions associated with dental caries (18).ECC may have an impact on "family, community, and the health care system of the country" (18).

The most affected group in the community is the low and middle-income population, since dental care is not considered a vital necessity. Because most care is provided by private practitioners (6, 7, 9, 11), it is very expensive for the individual and for the country's budget if dental care expenditures are covered by a basic benefit package. Dental care expenditure is a significant financial burden for many developed countries where 5-10% of public health expenditures relates to oral health (6). Approximately 110million dollars was spent in the United States for treating conditions attributed to dental caries on an emergency basis by hospitals in 2006 (21).

According to the World Health Organization (WHO), oral disease prevention and hygiene improvement should be integrated with chronic disease prevention and control

programs (19). "The policy of the WHO Global Oral Health Program emphasizes that oral health is integral and essential to general health, and that oral health is a determinant factor for quality of life" (19). Some chronic diseases occurring at one age may predict the level of severity of the disease at later ages (20).

Methods to prevent dental caries

There are different strategies to address the dental caries issue. Mainly four types of caries prevention strategies exist: pit and fissure sealants, dietary counseling, oral hygiene instructions, and fluorides (22).

The pit and fissure sealant method to prevent dental caries is a relatively new method and mainly designed to prevent development of carious lesions on the tooth surface with pits and fissures (23). The role of sealants is to isolate the tooth surface from dental plaque (24). Approximately 80% of all caries occurs on the surfaces of biscuspid and molar teeth (25). Sealants' treatment is directed to prevent dental caries on those teeth judged at risk to develop dental caries (23). Patient behavior and compliance in addition to the high quality technique of using sealants by practitioners play an important role in the effectiveness of the treatment outcome (24).

Pit and fissure sealants are associated with several costs such as materials and personnel time and indirect costs such as patient's transportation and time off work (26).

The American Academy of Pediatric Dentistry (AAPD) emphasized that the promotion of well-balanced, low-caries risk and nutrient-dense diet plays an important role in the development and healthy life of infants, children, and adolescents (27). According to the American Academy of Pediatrics (AAP) approximately 15% of American children are obese, which can lead to much more serious diseases in adulthood such as coronary-heart diseases, atherosclerosis, type 2 diabetes mellitus, and mental health problems (28).

Pediatric dentists have an important role in developing healthy dietary behavior through counseling children and their parents regarding dietary factors that can influence children's oral health (27). Pediatric dentists should discuss with parents and caregivers the negative influence of "refined carbohydrates" in food and drinks on the oral health of children (29). However, dietary counseling should be associated with regular visits to pediatric dental care or primary health care units. Dietary counseling is directed to provide knowledge and changing existing behavior. However, "providing knowledge alone rarely leads to long-term changes in preventive behaviors" (30).

Oral hygiene is one of the factors that have impact on dental caries development, since the dental biofilm is an etiological factor of dental caries (4). One study showed that lack of oral hygiene and sugar consumption for 23 days led to development of dental caries (31). Dental plaque deposition on the tooth surface is a one of the main causes of dental caries and therefore, adequate removal of dental plaque and application of fluoride can be important in the prevention of dental caries (4).

The effect of oral health promotion programs using preventive activities may have variable success (4). Programs to improve oral hygiene are usually directed to change behavioral factors and require the individuals' compliance and training (32).

Fluoride is a natural element found in the earth and in different amounts in all sources of water. The range of the concentration of fluoride in the water is varying from 0.01 mg/L and higher (44). The high concentration of fluoride in the water is associated with underground water sources (43). In fluoride-rich areas, the concentration can reach 10 mg/L, but much higher concentrations of fluoride in the water can be found (43). Some regions such as China, Central Africa and some parts of India and South America can be considered as fluoride-rich areas (43). The most optimal concentration of fluoride in the water to provide a caries protective effect is between 0.5- 1.0 mg/L (43).

Fluoride serves as an important element in a healthy development of human bones and teeth and, fluoride has an important role in prevention of dental caries as soon as teeth have erupted in the mouth (33). Fluoride may provide its caries protective effect only when it is "free and soluble in the oral environment (biofilm, saliva)" (39). Fluoride provides caries protective effect by reducing mineral loss of the teeth, which is initiated by the combination of the cariogenic factors such as biofilm accumulation and the production of acids (39). Fluoride acts by providing a "precipitation of a fluoridated mineral on the teeth" (39).

Fluoride provides benefit to children before eruption of the teeth as well as protects the teeth of children, adolescents and adults after the teeth have erupted in the mouth (33). In children and adults, more than 90% of fluoride is removed from the organism through urine and only a small part is retained in saliva and skeletal bones (45). Water and salt fluoridation is a similar process for the supplementation of various foods and beverages to provide and promote a healthy life and development to humans (33).

There are two general ways that fluoride may be obtained to have a protective effect against dental caries:

1. Fluoride through systemic sources (34) (water, salt, tablets, foods, and beverages)
2. Fluoride through topical sources (35) (fluoride toothpaste, fluoride mouthrinses, fluoride varnishes, and fluoride treatments)

Another classification of fluoride delivery to the human organism can be based on the strategy used to deliver fluoride. This could be community-based (water, salt), individual-based (fluoride toothpastes and rinses), professional (gels and varnishes with high-concentration of fluoride) and the combination of these methods (38). However, the aim of all fluoride methods is to provide effective protection to the teeth against dental caries.

Fluoride received through systemic sources (water, salt, tablets, foods, and beverages) become a part of the structure of human bones and teeth from childhood to adult (33).

Consequently, the teeth that have erupted in this condition are much stronger and protected against dental caries exposure. Fluoride obtained through systemic sources regularly become a part of the human saliva and have constant contact with surfaces of the teeth, and protect them during life (36). According to a study in Brazil, "the fluoride available in ionic form in the oral cavity is able to counterbalance the mineral losses caused by acid production in the biofilm, by inducing the precipitation of the less soluble mineral phase fluorapatite in the tooth structure" (37). Even low but constant concentration of the ion of fluoride has a protective effect and prolongs the process of the demineralization of the teeth (37). When the initial stage of enamel demineralization occurs (white spot lesion), fluoride will help to limit the process of demineralization. The presence of fluoride in the saliva leads to a brighter "white spot lesion" surface and remineralization of the enamel (38). The importance of systemic fluoride sources (especially water and salt) is to provide continuous availability of the fluoride (38).

One of the most used sources of topical fluoride is fluoride toothpaste with significant evidence that fluoride toothpastes are effective in caries protection (42). Tooth-brushing with fluoride toothpaste impairs the development of dental caries not only on the cleaned surface, but also on the unreachable areas (40). The concentration of fluoride in the saliva after using toothpaste reaches the baseline level in 1-2 hours after use (37).

Other types of topical fluoride sources are high-fluoride-concentration gels and varnishes as well as fluoride-releasing dental materials (37). In addition, it should be mentioned that professionals only (37) must use all these fluoride sources (high-fluoride-concentration gels, varnishes and fluoride-releasing dental materials).

Comparison of different topical fluoride sources shows that there is a similar degree of effectiveness among fluoride toothpastes, mouth rinses, gels and varnishes (41). The concentration of fluoride in saliva has a short duration and provides temporary benefit to the

tooth surface. For this reason, the effectiveness of systemic sources of fluoride is much higher and longer lasting than that of the topical fluorides (33).

It is important to mention that topical fluoride as well as some systemic fluoride sources such as fluoride tablets and vitamins with fluoride are associated with additional financial expenditures including the cost of fluoride toothpaste, mouth rinses and fluoride applied by the professionals. In other words, there are direct costs such as cost of materials and administrative costs as well as indirect costs such as patient's transportation and working time (26).

Fluorosis

Overexposure to fluoride can lead to developing dental and skeletal fluorosis (43). Dental fluorosis is a "developmental disturbance of dental enamel, caused by successive exposures to high concentrations of fluoride during tooth development, leading to enamel with lower mineral content and increased porosity" (46).

As was stated, fluoride is a natural element and its main source is water. Fluoride has a strong caries protective effect, but in addition, overexposure to fluorides may have adverse effects for human health depending on the amount of intake through systemic or topical sources.

The severity of the dental fluorosis depends on such factors as duration of the overexposure, weight of the person, level of physical activity and, personal health status (malnutrition, renal insufficiency) (48). According to a study conducted in Tartu, the risk to develop dental fluorosis is six times higher in areas with high fluoride concentration (4 mg/L) in contrast with low-level fluoride concentration (0.2 mg/L) areas (44). The fluoride concentration 0.9-1.2 mg/L may cause only mild dental fluorosis depending on the amount of drinking-water intake and exposure to fluorides from other sources. The prevalence of mild

fluorosis is reported between 12-33% (43). According to one report, the critical age of children for fluoride overexposure is between 1 and 4 years (46). There is a direct association between amount of fluoride intake and weight of the child rather than age (47). The recommended safe level of fluoride daily intake is 0.05-0.07 mg F/Kg/day (46).

Mild dental fluorosis is not noticeable and can only be identified by a specialist's examination (43). Monitoring fluoride intake is one of the best methods to prevent dental fluorosis (46).

Skeletal fluorosis can develop when concentration in drinking water is 3-6 mg/L and higher in association with high level of water consumption (43). The daily consumption 6 mg of fluoride per day and higher increases the risk of developing skeletal fluorosis, which is more than 6 times the normal dosage (43).

Thus, in association with reduction of dental caries there can be an increase in prevalence of mild dental fluorosis (51). The fluoride concentration necessary for caries prevention will assure that fluorosis remains at low levels (37). There is a recommended amount of fluoride intake related to different age groups to prevent dental caries and dental fluorosis (52).The recommended average daily intake of fluoride for infants up to six months is 0.01 mg/day, for children over six months the daily fluoride intake is based on the weight of the child and should be about 0.05 mg/kg/day, for adult females it is 3 mg/day and for adult males it is 4 mg/day (52).

Salt fluoridation

As previously described, delivery of fluoride to a population to prevent development of dental caries can be systemic, topical or a combination (34, 35, 38). The experience of using fluoridated salt and fluoridated water as a successful tool to decrease the prevalence of dental caries led to a study conducted in 1967 by PAHO (Pan American Health Organization), the

National Institute of Dental and Craniofacial Research and the University of Antioquia in Medellin, Colombia. This study established that the use of fluoridated salt has the same caries protective effect as fluoridated water (55). In addition, salt fluoridation is a cost-effective preventive program. According to a study conducted in Jamaica, salt fluoridation cost was 6 cents per person annually (64). Cost savings from the program implementation were significant: for each $1 spent on salt fluoridation, $250 can be saved in reducing the need for future dental treatment (64).

The maximum recommended average daily intake of fluoride for adults for caries protection is 4 mg of fluoride (52). This was determined by research, practical experience and evaluation of fluoridation program implementation in several countries. There are several ways to provide fluoride including fluoridated water, toothpaste, mouth rinses, tablets, vitamins, milk, flour, and salt among others. One of the most appropriate methods of fluoride delivery to a population is salt fluoridation. Salt is a very broadly used and affordable product. Many countries cannot afford water fluoridation; and salt fluoridation can be much cheaper. Salt fluoridation, in comparison with water fluoridation, costs from 10 to 100 times less than water fluoridation. When salt fluoridation is used, it does not change the price of salt (53).

According to a study conducted in Mexico in 1986, the consumption of salt increases with age (55). Based on this study, average consumption of salt in children 1-3 years is 1.9 g/day, in age group 4-6 years it is 3.4 g/day and for adults it is up to 6.9 g/day (55).The best concentration of fluoride in the salt, which was determined from many studies, is 250 mg/kg (54). According to these values, the average daily consumption of fluoride through fluoridated salt with a concentration of 250 mg/kg fluoride would be 0.5, 0.8 and 1.3 mg per day for these age groups respectively.

There are two different methods of salt fluoridation process:

1. Wet method

2. Dry method

Potassium fluoride is used for the wet method of salt fluoridation, which is as an aqueous solution continuously sprayed, at a specific ratio, on salt travelling past on a conveyor belt (62).

For the dry method, sodium fluoride is used in continuous mixing of powdered fluoride with salt in special mixers (62). Grain size of the sodium fluoride ranges from 10 to 20 μm;- so that a homogeneous product is achieved and there is no tendency for separation in the salt packages (62).

Both methods have advantages and disadvantages. The primary advantage of the dry method of salt fluoridation is the cost of the chemicals and equipment used (62). With the dry method, the appropriate granule size of the salt is from 0.2 to 0.8 mm, so the dry method is not suitable for the coarse salt (62).

The wet method of salt fluoridation is suitable for all types of salt, but it is much more expensive than dry method (62).

Many successful programs regarding salt fluoridation were implemented throughout the world. There are many examples of reducing the DMFT index of caries through fluoridation programs in several countries of the Americas and Europe such as Costa Rica (60%), Jamaica (83.9%), and Mexico (29.6%) (see figure 1) (55). In addition, fluoridation programs can reduce the inequalities in dental caries among different social classes (56).

A salt fluoridation program is a long-term intervention, which requires collaboration between different types of institutions inside the country (internal), as well as outside the country (external). An example of the internal institutions can be Ministry of Health, Medical and other universities, public and private laboratories and clinics, NGOs, dental

associations, salt plants, etc. Donor governments and other foreign organizations can be external sources of cooperation in a national salt fluoridation program implementation (55).

There are some advantages and disadvantages to use salt as a vehicle for fluoride. The advantages to use salt to provide fluoride to the population at large for caries prevention are: in comparison with fluoridated water, fluoridated salt provides consumers the free choice. The use of fluoridated salt does not require lifelong daily compliance. Fluoridated salt is not ingested once a day such as drops and tablets with their peak of concentration in saliva but, the fluoridated salt is consumed in small amounts during the day. The process of fluoridation does not increase the price of the salt (45).In addition, fluoridated salt helps to eliminate the inequalities between different socio-economic classes in terms of dental care affordability.

One disadvantage is that a high consumption of the salt is a risk factor for hypertension (45).

Thus, the increase in consumption of fluoridated salt should not be encouraged, but detailed information regarding the benefit of fluoridated salt should be provided. Fluoridated salt should be labeled and detailed information about content of the salt should be described on the packages. Non-fluoridated salt should also be available for consumers.

Situation in Armenia

The Republic of Armenia is one of the post-Soviet republics. The Republic of Armenia is located in the south Caucasus and has borders with Georgia, Azerbaijan, Turkey and Iran (57). The population of the country is ethnic Armenians (approximately 97.9%), while the rest of the population is Yezidi (Kurd) 1.3%, Russian 0.5%, other 0.3% (census 2001) (58). The total population of the Republic of Armenia is 2,967,975 (58). The urban

population of the republic is 64% of the total population (58). The capital of the republic is Yerevan with population 1.11 million (58).

The Republic of Armenia declared independence on 21 September 1991. Independence of the Republic of Armenia became a reason to have many changes in the economic situation as well as in the health sector (57). The process of privatization was initiated not only in the economic sphere but also in the health section. After acquiring independence, the Republic of Armenia inherited the former Soviet Union health care system (57). The health care system in Armenia is comprised of the Ministry of Health, Public sector (hospitals, policlinics, regional health care facilities) and Private sector (hospitals, outpatients clinics/centers, dental clinics, pharmacies) (57). Currently there are three institutions to provide medical education: 1) the Yerevan State Medical University; 2) the National Institute of Health, and; 3) the College of Health Sciences of the American University of Armenia.

Mainly private dental practitioners and clinics provide the dental health care in Armenia with at least 80% dental care related to private sector (57). Fees for dental health services provided in private dental clinics are largely regulated by the market, with the government having little influence on pricing policy (57).

One of the few programs directed to improve oral health condition among schoolchildren was UMCOR Dental Care project conducted in 2003 in disadvantaged communities such as Gegharkunik, Syunik, and Lori (57). All programs were directed to conduct screening and treatment for existing dental caries problem.

The situation in Armenia regarding prevalence of dental caries is approximately the same as in many countries. According to a study conducted by the American University of Armenia the prevalence of dental caries is 86% among the 12 year old population and the mean DMFT is 2.84(10). According to another research study, the mean DMFT index in 2000 for children aged 12 years was 4-5 on average and for adults aged 35 years the DMFT

index was approximately 14 (11). Thus, oral diseases are a widespread health problem in Armenia, especially among populations with a low socio-economic level and in rural areas (57).

There were several programs conducted in Armenia by different organizations to improve the oral health of the population, especially among the low socioeconomic population. Examples of such programs are the several programs operated by the American Dental Society of California and the programs organized by the student council of the Yerevan State Medical University (63). However, the main objectives of these programs were the treatment of the dental caries (63). Thus, there is a need to develop and implement community based preventive programs to promote and improve the oral health of the population in Armenia.

The main natural source of fluoride is water. The concentration of fluoride in potable water of Yerevan is ranged from 0.2 to 0.46 mg/L (59). The ideal concentration of fluoride in drinking water in Yerevan is approximately 0.32 mg/l (59). The best concentration of fluoride in the water to provide a caries protective effect is 0.5-1.0 mg/L (43). Fluoride supplements should be considered for all populations with fluoride-deficient drinking water (<0.6 mg/l) (see table 2) (65).

Thus, there is a necessity to develop and implement a community based fluoridation program.

The two main cost effective ways to provide fluoride to the population are salt and water. Salt and water refer to systemic sources of fluoride (34).

Armenia is rich with potable water resources, though, not all settlements in Armenia have sweet water springs (60). There are around 330 settlements supplied with drinking water through 110 water systems (60). Thus, water fluoridation would require high financial expenditures, because there are many different sources of drinking water.

Salt fluoridation is the most appropriate and effective method to provide fluoride to the population in Armenia. The Republic of Armenia has its own salt plant called "Avan Salt Plant". The "Avan Salt Plant" is the only salt production company in the region (61). The salt plant produces iodized domestic, agricultural and technical salt (rock-salt for cattle breeding, technical ground salt) (61). The local population primarily uses the salt coming from that source. Salt fluoridation, in comparison with water fluoridation, costs from 10 to 100 times less than water fluoridation and importantly, does not change the price of salt (53). In addition, there are some advantages to use fluoridated salt than fluoridated water to prevent dental caries (45). One systemic source of fluoride is recommended for each country.

The dry method of salt fluoridation is appropriate to deliver fluorine to the population, because salt, with granule size 0.2 to 0.8 mm, is more often used as a domestic salt (45).

Methodology

Conceptual framework

Salt fluoridation program is a long-term intervention, which requires collaboration between different types of institutions inside the country (internal), as well as outside the country (external). An example of the internal institutions can be Ministry of Health, Medical and other universities, public and private laboratories and clinics, NGOs, dental associations, salt plants, etc. Donor governments and other foreign organizations can be external sources of cooperation in a national salt fluoridation program implementation (55).

The conceptual framework of salt fluoridation program implementation should be based on comprehensive needs assessment, adoption of legislation regarding fluoridated salt, educational process, monitoring of the program implementation and evaluation.

Implementation plan (see table 3)

Food fortification is an essential part in prevention of some diseases associated with micronutrient deficiencies. Salt fluoridation can be considered as food fortification program. The community support has to be achieved for successful program implementation. Before the practical implementation of the project, an assessment of specific obstacles and supporting factors (technical, financial) should be done through discussing with policy makers, physicians, salt producers and general population. Specifically, during the assessment campaign knowledge, attitude and perception regarding fluoridated salt should be identified in order to find the effective strategies for future educational and advocacy campaigns.

The strong collaboration between project initiators, Ministry of Health of Armenia, Avan Salt Factory and the State Standards Department has to be established for achievement of the program objectives.

Special series of meetings have to be organized with policymakers and salt manufactures to conduct discussion regarding the need for salt fluoridation and its feasibility in Armenia. Priorities and action plans have to be established to achieve sustainability of the implemented program. In addition, the norms and standards for fluoridated salt have to be developed in strong collaboration with Ministry of Health of Armenia and the State Standards Department. The recommended standard of fluoride concentration in the salt is 250 mg/Kg. This standard was established during several successful salt fluoridation programs implemented in different countries (55).

The educational and advocacy campaigns should be initiated first and continue for a while after salt fluoridation implementation and production (66). The purpose of the preliminary educational program is “to increase the acceptance and support of the general population” for salt fluoridation (66).

Education and advocacy is a very relevant process for implementation of a preventive program like salt fluoridation. Negative attitudes, misunderstandings and disbelieves might be revealed during program implementation, so the educational activities have to be initiated to meet such kind of threats. Not only does the general population need to be educated about the benefits of using fluoridated salt, but also health care providers have to increase their knowledge regarding fluoridated salt. According to research conducted by the American University of Armenia, Center for Health Services Research and Development (CHSR) in 2009 the increasing awareness, knowledge and acceptance of primary health care providers through special trainings and seminars, can play a substantial role in the acceptance of flour food fortification by the general population (66).

Different types of educational materials such as brochures, posters, leaflets and videos have to be used for providing information to the population. Educational materials should be prepared by using plain language and specific ethnic, cultural and age groups must be taken into account. Face to face communications, group presentations and discussions and mass media are the most appropriate methods to provide information about salt fluoridation and its benefit.

Special workshops have to be designed and conducted to increase public awareness regarding the benefit of fluoridated salt throughout the country with involvement of community policymakers and health care providers.

The educational process has to be continuous, because of successive generations. Therefore, the new parents, doctors and other users need to be informed about the benefit of using fluoridated salt. In addition, the educational process is more effective when it is reinforced periodically.

According to PAHO recommendations there are two essential baseline studies to determine necessity of fluoridation program initiation: 1. Baseline information on dental caries 2. Baseline levels of fluoride in water supplies (55).

Dentists in the schools using instrument that were developed and approved by WHO should collect the baseline information regarding severity of dental caries in Armenia (DMFT index) (Appendix) (68).

The production of fluoridated salt has to be organized, conducted and monitored in the Avan Salt Plant of Armenia. The control of the quality in production, distribution and storage of fluoridated salt has to be conducted by the salt plant and health sector (55). The Avan Salt Plant is the only salt producer in Armenia and covers all the needs of the entire population in regards to salt. This fact makes the fluoridated salt accessible and available for the population. The dry method for salt fluoridation has to be chosen as the easiest implemented and affordable.

The level of fluorine in urine has to be measured after 15 months of salt fluoridation program implementation to identify the population's daily total fluoride intake. A 24-hour urine collection is recommended by PAHO (55). In addition, households that use fluoridated salt need to be monitored to identify availability and affordability of fluoridated salt.

Evaluation of the salt fluoridation program should be conducted seven years after program implementation. This period is enough to conduct assessment of early erupting teeth exposed to fluoridated salt concerning dental caries and fluorosis (55). The evaluation has to be conducted by using the DMFT index for dental caries assessment and the rate of households that use fluoridated salt.

Evaluation plan

The evaluation of the salt fluoridation program implementation should be conducted after seven years. The DMFT index for 6-8, 12 and 15 years groups should be calculated. These age groups must be included because at the age of 6-8 primary teeth and one or two permanent teeth can be observed. At age 12, the first and second permanent molars can be observed and at age 15 canines can be observed (55). The teeth from canine to canine on the upper jaw have to be observed to identify level of fluorosis (55).

The study design for the program evaluation is non-equivalent different group pre/post test:

O X O

X- intervention

O- observation

The appropriate sample size will be 552 observations, which represent the true value of target population (confidence interval=95%, power=80%, rate difference=0.10).Two should be multiplied considering design effect of the sample. The sample will be stratified by three age groups (6-8, 12, 15 years old) and proportionally stratified by urban vs, rural population. The schools will be randomly chosen by using simple random selection or systematic random selection. The classes of the chosen schools will be considered as clusters. The observation will be organized and conducted in the schools' medical office and documented.

Medical personnel (dentists) will collect data (DMFT index) with instrument that was developed and approved by WHO and used during baseline assessment (Appendix) (68). Missing and filled teeth have to be counted and included when they are the result of caries. They would not be counted missing and filled teeth if caused by other reasons such as orthodontic or orthopedic aims.

Budget/Planning

The budget of the project is 250,060 dollars (see table 4)**.** The budget of the project includes the expenditures on administrative staff, personnel salaries, transportation, project materials, salt fluoridation equipment and other expenses. The personnel salaries will be based on the preparatory and training part of the project. The salt fluoridation equipment cost includes price, transportation, taxes and installation in the factory. The personnel include salaries of local workers and cost for trainings.

Community Support

The human organism receives approximately all important vitamins and minerals through food. The lack of these vitamins and minerals lead to the development of the wide range of the health problems. A lot of health related problems can be solved through food fortification (66).

Food fortification refers to the addition of micronutrients to processed foods (67). The process of the implementation is a long, but the food fortification's outcome has much more wider and sustained impact on human health (67). Salt fluoridation has a similar need for success.

The qualitative study was conducted by Center of Health Research and Development of AUA to identify level of knowledge, perception and attitude of general population regarding food fortification (66). According to this study, the lack of knowledge regarding fortified food was identified among general population especially in the marzes of Armenia (66). As a result of the study several recommendation were made to assure community acceptance concerning food fortification program implementation. The cooperation of different types of sources is needed to increase knowledge and awareness of general population (66). Educational campaigns conducted before the food fortification program implementation

included, increase awareness and knowledge of medical staff and, use of mass media with participation of the recognized health care professional. All these factors can lead to a similar enhancement of the salt fluoridation program acceptance and support by the general population (66).

Ethical Considerations

The aim of the salt fluoridation program is not to encourage the population to increase the level of salt consumption, but to use fluoridated salt instead of non-fluoridated. The Ministry of Health in cooperation with the National Standards Institute has to develop standards for packaging, storing and transportation of fluoridated salt. In addition, detailed information has to be provided on the salt package. Finally, non-fluoridated salt has to be available for consumers also.

Sustainability of the program

Food fortification refers to the addition of micronutrients to processed foods (67). The process of the implementation is long, but the food fortification's outcome has much more wider and sustained impact on human health (67). In a similar way, the salt fluoridation program has sustainability beyond the funding period. Direct and indirect expenditures such as supplies, materials, equipment and human resources are low and large investments are not needed in terms of salt factory (55).Salt fluoridation in most cases does not change the price of salt (53). It is also possible that the investments in fluoridated salt production are recoverable through a minimal increase in the price of salt (55). The Avan Salt Plant can have benefit from exporting fluoridated salt.

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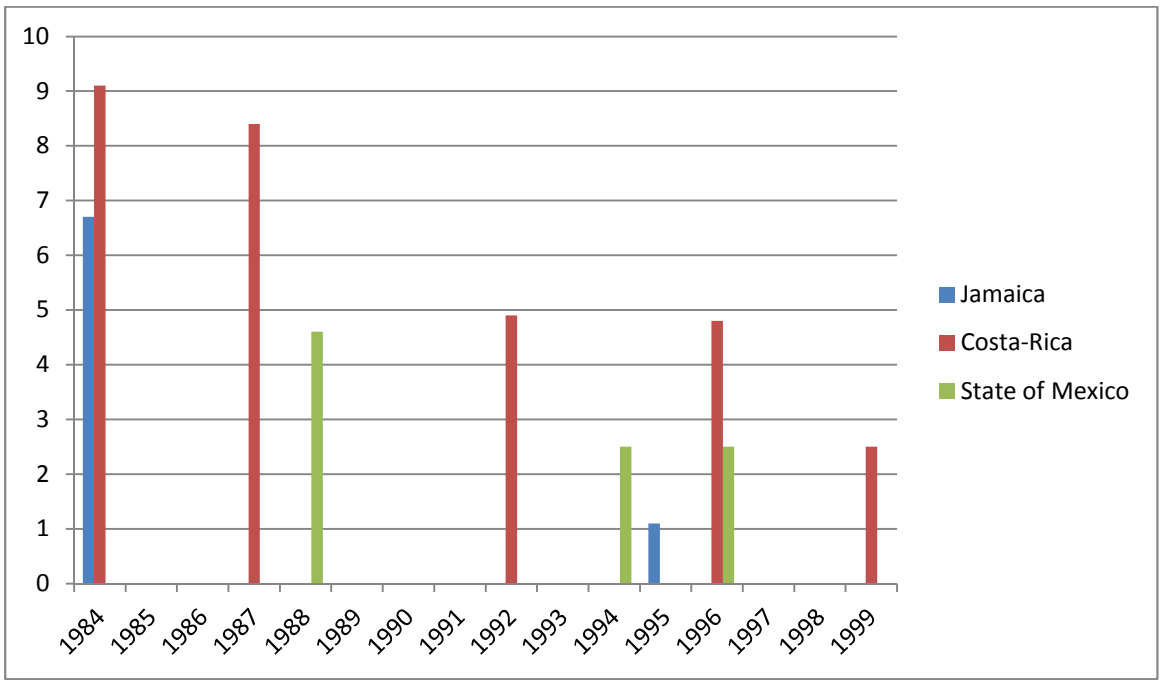
Figures/Tables

Figure 1

Figure 1.Trend in DMFT at 12 years of age, Costa Rica and State of Mexico (Mexico), 1984-1999.(Salt fluoridation in Costa Rica and Jamaica began in 1987, in Mexico began in 1991)



Source: SaskiaEstupinan-Day.Pan American Health Organisation. Promotion Oral Health:The use of salt fluoridation to prevent dental caries. Washington,D.C.:PAHO,2005.

Tables

Table 1. Dental caries prevalence, on an individual basis, from the studies that are referred to in this review.

Age	Prevalence (%)	Sample size	Country	Year
5-9	50	1,598	USA	2004
17	78	3,249	USA	2004
6	97.1	4,050	Philippines	2006
6-12	92.3	1,200	Philippines	2005
2-6	59-92	993	Philippines	2003
3-5	55	2,014	China	2007
5-74	100	350,000	China	2008
5	76	140,712	China	2002
5-6	84	1,587	China	2001
6	89.4	178	Taiwan	2006
1-6	52.9	981	Taiwan	2006
0-5	40	1,487	Brazil	2007
1-2.5	20	186	Brazil	2007
12	53.6	1,151	Brazil	2004
7-9	78.5	121	Argentina	2006
6-12	90.2	3,048	Mexico	2006
6-9	34.7	452	Mexico	2006
8	50	5,580	UK	2003
12	59.8	48,168	Norway	2006
12	86	117	Armenia	2005

Source:Bagramian RA, Garcia-Godoy F, Volpe AR.The global increase in dental caries.A pending public health crisis. Am J Dent. 2009 Feb; 22(1): 3-8.

Table 2. Dietary daily fluoride supplementation schedule

Age	**<0.3mg/l F**	**0.3-0.6mg/l F**	**>0.6mg/l F**
Birth-6 months	0	0	0
6 m-3 years	0.25 mg	0	0
3-6 years	0.50 mg	0.25 mg	0
6y up to at least 16 years	1.00 mg	0.50 mg	0

Source:Guideline on fluoride therapy.Available at: http://www.aapd.org/media/policies_guidelines/g_fluoridetherapy.pdf

Table 3 Ghantt chart timetable

First year												
	Tasks	Months 1	Months 2	Months 3	Months 4	Months 5	Months 6	Months 7	Months 8	Months 9	Months 10	Months 11	Months 12
1. Preparation													
1	Special series of meetings with policymakers and salt manufactures												
2	establishing the necessary standards												
3	Hiring Personnel												
	Tanning project staff												
	preparation of necessary educational materials and social awarenss program												
4	Educational and awareness program for general population and health care specialists												
2. Organizing and conducting the production of fluoridated salt													
1	Identification of necessary and existing resources												
2	Purchase of necessary equipment												
3	Installation of the necessary equipment in the salt producing plant												
4	Tanning of the salt producing plant staff												
5	Starting the production of fluoridated salt												
6	Production of fluoridated salt												
7	Monitoring (availability of fluoridated salt in the households)												
8	Quality control in the salt plant (technology maintenance, standard compliance, safety)												
Second Year													
	Tasks	Months 13	Months 14	Months 15	Months 16	Months 17	Months 18	Months 19	Months 20	Months 21	Months 22	Months 23	Months 24
1	Midterm report to the sponsor												
2	Financial final report to the sponsor												
3	Monitoring (availability of fluoridated salt in the households)												
4	Monitoring (urinary fluoride excretion in children 3-5 years of age)												
5	Educational and awareness program for general population and health care specialists												

Table 4.Budget.

Item	UNIT	UnitCostinUSD	Multiplied by: Number of Units	Amount requested from Sponsor
Needsassesment				
Needs assesment meetings with policymakers, doctors, salt producers, potential beneficiaries	meeting /discussion	200	10	2000
TOTAL				*2000*
Programimplementation				
1.Staffcostsperfunction:				
Project Manager Salary (first 12 months)	month	*1000*	*12*	*12000*
Project Manager Salary (13 through 24 months)	month	*500*	*12*	*6000*
Managerassistant	month	*700*	*12*	*8400*
Accountant (parttime)	month	*300*	*24*	*7200*
Trainer 1	month	*500*	*12*	*6000*
Trainer 2	month	*500*	*12*	*6000*
TOTAL				***45600***
2.Equipment (one time capital investment):				
Computer	piece	4	500	2000
Mixingandpackageingequipment	piece	5000	1	5000
Installing Mixing and packageing equipment	piece	2000	1	2000
TOTAL		***7004***		***9000***
3. Running costs (rent, transport, consumable such as stationery, communal costs etc.):				
Rentofoffice	month	15	500	7500
Stationary	set	30	*15*	450
Publicationofbooklets/leaflets	quantity	0,04	*30000*	1200
Rent a conferencehall	(hours)	120	*3*	360
Materials for meetings of policymakers etc.	set	*5*	*50*	250
Materials for trainings (bags, pens, notepads etc.)	set	*5*	*200*	1000
Monthly Radio and television programmes	program	*500*	3	1500
Socialadvertisment	minute	*300*	600	180000
Posters for health care facilities and schools and food markets	copies	*0,6*	2000	1200
TOTAL				***193460***
5. Unexpectedcosts (1%)				2500,6
GRANDTOTAL				***250060***

Appendix

WHO ORAL HEALTH ASSESSMENT FORM (1986)

COUNTRY .....

Leave Blank	Year	Month Day	ID Number	Original/ Duplicate	Examiner
(1)□□□□(4)	(5)□□(6)	□□□□	(7)□□□□(10)	□(11)	□(12)

General Information Name..... **Other Data** (to be specified)

Age in years (13)□□(14) Geographic Location (18)□□(19) ..... □(21)

Sex (M=1, F=2) □(15) Location type: ..... □(22)

Ethnic Group □(16) 1 = urban, 2 = periurban, 3 rural □(20) ..... □(23)

Occupation □(17)

Malocclusion

0 = none □(17)

1 = slight

2 = moderate or severe

Periodontal Status (SPITN)

17/16 11 26/27

(25) □□□ (27) 0 = healthy 1 = pocket 4-5 mm

(28) □□□ (30) 1 = bleeding 4 = pocket 6 mm or more

47/46 31 36/37 2 = calculus x = excluded sextant

Dentition Status and Treatment Need

55 54 53 52 51 61 62 63 64 65

18 17 16 15 14 13 12 11 21 22 23 24 25 26 27 28

status

(31) ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ (46)

(47) ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ (62)

treatment

85 84 83 82 81 71 72 73 74 75

48 47 46 45 44 43 42 41 31 32 33 34 35 36 37 38

status

(63) ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ (78)

(79) ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ (94)

treatment

Status		Treatment
Permanent Teeth		
0= sound	A	0= none
1=decayed	B	1= caries arresting or sealant care
2= filled and decayed	C	
3= filled, no decay	D	2= one surface filling
4= missing due caries	E	
5= missing, any other reason	-	3= two or more surface fillings
6= sealant, varnish	F	4= crown or bridge
7= bridge abutment or special crown	G	5= bridge element
8= unerupted tooth	-	6= pulp care
9= excluded tooth	-	7= extraction
		8= other care
		9= (specify) ……

Fluorosis

☐ (495)

0= normal	3= mild
1= questionable	4= moderate
2= very mild	5= severe