Rapid Response

Informing the Salt Fluoridation Law in Lebanon

A K2P Rapid Response responds to urgent requests from policymakers and stakeholders by summarizing research evidence drawn from systematic reviews and from single research studies. K2P Rapid Response services provide access to optimally packaged, relevant and high-quality research evidence for decision-making over short periods of time ranging between 3, 10 and 30-days.

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Informing the Salt Fluoridation Law in Lebanon

Knowledge to Policy Center K2P

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Key Messages

Key Messages

Question

- Is mandatory salt fluoridation that has recently been proposed by Law no. 178 in Lebanon the most viable option for reducing dental caries in the country?

Synthesis of the Evidence we Found

- Systemic fluoridation is a debatable subject at the international level with proponents and opponents arguing for or against it.
- We found 12 systematic reviews that focused on the benefits and harms of water and salt fluoridations and 12 systematic reviews that focused on the effects of oral health programs on dental caries.
- Fluoridation of drinking water at levels of 1ppm (parts per million)* reduces the prevalence of dental caries among children and adults, but it also leads to the development of “any fluorosis” and fluorosis of aesthetic concerns.
- At higher concentrations, fluoride is toxic and leads to diminished IQ levels and cognitive disorders among children.
- Fluoride can also disrupt the normal functioning of the endocrine system including thyroid function, with the latter effect aggravated in individuals with iodine deficiencies.
- The evidence for the adverse effects of fluoride on bone fracture and cancer is mixed, with studies reporting either deleterious or protective effects at levels equal to or higher than 1ppm.
- While salt fluoridation may be beneficial in reducing dental caries among children aged 6-15 years, it also leads to fluorosis.
- No data is available to investigate other potential adverse health effects of salt fluoridation.
- A single 'safe' level for systemic fluoridation has been contested due to variations in individuals’ dietary habits and exposures to fluoride.
- Topical fluoridations through the use of fluoridated toothpaste, mouth-rinses, gels and varnishes were highly effective in reducing dental caries, while the evidence was inconsistent for the development of fluorosis.
- The use of Xylitol chewing gum and vitamin D supplements were shown to reduce dental caries.

- Incorporating oral health as part of a school's health promotional activities showed promising results in achieving behavioral change.
- Integrating community participatory models seemed to narrow oral health inequalities by social class.

What other countries are doing

- Salt fluoridation emerged as an alternative to water fluoridation in several countries where implementation of the latter is not plausible. Fluoridated salt is sold alongside non-fluoridated alternatives on a voluntary basis in all European countries with salt fluoridation programs.
- National oral health programs have been implemented in several countries and were shown to be effective preventive approaches for improving oral health in children in Scotland, Austria, England, and China.

Implementation considerations

- Implementation of fluoridated salt programs requires the following components as prerequisites:
  - Updated and comprehensive studies on fluoride exposure, total fluoride intake, and salt consumption
  - Epidemiological surveillance program/system with internal and external quality control
  - Mapping of distribution network to keep fluoridated salts away from areas where additional fluoride is not needed
  - Coordination among relevant stakeholders, information-sharing, and community education
- Building a comprehensive oral health program requires a mix of oral health education and awareness campaigns, primary preventive measures, and (if needed) secondary preventive measures for early detection and treatment. The success of school- and community-based oral health programs depends on the commitment of teachers, parents, schools, health professionals and health authorities.

Policy elements and implementation considerations

- Element 1: Re-evaluation of the current salt fluoridation law due to its potential adverse health effects.
- Element 2: Implementation of oral health programs as alternative public health approaches to promote oral health and reduce dental caries that do not involve systemic ingestion of fluoride

[*] *1 ppm of fluoride = 1 milligram of fluoride per one liter of water (1 mg/ L)*

Content

This Rapid Response document is structured as follows

1) Current Issue and Question
2) Synthesis of the Evidence we Found
3) What Other Countries are Doing
4) Implementation Consideration
5) Policy Elements and Implementation Considerations
6) Next Steps

Current Issue and Question

On August 29, 2011, the salt fluoridation law no. 178 was approved by the Lebanese Parliament, mandating that all table and kitchen salts in Lebanon be fluoridated. The Law was assumed to come into effect on December 2014, thus stirring up controversy among the Lebanese population. Proponents of the law argue that salt fluoridation, which is a 60 -year-old practice that began in Switzerland and other European countries, can significantly help reduce tooth decay especially that the decay rate in children in Lebanon is among the highest. Opponents, on the other hand, claim that fluoride is toxic and its addition to salt can lead to various adverse health effects, thus questioning whether the assumed dental benefits outweigh the risks.

The aim of this K2P rapid response is to foster dialogue informed by the best available evidence. Specifically, it attempts to inform the following question: Is mandatory salt fluoridation that has recently been proposed by Law no. 178 in Lebanon the most viable option for reducing dental caries in the country? The intention is not to advocate specific policy elements or close off discussion. Further actions can flow from the deliberations that the rapid response is intended to inform.

Text Box 1: Background to K2P Rapid Response

A K2P Rapid Response responds to urgent requests from policymakers and stakeholders by summarizing research evidence drawn from systematic reviews and from single research studies. A systematic review is an overview of primary research on a particular question that relies on systematic and explicit methods to identify, select, appraise and synthesize research evidence relevant to that question.

K2P Rapid Response services provide access to optimally packaged, relevant and high-quality research evidence over short periods of time ranging between 3, 10, and 30-day timeframe.

This rapid response was prepared in a 30-day timeframe and involved the following steps:

1) Formulating a clear review question on a high priority topic requested by policymakers and stakeholders from K2P Center.
2) Establishing what is to be done in what timelines.
3) Identifying, selecting, appraising and synthesizing relevant research evidence about the question
4) Drafting the K2P Rapid Response in such a way that the research evidence is present concisely and in accessible language.
5) Submitting K2P Rapid Response for Peer/Merit Review.
6) Finalizing the K2P Rapid Response based on the input of the peer/merit reviewers.
7) Final Submission, translation into Arabic, validation, and dissemination of K2P Rapid Response

The Lebanese Context

A national Oral Health Survey was conducted for the first time in Lebanon in 1994, the results of which pointed to a high prevalence of dental caries in all age groups (Doumit et al, 2004). Consequently, the magnitude of the dental health problem encouraged the Ministry of Health (MOH) to work on the introduction of a mass oral health preventive program, especially that research had shown reductions in dental caries in countries in which public health programs were implemented, particularly systemic fluoride supplementation (MOH website).

A number of local studies have been produced to reflect on the levels of fluoride exposure and fluoride intake in Lebanon. To start with, a series of fluoride exposure studies supported by the MOH and conducted among school children led to the conclusion that the Lebanese population is not exposed to sufficient fluoride (Doumit et al, 2004). Yet, such assessments did not include all age groups, and 15 of the tested water sources (2 of which fall within an industrial zone) had fluoride concentrations within or above the minimum recommended level of 0.5mg/L[1] fluoride in water (WHO, 1994; 1993; US EPA, 1985) (See annex 1 for a full list of the water sources). In addition, fluoride in tea, which many Lebanese drink heavily, appears to be substantial, with concentrations ranging from 0.620 to 1.680 mg/L (Jurdi et al, 2001). Fluoride intake from non-milk fluids was also found to be above the estimated safe and adequate (ESA) intake of fluoride level for all the rural children studied (aged 0-2 years) and for urban children (aged 7 to 12 months) (Jurdi et al, 2001). Having said that, there are no data on fluoride intake from local and imported food (for example, canned fish, in which the fluoride level can reach 370 mg/kg intake (Abu Zeid and EL-Hatow, 2007)) with insufficient data on dental care products and supplements. In addition, a subgroup of the Lebanese population was found to suffer from mild iodine deficiency (Global nutrition report, 2014; Global Iodine Nutrition Scorecard for 2012, 2012) which can be aggravated in the presence of fluoride (US National Health Research, 2006).

Text box 2: Critical Information on Water fluoridation Concentration

The recommended *minimum* value of fluoride in drinking water is set at 0.5mg/L (US EPA, 1985; WHO, 1993; WHO 1994) and the recommended *maximum* value is set at 1.5mg/L (WHO, 2011).

The *optimal* fluoride concentration in water falls within the range of 0.5-1 mg/L (WHO, 1993). In Halton, Canada, the therapeutic value is considered within the range of 0.5-0.8mg/L (Halton Region website).

In the US, Canada, and Ireland, the recommended optimal value for water fluoridation has recently been decreased from a range of 0.7-1.2 mg/L to 0.7 mg/L (Harding and Mullane, 2013; U.S. Department of Health & Human Services, 2011).

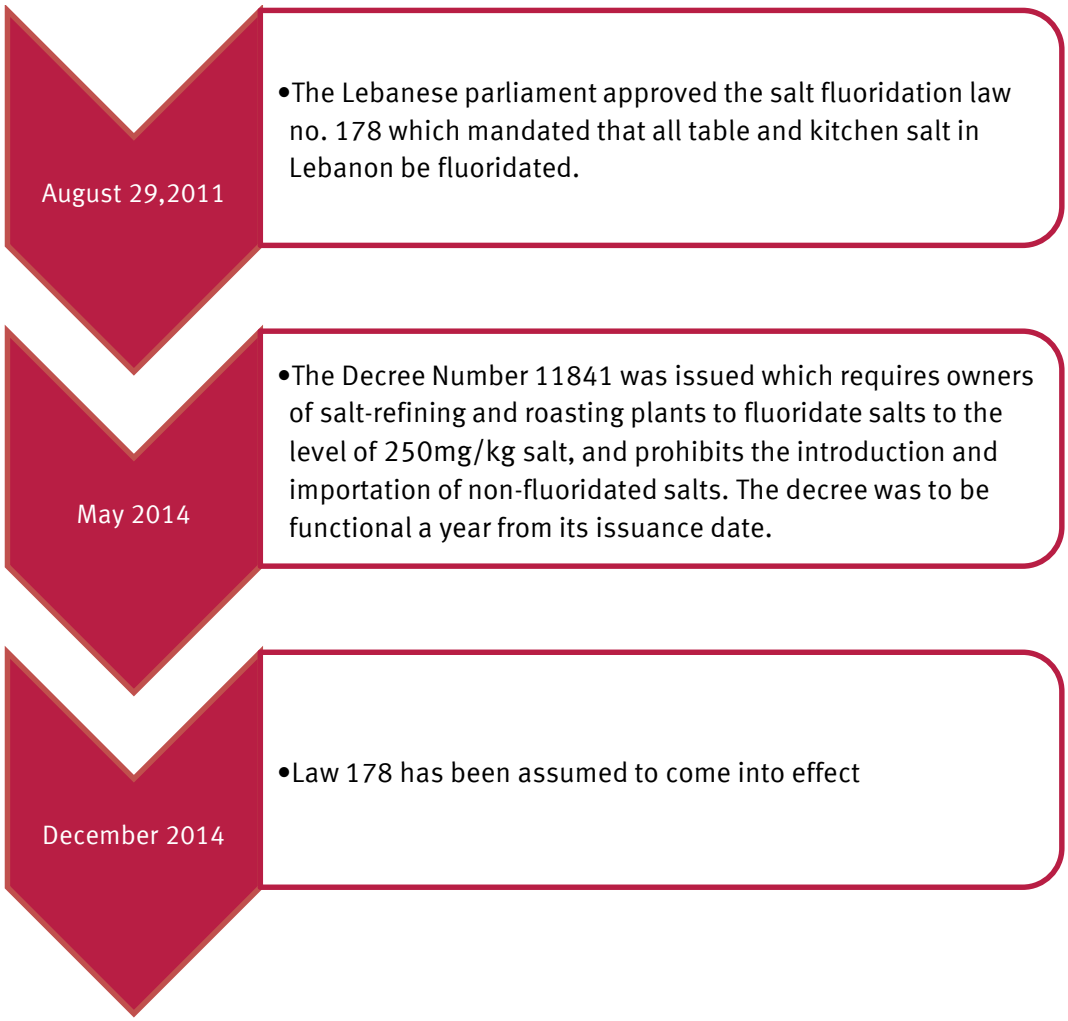
Since water fluoridation was not deemed a feasible approach in Lebanon, salt fluoridation was chosen as an alternative given the success that Lebanon experienced after the iodization of salt since 1971. The salt fluoridation law no. 178 was passed in the Lebanese Parliament on September 3rd 2011. The main contents of the law are as follows (MOH website):

[1] See text box 2 for information on water fluoride concentration

- Potassium fluoride (KF or KF2H2O) must be added to all table and kitchen salts (domestic salts) in Lebanon at a concentration of 250mg/kg salt.
- Salt producers and importers are prohibited from delivering non-fluoridated salts to the Lebanese market.
- Owners of salt-producing and refining plants must equip their factories with the necessary technology for the addition of fluoride to salt. They should also coordinate with the head of chemistry department at the MOH's central laboratory[2] for instructions on how to control and measure the percentage of iodide and fluoride added to salts.

On December 2014, the salt fluoridation law was assumed to come into effect, thus stirring up controversy among the Lebanese population (see figure 1 for information on the historical progress of the law). A detailed summary of the local evidence of relevance to the salt fluoridation law is presented in Table 1.

Figure 1: **Historical progress of the salt fluoridation law** (MOH website, media reports)



[2] The MOH's Central lab is currently closed

Table 1: Detailed summary of local evidence

Salt Consumption	-The Lebanese population suffers from excessive intake of salt (Lebanese Action for Salt and Health 2014). -A recent study found that that the average salt intake of 60% of individuals in Lebanon reaches 3130 mg of sodium, exceeding the recommended 2000 mg (Lebanese Action for Salt and Health 2014). The major food groups contributing to the Lebanese individual daily salt intake are bread, and bread-like products, pies (or manaeesh) as well as other processed foods.
Oral-Health Related Diseases	-The results from the national Oral Health Survey conducted for the first time in Lebanon in 1994 pointed to a high prevalence of dental caries in all age groups, reaching 93% and 96% for the 12 and 15 year old, respectively (Doumit et al, 2004). -A study on children aged 0-4 showed that most had at least one carious lesion (74.7%), and 70.7% showed high to very high plaque scores. (Chedid et al, 2011). -Occurrence of fluorosis (excess fluoride causing hypoplastic lesions on enamel of teeth) was reported in very few cases (Doumit et al., 2004).
Fluoride Level in Water Supplies	-There is variability in the fluoride level of Lebanon's community water supplies, with the concentration ranging from 0.00 to 2.4 mg/L. Beirut: (0.1-0.18 mg/L), Bekaa: (0.0-0.54 mg/L), Mount Lebanon: (0.05-2.4 mg/L), North: (0.00-0.6 mg/L), South: (0.10-0.55 mg/L). These findings date back to year 2000 (Doumit et al., 2004). -In a sample of thirty-two brands of bottled waters in Lebanon, the composition of fluoride ranged between ‹0.02 and 0.6 mg/L (mean = 0.15 mg/L) (Semerjian, 2011).
Fluorides from Non-Water Sources	-The contribution of fluoride in tea which is a widespread cultural habit in Lebanon appears to be substantial, ranging from 0.620 to 1.680 mg/L (mean, 0.955 mg/L) for two-minute decoctions (Jurdi et al, 2001). -Fluoride intake from non-milk fluids, expressed as % of the estimated safe & adequate (ESA) intake of fluoride, was found to exceed the ESA level for all the rural children studied (0-2 years) and for the urban children aged 7-12 months(Jurdi et al, 2001) -There are no data for fluoride intake from food in the Lebanese market. For example, fish can contain fluoride levels of ranges 2-5mg/kg, reaching 370mg/kg intake for canned fish (Abu Zeid and EL-Hatow, 2007). -The concentration of fluoride in dentifrices used by children 3-5 years of age ranges from 0.1 -0.86 ppm. Fifty children (26%) of 192 had ever taken fluoride supplements (Doumit et al, 2004).
Renal and Urinary Fluoride Excretion	-Urinary fluoride excretion rates in children aged 3-5 were found to be approximately one half of optimal levels set by the WHO (Doumit et al, 2004). -Renal fluoride excretion in children aged 3-5 varied by region, but compared to provisional WHO standards, correspond to a low fluoride intake (Doumit et al, 2004). -Data is not available for other age groups.
Iodine intake	-A subgroup of the Lebanese population suffers from mild iodine deficiency, with a median urinary iodine excretion (UIE) of 95ug/L (Global Iodine Nutrition Scorecard, 2012) compared to the optimal level of 100-199 ug/L (WHO, 2013). - Iodine nutrition was classified as mild iodine deficiency in the age group 6–12 (data from year 1997) (Global nutrition report, 2014).

Synthesis of Identified evidence

We identified 12 systematic reviews that focused on the benefits and adverse effects of water and salt fluoridations and another 12 systematic reviews (including 1 overview of 7 Cochrane reviews) that focused on the effects oral health programs on dental caries.

We will begin this section with a summary of the best available evidence on water and salt fluoridation followed by an overview of the evidence on oral health programs.

Water and Salt Fluoridation

Water and salt fluoridation operate systemically because the fluoride consumed through these interventions is ingested in the body. However, the importance of systemic administration of fluoride has come under question with studies showing that the cariostatic[3]effect of fluoride is almost exclusively post-eruptive and the mechanism of action is primarily topical, making it unnecessary to ingest fluoride (EFSA 2013, Oganessian et al., 2007; Fejerskove, 2004; Zimmer et al, 2003; CDC, 2001).

While the evidence shows that fluoridation of drinking water at levels of 1ppm is beneficial in reducing dental caries among children and adult, it also leads to the development of "any fluorosis"[4] and fluorosis of aesthetic concerns.

At higher concentrations, fluoride is toxic and leads to diminished IQ levels and cognitive disorders among children.

Fluoride can also disrupt the normal functioning of the endocrine system including thyroid function, with the latter effect pronounced even at fluoride intake of 0.03 mg/kg/day in the presence of iodine deficiency.

The evidence for the adverse effect of fluoride on bone fracture and cancer is mixed, with studies reporting either deleterious

Text Box 3: Identification and Selection of Research evidence

We searched the following databases:
1) **Pubmed** using the following key words and limiting the search to systematic reviews: (fluorid*[TIAB] OR fluorin*[TIAB] OR flurid*[TIAB] OR florin*[TIAB]) AND (salt*[TIAB] OR water*[TIAB])
2) **Medline** using the following meshes and limiting to English, systematic reviews, and humans: exp Oral Health/ OR *Dental Caries/ OR exp Cariostatic Agents/ OR (exp Sodium Fluoride/ OR exp Fluorides, Topical/ OR Fluorides/ and
3) **Cochrane** database for systematic reviews.

One reviewer assessed the studies for inclusion. A systematic review was included if it met the following criteria:
-Focused on water or salt fluoridation or on oral health programs to improve oral health and reduce dental caries
-At least one bibliographic database was searched

In the absence of systematic reviews, we included high-quality single studies.

For each review included in the synthesis, we documented the search date, the countries of the included primary studies, the key findings, and the methodological quality.

[3] Cariostatic: tending to inhibit the formation of dental caries

[4] 'This is defined as any degree of dental fluorosis on any fluorosis scale

or protective effects at levels equal to or higher than 1ppm. The evidence for Down's syndrome is inconclusive.

Salt fluoridation may also be beneficial in reducing dental caries among children aged 6-15 years old, although its contribution to the declines in DMF scores could not be quantified (in the systematic review) due to participants' exposures to other sources of fluoride. Salt fluoridation also leads to the development of fluorosis. There is currently no evidence available to determine the impact of salt fluoridation on fracture risk, cancer, Down's syndrome, and other adverse effects.

Having said the above, it is important to note that the different studies within the systematic reviews varied in the fluoride concentrations at which adverse effects were reported. Indeed, the concept of an "optimal" level for fluoride intake has been debated (Peckham and Awofeso, 2014; European Commission, 2011; Warren et al, 2009; Ismail, 2008; Burt and Eklund, 2005) (see Annex A for critical information on fluoride concentrations).

A summary of the key findings from the evidence search is displayed in Table 2 below, stratified by the type of outcome (see Appendices C and D for more details).

Table 2: Summary of Key findings related to Water and Salt fluoridation

Outcome[5]	Summary of Key Findings
Dental Caries	*Water fluoridation (2 systematic reviews, 1 meta-analysis)* -Moderate quality evidence suggests that fluoridation of drinking water at levels of 1ppm reduces the prevalence of dental caries among children and adults. -The evidence also indicates that caries prevalence increases after the discontinuation of water fluoridation in areas that had been previously fluoridated. -The evidence from one systematic review suggested no difference by social class in proportion of caries-free children, with a difference observed only when measuring the number of decayed, missing, or filled teeth (DMFT). *Salt fluoridation (3 systematic reviews)* -Two of the systematic reviews did not identify any eligible studies that met their quality criteria. -The best available evidence suggests that fluoridated salt can reduce caries and decrease the prevalence of DMFT in populations of children aged 6-15 years. -However, the contribution of fluoridated salt to declines in DMF scores could not be quantified due to participants' exposures to other sources of fluoride.
Fluorosis	*Water fluoridation (3 systematic reviews)* -Fluoridation to concentration of 1ppm is strongly associated with an increased risk of

[5] The definitions for dental caries, fluorosis, endocrine system and Down's Syndrome are provided in Annex 1

Outcome[5]	Summary of Key Findings
	developing 'any fluorosis'[6] and for developing 'fluorosis of aesthetic concern. -One systematic review found that the prevalence of any fluorosis at a water fluoride concentration of 1 ppm was 48% and for fluorosis of aesthetic concern, 12.5%. *Salt fluoridation (3 systematic reviews)* -Existing evidence indicate that salt fluoridation is strongly associated with increased risk of any fluorosis.
IQ	*Water fluoridation (3 systematic reviews)* -The evidence indicates that children in high-fluoride areas have significantly lower IQ scores than those who lived in low-fluoride areas. -The consistency of the results among the different studies establishes a strong case that elevated levels of fluoride impair intelligence. -Such effect was observable at fluoride concentrations below 3ppm for at least 15 studies and above 3 ppm for the remaining studies. *Salt fluoridation (1 systematic review)* -The systematic review did not identify any eligible study. There is currently no evidence[7] available to determine the impact of salt fluoridation on IQ.
Endocrine function	*Water fluoridation (1 systematic review, 1 non-systematic review)* -The systematic review identified 1 study (out of 3) which found a significant increase in goiter and mental retardation in areas with low-iodine and high fluoride level (0.5–5.5 ppm). -The US National Research Council Review found several lines of information indicating an effect of fluoride exposure on normal endocrine function including thyroid function, thus concluding that fluoride is an endocrine disruptor. -Altered thyroid function was associated with fluoride intakes as low as 0.05-0.1 mg /kg/day, or 0.03 mg/kg/day with iodine deficiency. -Increased prevalence of Goiter (›20 percent) was associated with fluoride intakes of 0.07-0.13 mg/kg/day, or 0.01 mg/kg/day with iodine deficiency. *Salt fluoridation (no systematic review)* -No systematic reviews were identified
Bone fracture	*Water fluoridation (3 systematic reviews)* -There is moderate evidence that water fluoridation at levels equal to or higher than 1ppm appears to have little effect on fracture risk, either protective or deleterious. -The evidence is mixed with no definite patterns of association for fractures of the hip or other fractures. -One systematic review noted two studies which suggested that higher fluoride exposures above 1.5 ppm may be associated with an increased risk of fracture. *Salt fluoridation (1 systematic review)* -The systematic review did not identify any eligible study. There is currently no

[6] 'This is defined as any degree of dental fluorosis on any fluorosis scale

[7] Absence of evidence is not evidence of absence or no adverse effects

Outcome[5]	Summary of Key Findings
	evidence available to determine the impact of salt fluoridation on fracture risk.
Cancer	*Water fluoridation (2 systematic reviews*) -There is no clear association between water fluoridation and overall cancer incidence for 'all cause' cancer, and specifically for bone cancer and osteosarcoma. -The evidence is mixed, with small variations on either side of the effect (10 analysis found more cancers with fluoridation, 11 found fewer cancers with fluoridation, and 3 found no effect). -One study included in the systematic review found an association between fluoridation and increased cancer incidence in 23 of the 36 bodily sites investigated, and between fluoridation and decreased cancer incidence in 4 sites. *Salt fluoridation (1 systematic review)* -The systematic review did not identify any eligible study. There is currently no evidence available to determine the impact of salt fluoridation on cancer.
Down's Syndrome	*Water fluoridation (2 systematic reviews)* -The evidence of an association between water fluoride level and Down's syndrome incidence is inconclusive. -The concentration of fluoride ranged from 0.00-2.8 ppm for the different studies. *Salt fluoridation (1 systematic review)* -The systematic review did not identify any eligible study. There is currently no evidence available to determine the impact of salt fluoridation on Down's Syndrome.

Oral health programs

Several countries have implemented national oral health programs to promote oral health and reduce dental caries. These programs include a mix of school-based tooth-brushing programs coupled with community education and awareness campaigns to promote healthy dietary behaviors among children and adults. Such programs also incorporate the application of topical fluoridations (through the use of fluoridated toothpastes, gels, varnishes and mouth rinses) as one of their components.

While we could not identify systematic reviews that focused on the effectiveness of comprehensive oral health programs, we found evidence on the effectiveness of the different components in reducing dental caries and improving oral health. Topical fluoridation through the use of fluoride-containing toothpastes, mouth-rinses, gels and varnishes was highly effective in reducing dental caries. The evidence on the association between fluoride concentration of toothpaste used and fluorosis was inconsistent. Incorporating oral health as part of a school's health promotional activities showed promising results in achieving behavioral change and reducing dental caries. Incorporation of community participatory models also appeared to narrow oral health inequalities by social class. The use of Xylitol chewing gum and vitamin D supplements was also shown to reduce dental caries.

The key findings related to oral health programs are summarized in Table 3 below, stratified by type of intervention (see Appendix D for more details):

Table 3: Summary of Key Findings related to Oral Health Programs

Intervention	Summary of key findings
Topical Fluoride (1 overview of 7 systematic reviews; 1 systematic review)	-An overview of 7 Cochrane systematic reviews firmly established the effectiveness of topical fluoride applications (toothpaste, mouth-rinses, gels and varnishes) in reducing dental caries (Marinho, 2009). -No clear evidence was found that any modality is more effective than any other. -No conclusion could be reached about the risk that using fluoride toothpastes could lead to fluorosis. -Another overview of two Cochrane reviews found no significant association between the frequency of tooth brushing or the amount of fluoride toothpaste used and fluorosis, with inconsistencies in the association between fluoride concentration of toothpaste used and fluorosis (Wong et al., 2011). -The overview found weak, unreliable evidence that starting fluoride toothpaste in children less than 12 months of age may be associated with an increased risk of fluorosis (Wong et al., 2011).
Behavioral interventions (2 systematic reviews)	-One Cochrane review found that children who received the school-based behavioral intervention (tooth brushing and dietary habits) developed fewer caries (1 study) and presented with less dental plaque (3 studies), but the authors concluded more research is needed to confirm these findings (Cooper et al, 2013). -Motivational interventions were found to be the most effective method for altering health behaviors in clinical settings compared to health education or counselling (Yevlahova and Satur, 2008).
Reduction of sugar intake (1 systematic review)	-There was largely consistent evidence that supported the association between the amount of sugars intake and the development of dental caries across age groups (Moynihan and Kelly, 2014). -Moderate quality evidence showed that caries is lower when sugar intake is restricted to ‹10% energy (Moynihan and Kelly, 2014).
Parental influence (2 systematic review)	-One review concluded that parental variables (i.e. parental behavior, oral health, and attitudes, knowledge and beliefs) were important in the development of caries in children aged 0-6 years (Hooley et al, 2012). -Another systematic review found that parents' dental health habits influenced their children's oral health, suggesting oral health education programs that target the entire family (Castilho et al, 2013).

Intervention	Summary of key findings
Use of Xylitol chewing gum (2systematic reviews)	-There was consistent evidence to support the use of xylitol- and sorbitol-containing chewing gum to prevent dental caries in school-age children compared to flossing and regular brushing with a fluoride or non-fluoride containing toothpaste (Mickenautsch and Yengopal, 2012). -Another systematic review found that the use of sugar-free chewing gum as an adjunct to tooth brushing provides a small but significant reduction in plaque scores (Keukenmeester et al, 2013).
Dietary supplements (1 systematic review)	-The systematic review concluded with a low-certainty that vitamin D may reduce the incidence of caries (Hujoel, 2012). -There were no detectable differences in the caries preventive effects of ultraviolet radiation therapy or nutritional supplementation (either with vitamin D2 or vitamin D3) (Hujoel, 2012).
Oral Health Promotion models (2 systematic reviews)	-Chairside oral health promotion has been shown to be effective more consistently than other methods of health promotion. Mass media programs have not been shown to be effective (Kay and Locker, 1998). -Information giving alone is not an effective approach to improve oral health status (Satur et al, 2010). -Incorporating oral health into health promoting schools approaches showed promising results when included as part of a comprehensive approach including healthy food policies in schools and educational approaches (Satur et al, 2010). -The incorporation of community participatory models appeared to narrow oral health inequalities by social class, improve engagement in communities at high risk of oral diseases, and facilitate healthier snacking among children from 'disadvantaged' schools (Satur et al, 2010).

What other countries are doing

This section will primarily focus on providing information about the application of salt fluoridation interventions in several European countries. In addition, a brief summary on existing oral health programs will be included. Water fluoridation interventions will not be discussed in this section; nevertheless, it is worth noting that water fluoridation schemes have been withdrawn in countries such as Germany, Finland, Japan, the Netherlands, Sweden, and Switzerland (Cheng, 2007). As of 2012, 25 countries worldwide operate artificial water fluoridation schemes (British Fluoridation Society, 2012).

How other countries applied Salt Fluoridation Programs

Salt fluoridation emerged as an alternative to water fluoridation in areas where implementation of the latter is not plausible. In fact, one of the attractions towards implementing salt fluoridation is that it does not limit consumers' choice since a fluoridated salt can be sold alongside non-fluoridated alternatives (WHO, 2010).

Overview of legislation for fluoridated salt

(Marthaler, 2013; Gotzfried, 2006; Martheler and Peterson, 2005; Baez, 2000)

In Europe, fluoridation of salt has always been on a voluntary basis where legislation allowed for the presence of both fluoridated and non-fluoridated salts in the market, thus providing consumers with the option of also buying edible salts without fluoride. None of the European countries listed in table 4 have water fluoridation systems operating in conjunction with their salt fluoridation programs, except Spain where around 10% of the population is covered (see table 4). Universal salt fluoridation has been implemented only in few countries in Latin America such as Jamaica and Costa Rica. Below is a summary of the legislations pertaining to salt fluoridation in some European countries.

Table 4: **Summary of legislations for fluoridated salts in some European countries**

European Country	Law/Authorization	Type of Fluoridated salt	Concentration (mg F per kg of salt)	Availability (H=Household)	Market share (% of household)	Availability of fluoridated water[8]
Austria	Letter from Federal Ministry of Health and Consumer Protection dated April 10th, 1995	KF	200–250	H	6	Never implemented fluoridation. 2% of population receive natural fluoridation
Czech Republic	Communiqué No. 331 of the Czech Ministry of Agriculture of 1997 on Law No. 110 of 1997	KF, NaF	250	H	15	Water fluoridation was fully abandoned in 1993. 0.14% receive naturally fluoridated water
*France	Decree on Edible Salt and Additives for its	KF	250 +/– 15%	H School	27 (2003) Below 10	Water is not artificially

[8]Source: British Fluoridation Society, 2012; Cheng, 2007; Marthaler and Pollak , 2005; Mullen, 2005; British Fluoridation society, 2004; Meyer, J., and Wiehl, P.P. Wiehl, 2003; NCFPR, 2000; Kalsbeek et al., 1993

European Country	Law/Authorization	Type of Fluoridated salt	Concentration (mg F per kg of salt)	Availability (H=Household)	Market share (% of household)	Availability of fluoridated water[8]
	Fortification dated May 28 1997			canteens	(2010)	fluoridated. 3% of the population uses naturally fluoridated water
**Germany	Exceptional time-limited agreements (Section 37 Foodstuffs and Food Contact)	KF, NaF	250 +/– 15%	H	65	Drinking water is not fluoridated in any part of Germany
***Slovakia	Foodstuffs Code, part 3, chapter 23 on Edible Salt (Decree No. 1781/3/1999-100 dated June 2, 1999)	KF	260	H	Unknown (very limited)	A water fluoridation policy existed up to 1989
Spain	Royal Decree 1424/1983	KF, NaF	90–225	H	10	Around 10% of the population receives fluoridated water
Switzerland	Nutrients Order SR 817.021.55 by the Swiss Department of the Interior, Article 10, dated June 26 1995	KF, NaF	250	H Foodstuff processing Commercial caterings	85	Water fluoridation programs had operated only in the City of Basel, but was ceased in April 2003
Belgium	The use of fluoride in food supplement and salt is currently not permitted due to safety concerns	_	_	_	_	No fluoridation but legislation allows it
Netherlands	Fluoridated edible salt is only produced for export	_	_	_	_	Drinking water no longer fluoridated since 1973
Greece	Fluoridated salt would be legal but there seems to be no interest	_	_	_	_	There is no water fluoridation in Greece

*Packaging must bear: “Not permitted for use when the drinking water contains more than 0.5 mg/L of fluoride.” Edible salt containing sodium fluoride and potassium iodate is not permitted

**Licenses are only valid for household salt in packages of up to 500 grams. Packaging must bear the wording "with the addition of fluoride. Packaging should also state "If using this edible salt, medicines containing fluoride should only be taken on the advice of your doctor"
***Any launch of a table salt has to be notified to the local or regional Sanitary Inspector at the time of marketing at the latest.

How other countries implemented Oral Health Programs

Oral health programs have been implemented in several countries to promote oral health and reduce dental caries. The rationale behind adopting such programs may relate to the following:

1. There is extensive evidence that dietary sugars and/or carbohydrate-rich diet are the main cause of dental caries (Sheiham and James, 2014; Moynihan and Kelly, 2014; Rugg-Gunn, 2013).
2. The cariostatic effect of fluoride is almost exclusively post-eruptive and the mechanism of action is primarily topical, making it unnecessary to ingest fluoride (EFSA 2013, Oganessian et al., 2007; Fejerskove, 2004; Zimmer et al, 2003; CDC, 2001).
3. Fluoride is not an essential nutrient. It has no known essential function in human growth and development (European food safety authority, 2013). No disease, not even tooth decay, is caused by a "fluoride deficiency" (NRC, 2006; Peterson et al, 2004; NRC 1993; Institute of Medicine 1997).

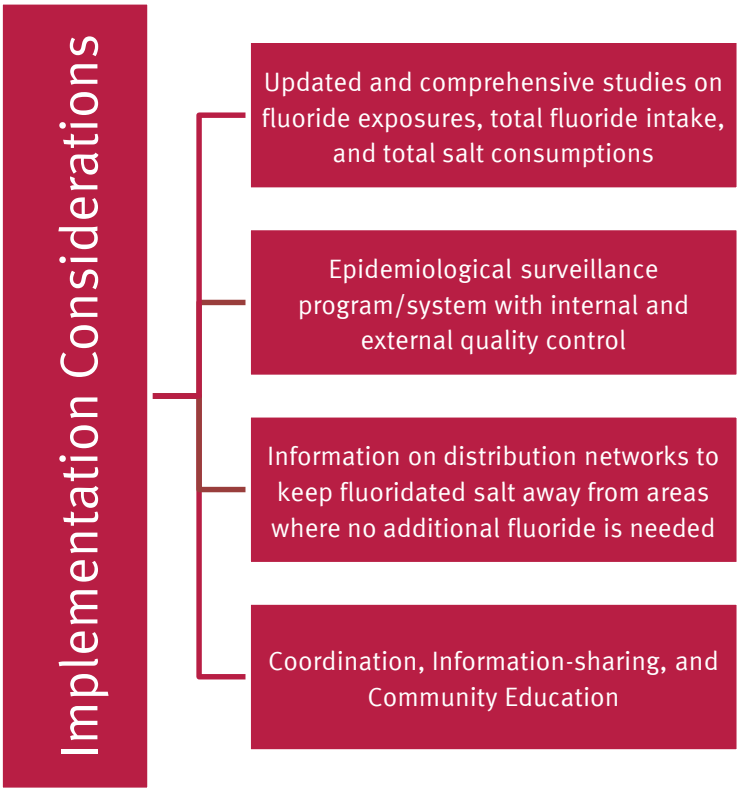
Preventive dental programs for school-age children have been implemented in Argentina, Federal Republic of Germany, France, Japan, Singapore, Sweden, Thailand, and the United Kingdom (Frazier, Jenny, and Johnson, 1982). In Scandinavia, oral health information systems remain an integral part of health service systems (Peterson et al, 2005). The introduction of fluoride toothpastes is favored as the key measure for improving public dental health in Central and Eastern Europe (for example Romania, Slovenia, Croatia, Poland, and The three Baltic states) (Marthaler and Pollak, 2005). The most recent success story comes from Scotland where the Government opted to pursue a program which adopted school-based tooth brushing schemes and the offering of healthy snacks and drinks to children, coupled with oral health advice to children and families on healthy weaning, diet, teething and tooth brushing (Information Services Division Scotland, 2013). The program proved to be successful in preventing the development of dental caries and DMFT among children and adolescents (Macpherson and Anopa, 2013). In addition, the introduction and uptake of nursery school tooth-brushing have contributed to an improvement and reduction in inequalities in the dental health of 5-year-old children (Anopa et al,

2014). National oral health promotion and education programs were also shown to be effective community-based preventive approach for improving oral health in children in Austria, England, and China (Lam, 2014; Peterson et al, 2005).

Attempts have been made to address considerations of equity while implementing oral health programs in other countries. The WHO Oral Health Program, for example, has promoted the development and use of "Affordable" fluoride toothpastes which can be purchased by people of low socioeconomic statuses (Jones et al, 2005). In Indonesia, a supervised school-based program for affordable fluoride toothpaste demonstrated its efficacy in significantly reducing dental caries and confirmed that companies can manufacture low-cost effective toothpastes. According to WHO, local studies in developing countries have also shown that affordable fluoridated toothpaste is effective in caries prevention and should be made available for use by health authorities in developing countries (WHO website; Yee, 2008).

Implementation Considerations

Implementation Considerations related to Salt Fluoridation Programs



Based on the experiences of several countries (see previous section), the following factors need to be taken into consideration when considering the

implementation of salt fluoridation programs (Marthaler, 2013; Gotzfried, 2006; Martheler and Peterson, 2005; Pan American Health Organization, 2005; Baez, 2000):

1) Before introducing any fluoridation or supplementation programs for caries prevention, it is crucial to have adequate planning and assessment. Public health administrators should have updated and comprehensive data on the total fluoride exposure and the total fluoride intake among the different age groups within the population as well as data on the total salt consumption pattern as detailed in table 5 below:

Table 5: Types of exposure studies required prior to implementing a salt fluoridation program

Fluoride exposure studies	**Salt consumption studies**
Fluoride in drinking water	Domestic salt
Fluoride in water supplies	Salt added in large kitchens
Fluoride in dental products including toothpastes	Salt used in bakeries
Fluoride supplements	Salt added during processing in food industry
Fluoride in diet (food, bread, tea, beverages) including imported processed food	Salt from imported processed food
Other potential sources	Other

2) The establishment of an epidemiological surveillance system is an indispensable step to determine the required dosage of fluoride in salts that is assumed to impose minimum risk on health, detect deviations, identify areas where fluoridated salts should not be made available, propose alternative solutions, and establish corrective measures. Epidemiological surveillance is carried out through continuous and systematic collection of epidemiological information by qualified and well-trained personnel on the following measures:

- Urinary fluoride excretion (urinary samples from school children and adults should be taken prior to fluoridation, and every 6 months after the supplementation of salt with fluoride for a period of two years).
- Fluoride dosages in salt (which must be classified as a Critical Control Point)
- Fluoride concentration in drinking water and water supplies (at different seasons) in places where fluoridated salt is consumed
- Fluoride concentration in dental care products and fluoride supplements
- Monitoring of salt samples at production sites and points of sale
- Monitoring of market samples and the distribution of samples to non-domestic use
- Monitoring the use of fluoridated toothpaste in preschool children
- Nutritional status of preschoolers
- Periodic evaluation of dental status carries and enamel fluorosis. For the permanent maxillary central incisors, the window of maximum susceptibility to fluorosis is the first 3 years of life. Thus, a close monitoring of fluoride intake is needed during this time (Buzalaf and Levy, 2011).
- Assessment of environmental, packaging, and storage conditions of processed fluoridated salt s to minimize the possibility of segregation of fluoride in large sacks

3) Mapping the distribution network of fluoridated salt products prior to the initiation of the salt fluoridation program is essential to avoid their distribution to areas with adequate exposure to fluoride (e.g. regions with more than 0.7ppm fluoride in water). Specific attention may be needed for specific populations such as:
   - People with impaired renal functions or with an age-related decrease of glomerular filtration, due to their inability to effectively excrete fluoride and, therefore, their susceptibility to accumulate fluoride systemically (Torra et al., 1998; Jeandel et al., 1992; Schiffl and Binswanger, 1982; Schiffl and Binswanger, 1980)
   - Infants since their excretion of absorbed fluoride can be as low as 10-20 % (Villa et al., 2010; Agency for Toxic Substances and Disease Registry (ATSDR 1993)
   - Individuals with diabetes insipidus9 or uncontrolled/ poorly controlled diabetes mellitus (Teotia 1998; Chen 1997; Seow 1994;

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9 Diabetes insipidus is a condition characterized by excessive thirst and excretion of large amounts of severely diluted urine, with reduction of fluid intake

ATSDR 1993; Lin 1991) because these patients can consume large amounts of water per day which may increase their total fluoride exposure from water sources

- ⇢ Individuals who suffer from malnutrition as this may increase their vulnerability to dental caries risk due to calcium depletion and enamel hypoplasia (Sadashivamurthy and Deshmukh, 2012; Waszkiel et al, 2004; Teotia 1998; Chen 1997; Lin 1991; Okazaki, 1987; Marier & Rose 1977; Klein 1975; Greenberg 1974; Massler & Schour 1952).

4) There is a need for:
   - ⇢ Development of a detailed plan with assigned roles and responsibilities on the training needs and "how-to" of on-going monitoring, surveillance and evaluation of the salt fluoridation program.
   - ⇢ Legislative decrees addressing inspection and responsibilities of inspectors, laboratory schemes, and the role of ministries, among other issues
   - ⇢ Coordination with a country's existing food control system,
   - ⇢ Communication between the Directorate of Food and the Ministry of Health and other key stakeholders,
   - ⇢ Information sharing
   - ⇢ Community education
5) The production of salt fluoridation programs requires financial assistance and active cooperation with some of the salt producers to encourage the production of fluoridated salts at prices equal to non-fluoridated salts (Gillepsie and Marthaler, 2005).
   - ⇢ Salt fluoridation has been financed by governments (e.g. in Costa Rica, Swiss Canton of Zurich, and Cuba), private sources, salt factories (Jamaica) and international agencies. In Switzerland, an intelligent packaging policy was used which increased the market share of fluoridated salts without any cost (Gillepsie and Marthaler, 2005). Examples of approaches adopted by different countries are presented in Annex 1C.

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having no effect on the concentration of the urine. Patients with diabetes insipidus can consume large amounts of water per day.

- The production of fluoridated salts is coupled to promotional activities to support their use in areas with low fluoride exposures and/or high dental caries prevalence (as identified from the baseline assessments done prior to program implementation) (Gillepsie and Marthaler, 2005).

Implementation Considerations related to Oral Health Programs

Based on the experiences of several countries, three elements are essential to build comprehensive oral health preventive programs (Lam, 2014; Macpherson and Anopa, 2013; Frazier, Jenny, Johnson, 1982). These include:

1) **Oral health education/instruction:** Instructional activities and awareness campaigns aimed at promoting oral health practices and improving awareness and attitude towards dental health and healthy eating (including cutting down of sugar intake) that target not only children but also their parents, teachers, and health workers. Reinforcing and teaching tooth-brushing is a main component in oral hygiene instruction.
2) **Primary prevention measures:** These may include the use of topical fluoride agents (toothpaste and mouth rinses and other forms of professionally-applied fluoride such as gels and varnishes).
3) **Secondary prevention measures:** These involve managing caries through minimum invasion and low-cost methods. For example, a review found that silver diamine fluoride (SDF) is a simple and cost-effective agent that has a significant benefit in arresting and preventing caries (Chu and Lu, 2008) and has been used successfully to arrest caries in children for many years in China and Japan.

Barriers that need to be overcome to ensure the successful implementation of oral health programs include financial and human resources, public acceptance, policymakers' attitudes, policy decisions, legal constraints and transportation. The success of school-based oral health programs depends on the commitment of teachers, parents, schools and health authorities in the planning, implementation and review processes of the programs. As for the success of community-based oral health programs, it lies in their cultural location and their ability to incorporate participatory approaches and flexible delivery mechanisms to fit local needs (Lam, 2014; Topaloglu-Ak et al, 2009; Frazier, Jenny, Johnson, 1982).

To enhance equitable access to the benefits of oral health programs especially among disadvantaged population, it is important to consider the following two aspects:

- Launching school-based and community-based oral health promotion initiatives can improve equity in access to oral-health related interventions across different social classes (Satur et al, 2010). The use of school or community-based oral health promotions targeting disadvantaged populations were also shown to be successful in Sweden and Germany (Patel, 2012). In Danish, for example, the oral health of children was among the poorest in Europe; the use of targeted and proactive approach to deliver preventive care especially among high-caries individuals resulted in significant improvement in oral health with the interventions reaching over 99% of the Danish children (Patel, 2012).
- For programs incorporating the use of fluoridated toothpaste as part of their initiatives, it is important to facilitate the availability of affordable toothpaste among disadvantaged population to improve their access to such intervention (Yee, 2008; Jones et al, 2005; WHO website). The WHO Oral Health Program, for example, has promoted the development and use of "Affordable" fluoride toothpastes which can be purchased by people of low socioeconomic statuses (Jones et al, 2005). In Indonesia, a supervised school-based program for affordable fluoride toothpaste demonstrated its efficacy in significantly reducing dental caries and confirmed that companies can manufacture low-cost effective toothpastes. According to WHO, local studies in developing countries have also shown that affordable fluoridated toothpaste is effective in caries prevention and should be made available for use by health authorities in developing countries (WHO website; Yee, 2008).

Elements

Policy Elements and Implementation Considerations

Systemic fluoridation remains a debatable subject at the international level with proponents and opponents arguing for or against it (Peckham, 2014; Sampaio and Levy, 2011; Cheng et al, 2007; Ananian et al, 2006; Hellwig and Lennon, 2004). We present below policy elements and implementation considerations

Element 1: Re-evaluation of the current salt fluoridation law due to its potential adverse health effects

1) Implementation of the law in its current state could lead to potential adverse health effects among subgroups of the Lebanese population.

Available data indicate that 15 tested water sources in Lebanon (see Annex 1B) contain fluoride levels within or above the minimum recommended level of 0.5 mg/L for water fluoridation (see text box 2). Existing data also suggest that a subgroup of the Lebanese population may already be exposed to adequate fluoride intake from their diets (see table 1). For example, the concentration of fluoride in tea, which many Lebanese drink heavily, appears to be substantial, ranging from 0.620 to 1.680 mg/L (Jurdi et al, 2001). Similarly, infants under the age of 2 were exposed to fluoride from non-milk fluids beyond the estimated safe and adequate (ESA) level of intake (Jurdi et al, 2001). In addition, there are no data on fluoride intake from food and other beverages and on the use of fluoridated dental care products and supplements that encompass the different age groups in Lebanon.

There is a concern that fluoridation of salt could lead to increased total intake of fluoride by a large margin for some individuals, putting them at risk of experiencing potential adverse health effects[10] beyond fluorosis. (Cheng et al, 2013; Choi et al, 2012; Tang et al, 2008; NHMRC, 2007; Khan et al, 2005; Soto-Rojas et al, 2004; McDonagh et al., 2000).

[10]Although data on adverse health effects beyond fluorosis was available only for water fluoridation, most of the experiences gained through water fluoridation can also apply to salt fluoridation since both operate systemically and the potential adverse effects are associated with the level of total fluoride intake (Ozsvath, 2009) as opposed to the route of delivery (i.e. water or salt).

At higher exposures, fluoride could lead to diminished IQ levels and cognitive disorders among children.

It could also disrupt the normal functioning of the endocrine system including thyroid function, with the latter effect aggravated in individuals with iodine deficiencies. This raises concern since a subgroup of the Lebanese population including children was found to suffer from mild iodine deficiency (Global nutrition report, 2014; Global Iodine Nutrition Scorecard, 2012).

There is also mixed evidence suggesting that such exposures may increase the risk of bone fracture and may be associated with increased risk of cancer in the long-run (NHMRC, 2007; McDonagh et al., 2000).

2) The current law can also disproportionately exacerbate the health status of some vulnerable populations. These populations may include:

- People with impaired renal functions or with an age-related decrease of glomerular filtration, due to their inability to effectively excrete fluoride and, therefore, their susceptibility to accumulate fluoride systemically (Torra et al., 1998; Jeandel et al., 1992; Schiffl and Binswanger, 1982; Schiffl and Binswanger, 1980)
- Infants since their excretion of absorbed fluoride can be as low as 10-20 % (Villa et al., 2010; Agency for Toxic Substances and Disease Registry (ATSDR 1993)
- Individuals with diabetes insipidus[11]or uncontrolled/ poorly controlled diabetes mellitus (Teotia 1998; Chen 1997; Seow 1994; ATSDR 1993; Lin 1991) because these patients can consume large amounts of water per day which may increase their total fluoride exposure from water sources
- Individuals who suffer from malnutrition as this may increase their vulnerability to dental caries risk due to calcium depletion and enamel hypoplasia (Sadashivamurthy and Deshmukh, 2012; Waszkiel et al, 2004; Teotia 1998; Chen 1997; Lin 1991; Okazaki, 1987; Marier & Rose 1977; Klein 1975; Greenberg 1974; Massler & Schour 1952).

[11]Diabetes insipidus is a condition characterized by excessive thirst and excretion of large amounts of severely diluted urine, with reduction of fluid intake having no effect on the concentration of the urine. Patients with diabetes insipidus can consume large amounts of water per day.

3) In its current form, the law could bear ethical implications related to informed consent and people's autonomy and their right to decide whether or not to use fluoridated salts (Cheng et al., 2007).

While mandatory action against informed consent may incur ethical implications, provision for exceptions to the principle of informed consent can be made under certain situations where the potential benefit of the proposed law or intervention is balanced against the established adverse effects, uncertainties about harms, other effective prevention methods, and people's right to autonomy (Cheng et al., 2007).This can apply to the case of salt iodization since iodine is an essential component of the thyroid hormones necessary for normal growth, development, and metabolism(CDC, 2012). In the absence of iodine (i.e. iodine-deficiency) a series of functional and developmental abnormalities occur, including thyroid function abnormalities (Gunnarsdottir and Dahl, 2012). Hence, the use of salt for the delivery of iodine is justified since there are no alternatives to treating iodine-deficiencies other than ingestion of iodine itself. Fluoride, on the other hand, is not an essential nutrient. It has no known essential function in human growth and development (European food safety authority, 2013). No disease, not even tooth decay, is caused by a "fluoride deficiency" (NRC, 2006; Peterson et al, 2004; NRC 1993; Institute of Medicine 1997). In addition, the cariostatic effect of fluoride is primarily topical, making it unnecessary to ingest fluoride (EFSA 2013, Oganessian et al., 2007; Fejerskove, 2004; Zimmer et al, 2003; CDC, 2001). And unlike iodine, there are alternatives to treating dental caries other than the ingestion of fluoride[12].

In light of the aforementioned implications, a re-evaluation of the salt fluoridation law can take the following issues into consideration:

Conduct a thorough assessment of the readiness of the Lebanese context for salt fluoridation programs. Updated and comprehensive fluoride exposure studies among different age groups (including infants aged 0-2 years and adults) are crucial to account for fluoride from i) existing and new water sources (e.g. new wells and drinking bottles) as well as other water sources[13] not tested in previous studies; ii) dietary habits (e.g. consumption of tea, other beverages, and food including imported and canned food which can contain high fluoride levels); and iii) the use of fluoridated dental care products and supplements. These need to be complemented with urinary fluoride excretion studies as well as studies on DMFT and dental fluorosis across

[12] A recent review in The Lancet classified fluoride as a developmental neurotoxicant (Grandjean and Landrigan, 2014)

[13] It is estimated that 650 public wells and over 43,000 private wells existed pre-water crisis in Lebanon (WASH Sector, 2014).

various age groups. (Marthaler, 2013; Gotzfried, 2006; Marthaler and Peterson, 2005, Pan American Health Organization, 2005). It may also be important to have updated studies on the nutritional status (e.g. iodine) of the population, especially children, as part of the baseline assessment.

The availability of such studies is necessary to reflect the present context and status of the Lebanese population. The results of such assessments would then inform decisions on the viability of this current law or whether it should be completely taken out. This re-evaluation could be guided by the experiences of other countries as outlined in this document.

Element 2: Implementation of Oral health programs

Oral health programs are alternative public health approaches to promote oral health and reduce dental caries that do not involve systemic ingestion of fluoride. Components of the program can include dental health education, awareness campaigns to promote regular tooth-brushing and healthy dietary behaviors among children and adults, appropriate use of topical fluoride products, and periodic examination by a dentist (Jumana B. Ammari, 2007).

There is sufficiently high evidence from an overview of 7 Cochrane systematic reviews that topical fluoride applications (one of the key components of oral health programs) will reduce dental caries among children and adults irrespective of other sources of fluoride exposure (Marinho, 2009). The overview confirms a clear and similar effectiveness of fluoride toothpastes, mouth rinses, gels and varnishes for preventing caries. However, young people were more likely to persist with using toothpaste, thus highlighting its major role as an effective and acceptable public health approach for the prevention of dental caries (Marinho, 2009).

National oral health promotion and education programs were shown to be effective preventive approaches for improving oral health in children in Scotland, Austria, England, and China (Lam, 2014; Macpherson and Anopa, 2013; Peterson et al, 2005). The use of school or community-based oral health promotions targeting disadvantaged populations were shown to be successful in Sweden and Germany (Patel, 2012).In Danish where the oral health of children was among the poorest in Europe, the use of targeted and proactive approach to deliver preventive care especially among high-caries individuals resulted in significant improvement in oral health with the interventions reaching over 99% of the Danish children (Patel, 2012).

Based on the identified evidence, the implementation of oral health programs can incorporate a mix of the following elements:

1) Increasing the availability and use of affordable fluoride toothpastes[14]. The international standard fluoride concentration recommended for younger children is 1000 ppm fluoride and can reach up to 1500 ppm for older children (Walsh et al., 2010; Wong et al, 2011).

2) Awareness campaigns to promote brushing of teeth twice daily and adopt healthy dietary habits as part of a concerted effort involving the dental profession, teachers, parents, the government, consumer associations and other stakeholders (Lam, 2014; Frazier, Jenny, Johnson, 1982). Chairside and motivational interventions have been shown to be effective more consistently than other methods of health promotion in achieving change (Yevlahova and Satur, 2008; Kay and Locker, 1998).

3) Incorporating oral health as part of a school's health promotion activities including the implementation of healthy food policies in schools and educational approaches to effectively achieve behavioral change (Cooper et al, 2013; Satur et al, 2010).

4) Incorporating community participatory models that can help in narrowing oral health inequalities and promote engagement in communities at high risk of oral diseases (Satur et al, 2010).

5) Promoting the use of sugar-free chewing gum after meals among high-caries risk individuals and the use vitamin D supplements in early childhood (Keukenmeester et al, 2013; Hugeoul, 2013; Mickenautsch and Yengopal, 2012).

[14] Use of fluoridated toothpastes is recommended after the age of 12 months to minimize the development of any potential fluorosis (Wong et al, 2011). It is also recommended to use a pea-size amount of toothpaste (with parental/teacher supervision) for children under the age of six. Regular use of fluoride mouth rinse may not be suitable for young children (below the age of 10) because they are likely to swallow the solution (Marinho, 2009).

Next Steps

The aim of this rapid response is to foster dialogue informed by the best available evidence. The intention is not to advocate specific policy element or close off discussion. Further actions can flow from the deliberations that the rapid response is intended to inform. These may include:

- Deliberation amongst policymakers and stakeholders regarding the policy elements described in this rapid response
- Refining elements, for example by incorporating components of elements, removing or modifying components.

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Annexes

Annex 1

A. Glossary

Dental caries: This refers to the formation of cavities in the teeth also known as tooth decay. Caries development is multifactorial (dietary sugars, extent and frequency, microbial population and composition of plaque, genetics and the oral environment) (ESPA, 2013)

Down's syndrome: A congenital disorder arising from a chromosome defect, causing intellectual impairment and physical abnormalities including short stature and a broad facial profile

Endocrine System: The endocrine system is made up of the pituitary gland, thyroid gland, parathyroid glands, adrenal glands, pancreas, ovaries (in females) and testicles (in males). The endocrine system is the collection of glands that produce hormones that regulate metabolism, growth and development, tissue function, sexual function, reproduction, sleep, and mood, among other things.

Fluorosis: There are two types of fluorosis (WHO, 2010):

> *Enamel fluorosis*: can develop only in children during the period of tooth development and is characterized by the appearance of white areas in the enamel. In severe forms, reduced mineralization of the enamel results in stained and pitted teeth.
>
> *Skeletal fluorosis*: fluoride accumulates progressively in the bone over many years. Early symptoms include stiffness and pain in the joints. Crippling skeletal fluorosis is associated with osteosclerosis, calcification of tendons and ligaments, and bone deformities.

B. Concentration of fluoride in tested water sources

Serial Number	Water Source	Concentration (mg/L)
1.	Bir Bakka	0.54
2.	Baasir Well	0.83
3.	Ain El-Hawer	0.72
4.	Sibline Well*	2.5

Serial Number	Water Source	Concentration (mg/L)
5.	Sibline reservoir*	2.4
6.	Deir Amar well	0.6
7.	Mar Yousef	0.54
8.	Bakash	0.55
9.	Ras Maska	0.55
10.	Saadoun	0.58
11.	Maghdousha	0.55
12.	Khartoun	0.5
13.	Bablieh	0.55
14.	Ansarieh	0.53
15.	Zeffa	0.54

***These fall within industrial zones**

C. Approach adopted for financing salt fluoridation by different countries (Gillepsie and Marthaler, 2005; Marthaler 2005)

Costa Rica	The government acquired the equipment for the four processing plants while the large salt cooperative coordinated production, marketing and distribution. Salt costs were not increased.
Swiss Canton of Zurich	When salt fluoridation started, the Executive Council stated that "fluoro-iodized salt would be put on sale at the same price as iodized salt". The total cost of fluoride addition was too low to noticeably affect the total annual cost of salt production.
Cuba	All costs were absorbed by the government as an "Investment in Health" with achievement of 60% population coverage.
Jamaica	The salt industry absorbed the cost of equipment and fluoride with a small initial increase in the price of all salts (in this situation non-fluoridated salts were not available to compete with the higher price of fluoridated salt).
Switzerland	An intelligent packaging policy was used which increased the market share of fluoridated salts without any cost. This was due to the fact that fluoridated salt was offered in several package sizes while non-fluoridated salt is available only in the not very popular 500-g package

Annex 2

Details of the systematic reviews included in the evidence on water fluoridation

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[15]
Caries reduction	McDonagh et al., 2000 (26 studies) Search data: Up to 2000	US, Holland, England, Wales, Scotland, Taiwan, Germany, Chile, Finland, Singapore, Canada	Water fluoridation (02.-1.2 ppm) versus no fluoridation	-The best available evidence suggests that water fluoridation reduces caries prevalence, though the degree to which caries is reduced is not clear from available data. The range of the mean difference in the proportion of caries-free children in fluoridated and non-fluoridated ranged from -5 to	Moderate quality 23 before-and-after studies, 2 prospective cohort studies, 1 retrospective cohort study Confounding factors: age, gender, social class, use and consumption of fluoride, other sources of fluoride, method of measurement

[15] This does not reflect the quality of the systematic review itself (we could not identify AMSTAR scores for the included systematic reviews). Instead, the quality reflects that of the included studies within the systematic review and the overall findings of the review as judged by the respective authors. This applies to all the summary of finding tables.

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[15]
				64%, with a median of 14.6%. The range of the mean change in decayed, missing, and filled teeth (DMFT) score children in fluoridated and non-fluoridated was from -0.5 to 4.4, with a median of 2.25 teeth.	
	NHMRC, 2007 (1 study) Search date: 2000-2007	Finland	0.1 ppm (cessation of water fluoridation)	This study examined the percentage of caries-free children from 1992-1998, six years after the cessation of fluoridation of the water supply. There was a substantial increase in the percentage of caries-free children among 3, 6 and 9 year olds and a significant decrease in caries-free children among individuals aged 12 and 15 year olds following the cessation of water fluoridation.	Low quality Controlled before -after study Lack of information regarding sampling and potential confounding variables and no blinding of outcome assessment

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[15]
	(Griffin et al., 2007) (9 studies)* Search date: Up to 2004 *focused on water fluoridation	USA, Canada, Australia, Great Britain, Sweden, Illinois, Iowa, Indiana, Oregon, New york, Alabama	0.7-3.5 pm	The pooled results of 5 studies focusing on adults found the prevented fraction of caries for water fluoridation to be 27 % (95 % CI: 19 %-34 %) The findings suggest that water fluoridation prevents caries among adults	Author did not comment on the overall quality of studies 1 prospective cohort trial and 8 cross-sectional studies
Discontinuation of water fluoridation	McDonagh et al., 2000 (11 studies with 20 units of analysis) Search date: Up to 2000	-	ppm	12 analyses found increased caries in areas that had been previously fluoridated (4 were statistically significant) 8 analysis found that level of caries improved more in areas that discontinued fluoridation (2 were statistically significant) The best available evidence indicates that caries prevalence increases after discontinuation of fluoridation, approaching the	Moderate quality Not controlling for exposures to other sources of fluoride (e.g. toothpaste)

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[15]
				level of the low fluoride group	
Fluorosis	McDonagh et al., 2000 (88 studies) Search date: Up to 2000	-	Up to 5 ppm A sensitivity analysis excluded studies with fluoride concentration levels of › 1.5 ppm	A significant dose-response relationship was identified between fluoride levels and fluorosis. The pooled estimate of the prevalence of fluorosis at a water fluoride concentration of 1.0 ppm was 48% (95% confidence interval 40% -57%) and for fluorosis of aesthetic concern 12.5% (7.0% -21.5%). After excluding studies with › 1.5 ppm fluoride, fluoridated areas were 1.8 times more likely to develop any fluorosis and 2.04 times more likely to develop fluorosis of aesthetic concerns	Low quality (4 before-after, 1 case-control, 83 single time-point cross-sectional studies) Little effort to blind assessor or control for potential confounding factors (beyond stratification by age or sex)
	Khan et al, 2005	-	Up to 1.4 ppm	The prevalence of fluorosis in the	Low quality

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[15]
	(55 studies) Search date: 1980-2000			three fluoride categories (‹0.3, ›0.3 to ‹0.7, and ›0.7 to 1.4 ppm) were 16.7 %, 27.4% and 32.2%, respectively.	Lack of detail given regarding each included studies, and the lack of quality assessment.
	NHMRC, 2007 (10 studies) Search date: 2000 – 2007	Finland, Greece, Jordan, China Ireland, Japan, US , Iceland, Portugal, UK Netherlands	‹ 0.4 ppm versus at least one optimal fluoride region (0.8-1.2 ppm)	Fluoridation to optimal levels is strongly associated with an increased risk of developing any level of fluorosis and 'fluorosis of aesthetic concern. Pooled relative risk (RR) for developing fluorosis of any type and fluorosis of aesthetic concerns were statistically significant (RR: 2.54; CI: 1.52-3.56; and RR 4.01; CI: 3.15-5.10, p‹0.001, respectively).	Low quality (9 cross-sectional studies, 1 national survey) Only 3 assessed impact of potential confounders
Bone fracture	McDonagh et al., 2000 (29 studies)	-	The area with water fluoride level closest to 1ppm was chosen and	There were no definite patterns of association for fractures of the hip or "other sites" with fluoride	Low quality 4 prospective cohort, 6 retrospective cohort, 15

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[15]
	Search date: Up to 2000		compared to areas with lowest water fluoride levels reported	concentration. Hip fractures: (18 studies with 30 units of analysis) 14 analyses found decreased hip fractures with increased fluoride level, 5 of which were statistically significant. 13 analyses found increased hip fractures with fluoridated level, 4 of which were statistically significant. 3 analyses found no associations. Other fractures: (12 studies with 30 units of analysis) 14 analyses found more fractures with increased water fluoridation, of which one was significant. 13 analyses found fewer fractures with increased water fluoridation;	ecological, 1 case control, 1 case control and ecological 12 studies presented adjusted effect measures such as odds ration or relative risks, and five presented standardized results

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[15]
				of which one was statistically significant 3 analyses found no any association.	
	NHMRC, 2007 (3 studies) Search date: 2000-2007	Mexico, USA, China	Around 1 ppm versus higher exposure	Studies indicated that intentional water fluoridation at around 1 ppm has no negative effect upon fracture risk. The higher fluoride exposures of 2 studies suggest that levels › 1.5 ppm may be associated with increased risk of fracture	Low quality Three cross-sectional studies
	Jones et al., 1999 (21 studies) Search date: 1966 to Nov 1997	New York, Michigan, Canada, Utah, Rochester, Finland, North Dakota, Pittsburg, Rural	Mostly 1ppm with few studies reaching up to 4 ppm	Water fluoridation at levels for preventing dental caries and, possibly, at higher naturally occurring levels appears to have little effect on fracture risk, either protective or deleterious. There is current lack of consensus	Moderate quality 10 ecological studies, 11 cross-sectional studies and 3 cohort studies Most of the studies are prone

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[15]
		Iowa, Southwest France, Taiwan		for an effect of dose or duration of fluoride exposure, requiring further research The relative risk of fracture ranged from 0.22 to 2.10. Subgroup analyses found a statistically significant increase in fracture risk for the any/all fracture category but the magnitude of the effect was small (RR: 1.12 95% CI 1.04-1.21).	to ecological fallacy
IQ score	Choi et al, 2012 (27 studies) Search date: 1980–2011	China (25) Iran (2)	0.57-11 mg/L 9 studies had fluoride levels below 3ppm	The consistency of the study findings across the studies supports the possibility of an adverse effect of high fluoride exposure on children's neurodevelopment. Individuals in fluoridated areas had significantly lower IQ scores compared to individuals in non-	Low quality The studies were generally of insufficient quality and mainly cross-sectional

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[15]
				fluoridated. (standardized weighted mean difference (SMD): –0.45; 95% CI: –0.56, to –0.35) The heterogeneity was significant. -The results remained significant after excluding studies with other exposures (iodine) or non-drinking-water fluoride exposure (SMD: -0.29; -0.44-0.14)	
	Cheng et al, 2013 (38 studies)* Studies carried out between 1989 and 2012 *24 studies in common with the previous SR	China (30) Mexico (2) Iran (2) India (4)	5 of the studies outside China had less than 3ppm	The consistency of relationship in all 37 studies establishes a strong case that elevated levels of fluoride impair intelligence. The weighted mean effect size on children's IQ scores between higher and lower regions of fluoride exposure was -0.46; 95%CI: -0.57 to -0.35; p<.001) equivalent to 6.9 IQ points.	Low quality The authors mentioned that 74% of studies used randomly selected samples; In terms of confounding, 84% mentioned that high fluoride and reference groups were compatible in social, economic, & environmental condition, and were free from other sources of high fluoride

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[15]
				The adverse effect of fluoride on children's intelligence remained significant, equivalent to a difference in IQ point of 5.55, after excluding studies with non-drinking water fluorides. Six of the studies reported significant negative correlations between fluoride in the body and intelligence, where individuals with higher fluoride concentrations had lower IQs.	intake
	Tang et al, 2008 (18 studies)* Search date: 1988-2008 *Overlap with the above 2 SRs	All studies where from China	Not available	Children exposed to fluoride had significant increase in the risk of developing low IQ. Twelve studies found statistically positive association between exposure to fluoride and low IQ. The risk of developing low IQ ranged from a low of 0.2 to a high	Author did not comment on the quality of studies All included studies were case-control

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[15]
				of 10.78. Authors concluded that children living in fluorosis area are 5 times more likely to develop low IQ compared to people living in non-fluorosis or slightly fluorosis area	
Increased risk of cancer	McDonagh et al (2000) (26 studies) Search date: up to 2000	-	A non-fluoridated control area with an area with fluoridation of any level, i.e., natural or artificial	The authors concluded that the evidence relating fluoridation to cancer incidence or mortality is mixed. 9 analysis found more cancers with fluoridation, 11 found fewer cancers with fluoridation, and 2 found no effect. Only two studies reported statistically significant associations, with one study reporting a decrease in cancer mortality, and one reporting an increase in cancer incidence in	5 moderate-quality studies 10 before-after studies, 11 ecological studies, and 3 case-control 12 used standardization to control for age and sex, and four controlled for ethnic groups

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[15]
				two of the eight subgroups investigated.	
	NHMRC, 2007 (4 studies) Search date: 2000-2007	USA (2) Taiwan (1) 1 international comparison	Two studies had fluoride levels in the range of 0.2-1.0 ppm	The results of the studies provided mixed evidence. The study suggested an association between fluoridation and increased cancer incidence in 23 of the 36 bodily sites investigated, and between fluoridation and decreased cancer incidence in 4 sites, with no significant association for the 9 remaining sites. A good-quality study found an increased significant risk of osteosarcoma amongst young males in 6th to 8th years (but not females) exposed to 1 ppm water fluoridation. The third study indicated similar	Three ecological studies of low quality and one matched case-control study of good quality The ecological studies failed to account for confounding factors such as socioeconomic/ development status, smoking.

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[15]
				cancer mortality rates between un-fluoridated and naturally fluoridated areas (‹ 0.28 ppm) for males and females, except for significantly higher female bladder cancer mortality in fluoridated areas (authors suggested this is a chance finding as a function of the large comparisons). The fourth study found that the lower the fluoride level, the higher the cancer incidence.	
Down's syndrome	Whiting et al, 2000; McDonagh et al (2000) (6 studies) Search date: 1957 and 1980	US (5) England (1)	0.00-2.8 ppm (value not given for 1 study)	Authors concluded that the evidence of an association between fluoride level and Down's Syndrome is inconclusive. The crude relative risk ranged from 0.84 to 3.0.	Low quality Ecological studies with methodological limitations (none incorporated any form of blinding, had a baseline survey or stated how level of fluoride in the water was

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[15]
	Up to 2000			4 studies showed no significant associations between the incidence of Down's syndrome and water fluoride levels. 2 studies found significant increase in incidence of Down's syndrome in areas with higher water fluoride levels ($p < 0.01$, RR ranged from 2.3 to 3.0; however the authors did not control for confounding effects of maternal age).	calculated) Only 2 controlled for confounding factors
	NHMS, 2007 (1 study) Search date: 2000-2007	England	>0.9 ppm with <0.3 ppm	There was no difference in down's syndrome incidence in fluoridated and non-fluoridated areas (Odds = 1.05; 0.79–1.41)	Low quality Ecological data
Thyroid	McDonagh	-	0.98–5.5 ppm	One study found a statistically	Low quality

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[15]
	(2000) (3 studies) Search date: Up to 2000		0.62 - 4.00 mg/L	significant association of combined low-iodine/high fluoride with increased risk of goiter and mental retardation. The results were insignificant for the other two studies	
	1 non-systematic review US National Health Research, 2006	-	-	-Goitre prevalence of at least 20% have been reported in humans exposed to water fluoride concentration ≥ 0.2 mg/L (low iodine situation), or 1.5-3mg/L (under-nutrition, adequate iodine). -Altered thyroid function was associated with fluoride intakes as low as 0.05-0.1 mg /kg/day, or 0.03 mg/kg/day with iodine deficiency -Few studies did not report significant difference in thyroid function or thyroid stimulating	Most of the studies had limitations (did not report on dietary status or factors or levels of hormones and did not control for all relevant confounding factors)

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[15]
				hormones between populations with low and high (3-3.5 mg/L) fluoride concentrations in the drinking water. - Authors concluded that fluoride is an endocrine disruptor in the broad sense, with consistency among the available studies in the types of effects seen in humans (and animal studies) and in concentration of fluoride associated with the effects in humans.	

Annex 3

Details of the systematic reviews included in the evidence on salt fluoridation

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[16]
Prevention of dental caries	NHMRC; 2007 Search date 2000-2007	Mexico, Jamaica, Costa-Rica	-	No studies were identified which met the quality criteria for inclusion. The results of three before-and-after cross-sectional studies (not included in the review) suggest that salt fluoridation reduces caries in populations of children aged from 6-15	Low quality Before -after cross-sectional studies All studies failed to provide baseline and endpoint information and to adjust results for any differences, and potentially contributing factors.
	Cagetti et al, 2013 Search date: 1966-2013	-	N/A	No study met the inclusion criteria which limited studies to RCTs and clinical trials Authors concluded that the scientific evidence regarding fluoridated salt was not possible to	_

[16] This does not reflect the quality of the systematic review itself (we could not identify AMSTAR scores for the included systematic reviews). The quality reflects that of the included studies and the overall findings of the review as classified by the respective authors. This applies to all the summary of finding tables.

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[16]
				assess	
	Yengopal et al, 2010 (9 studies)	-	N/A	The reduction in decayed, missing, and filled tooth (DMFT) favored salt fluoridation versus no salt fluoridation among children aged 6-8, 9-12, and 13-15. However, the contribution of fluoridated salt to declines in DMF scores could not be quantified as groups exposed to salt fluoridation were also exposed to fluoride from other sources	Low quality All studies were cross-sectional in design without concurrent controls. The main confounder was that the studies included exposure of fluorides from other sources.
	Additional Primary studies (1 study) Wennhall et al, 2014	Mexico	N/A	There was no significant difference in total increase in caries or progression rate between children exposed to school-based and domestic distribution of F-salt and control school children. -Enhanced fluoride exposure	Low quality 2-year prospective parallel group design Authors identified several confounders and biases

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[16]
				through domestic salt did not seem to reduce the number of new caries lesions or slow down the progression rate of the already existing lesions in permanent teeth of school children from a disadvantaged area.	
Dental fluorosis	NHMRC, 2007 (1 included study) Search data: 2000-2007	Mexico, Jamaica	N/A	One study included in the review provided evidence of a significantly increased risk of any fluorosis associated with salt fluoridation. -Two additional supportive studies which did not strictly meet the inclusion criteria were in agreement with the included study.	Low quality Comparative cross-sectional studies
	Soto-Rojas et al, 2004	Mexico	N/A	The prevalence of dental fluorosis reported in Mexico ranged from 52% to 82% in areas	Low quality Little information provided on included studies but authors

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[16]
	(14 studies) Search date 1997-200			where fluoridated salt is used. Most of the 14 studies were conducted in areas where water fluoride levels were above optimal, and the fluorosis cases reported in these publications ranged from "mild" to "severe". Some of studies indicated that the prevalence of fluorosis in Mexico was higher than what would be expected given the historical data from communities with optimal fluoridation in other countries	highlighted the issue of convenient sampling and lack of generalizability Most of the 14 studies were conducted in areas where water fluoride levels were above optimal
	Additional primary studies: (1 study) Betancourt-Lineares et al,	Mexico	N/A	The authors concluded that dental fluorosis in the 27 Mexican states that introduced salt fluoridation is a public health problem. The prevalence of fluorosis was 27.9% (95% CI 24.4, 28.5).	Low quality Retrospective study Little control for potentially confounding variables

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[16]
	2013			In 18 (64.3%) of the 27 states, more than 90% of the participants showed very mild or lower levels of the dental fluorosis index, with one-third showing the need of a reduction in fluoride exposure among the young population	
Osteoporosis or fracture	Systematic review (NHMRC; 2007)	-		No study met the eligibility criteria There is currently no evidence available to determine the impact of salt fluoridation upon fracture risk	
Increased risk of cancer	Systematic review (NHMRC; 2007)	-		No study met the eligibility criteria There is currently no evidence available to determine the impact of salt fluoridation upon cancer risk.	
Other adverse effects	Systematic review (NHMRC; 2007)	-		No study met the eligibility criteria There is currently no evidence available to determine the impact of	

Outcome	Type of Study	Countries	Concentration Fluoride	Results	Quality of study findings[16]
				salt fluoridation upon other harms	

Annex 4

Details of the systematic reviews included in the evidence on oral health interventions

Outcome	Type of Study	Countries	Results	Quality of study findings
Topical fluoridation	(Marinho, 2009) Search data: Cochrane Database of Systematic Reviews 2008 Overview of 7 systematic reviews	Not reported	The effectiveness of topical fluorides delivered in toothpastes, rinses, gels and varnishes in reducing caries increment in both the permanent and the primary dentitions are firmly established based on the large amount of evidence gathered from RCTs. The average Decayed, missing, and filled surfaces (DMFS) prevented ranged from	This is an overview of 7 systematic reviews Author stated that there evidence base was good All included studies were controlled trials

Outcome	Type of Study	Countries	Results	Quality of study findings
			24% for fluoride toothpaste to 46% for fluoride varnishes. No clear evidence was found that any modality is more effective than any other. However, the simultaneous use of a topical F treatment with F toothpaste resulted in an additional 10% enhanced caries inhibiting effect compared with using toothpaste alone. The caries preventive effect of F toothpaste increases with higher initial levels of DMFS and when higher F concentration is used. Fluoridated toothpaste is the most accepted modality among young people Supervised tooth brushing of children led to greater benefits.	
Fluoridated toothpaste in reducing dental caries	Wong et al, 2011 (75 papers) Search Date: 1950 to 2009	Mostly USA and UK	The findings confirm the benefits of using fluoride toothpaste in preventing caries in children and adolescents, but only significantly for fluoride concentrations of	Moderate quality 83 independent trials

Outcome	Type of Study	Countries	Results	Quality of study findings
			1000 ppm and above. The results support the international standard level of 1000 ppm fluoride for younger children and up to 1500 ppm for older children	
Fluoridated toothpaste on the development of fluorosis	Wong et al, 2011 (25 studies) Search date: up to March 2009	Mostly USA and UK	The findings from the 2 RCTs indicated that a higher level of fluoride toothpaste was associated with an increased risk of fluorosis. Weaker evidence from three cross-sectional surveys showed no statistically significant difference between toothpastes with a concentration of 250/550 ppm and those with a concentration of 1000 ppm or greater. There is weak, unreliable evidence that starting the use of fluoride toothpaste in children less than 12 months of age may be associated with an increased risk of fluorosis. Inconsistent statistically significant	2 RCTs, 1 cohort study, 6 case-control studies, and 16 cross-sectional surveys None of the observational studies was judged to be at low risk of bias. One of the RCTs had low risk of bias

Outcome	Type of Study	Countries	Results	Quality of study findings
			associations were found between starting using fluoride toothpaste before or after the age of 24 months and fluorosis. No significant association between the frequency of tooth brushing or the amount of fluoride toothpaste used and fluorosis was found.	
Primary school-based behavioral intervention addressing both tooth brushing and consumption of cariogenic food	(Cooper et al , 203) (4 studies) Search Date: Up to 2012	Brazil, Italy, UK, Tehran	One study found that children in the behavioral intervention group developed fewer new caries over the study period. Three studies reported statistically significant reductions in plaque in the intervention groups. Two of these trials involved an 'active' home component where parents were given tasks relating to the school oral health program (games and homework) to complete with their children. There is limited evidence that primary school-based behavioral interventions that promote twice daily tooth brushing and reduce snacking on sugary foods can	Low quality One study was at unclear risk of bias and three were at high risk of bias. All RCTs

Outcome	Type of Study	Countries	Results	Quality of study findings
			prevent caries by improving children's oral hygiene, with some evidence showing that they may have a positive impact upon children's knowledge and on plaque removal. The efficacy of primary school-based behavioral interventions may be increased through the inclusion of an 'active' home component.	
Xylitol chewing gum versus topical fluoride	(Mickenautsch et al, 2012) (6 studies) Search date: Up to March 2011	French Polynesia, Costa Rica, Sweden and Hungary.	Most studies compared fluoride with or without additional xylitol exposure; one study evaluated xylitol with and without tooth brushing. Five out of 21 extracted data sets showed no difference between treatment groups (Xylitol –containing chewing gum versus topical fluoride) while the rest significantly favored the xylitol group. The addition of xylitol to existing fluoride regimes may be beneficial in caries prevention.	High risk of bias All trials were limited by potential risk of selection, performance/ detection and attrition bias

Outcome	Type of Study	Countries	Results	Quality of study findings
Sugar-free chewing gum versus not using chewing gum	KeukenmeestEr et al, 2013 (10 studies) Search Date: Up to April 2012	USA	Four of five brushing comparisons showed a significant beneficial effect of sugar-free chewing gum with regard to the plaque scores. There was a 9–24% reduction in plaque scores compared to the 'no gum' group. In the non-brushing studies, the use of chewing gum did not significantly affect plaque and gingival inflammation scores. It may be concluded that the use of sugar-free chewing gum as an adjunct to tooth brushing provides a small but significant reduction in plaque scores.	Moderate risk of bias Potential risk of bias was low for 3 studies, moderate for 3 studies and high for the 4 other studies

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