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Local Organizing Committee
The Workshop on “Effective Use of Fluoride in Asia”

Phang-Nga, Thailand
March 22-24, 2011
It is evident that Fluoride is by far the most important element that helps prevent dental decay in humans. In the workshop “Effective Use of Fluoride in Asia”, we are fortunate to learn from practical experiences of 20 Asian countries, as well as recommendations of the world authorities in public health and oral health: WHO, FDI and IADR. Contributions of renowned scientists on effective use of fluoride and further research are also included.

We own deep gratitude to all the authors whose works are presented in this book.

Editors: Piya Siriphant
Sirivimol Srisawasdi
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Welcome to the Workshop

“Effective Use of Fluoride in Asia”

Welcome to Phang-Nga, Thailand,

On behalf of the Local Organizing Committee, I would like to welcome all of you to the workshop “Effective Use of Fluoride in Asia” in Phang-Nga, Thailand. This workshop, co-sponsored by WHO, FDI and IADR, follows two international meetings: “Global Consultation on Oral Health through Fluoride” in 2006 in Geneva, and “Promote Oral Health through Fluoride in China and Southeast Asia” in 2007 in Beijing.

As a member of the World Dental Development and Health Promotion Committee (WDDHPC) of FDI, I have been assigned for fluoride advocacy task since 2009. Since then, though fluoride administration has been worldwide using, data from FDI Oral Health Atlas have shown high caries prevalence among developing countries, especially in Asia. The effectiveness of fluoride on the prevention of dental decay remains questionable in many Asian countries. Thus, the key words “Effective Use of fluoride” for caries prevention need to be updated, shared and concluded for practical uses in Asia.

After discussion with FDI President Roberto Vianna and Dr. S.D. Shantinath; IADR President Maria Fidela Navarro and Dr. Christopher Fox; and WHO Professor P.E. Petersen; the structure of the workshop was formulated. Practical experiences on the use of fluoride among Asian countries are pivotal to the workshop in addition to lectures from the world renowned experts. The LOC is fortunate that we could have three key persons from each Asian country to join the workshop, namely 1) Chief Dental Officer from the Ministry of Health, 2) President of the National Dental Association and 3) a prominent academic representative from the national dental school. We highly expect that they, as a team, will return to advocate for the effective use of fluoride in the context of their own country.

Three key international dental organizations, WHO, FDI and IADR, substantially help LOC organize this workshop. LOC includes the Dental Association of Thailand Under the patronage of H.M. the King, and Thammasat University Dental School. Over the past two years, the Oral Health Programme at WHO has actively assisted the LOC on various technical supports, which I am deeply appreciated.

I am most grateful to all speakers and participants from 20 Asian countries. You all have contributed to the workshop on the updates of dental caries status, practical fluoride uses and other solutions to help solved dental decay problem in each country. This network of friends and colleagues will be useful for better collaboration within and outside the region in the future. LOC also plans to publish the proceeding of the workshop for wider dissemination of recommendations and decisions concluded at this workshop. Finally, we do hope that this workshop will be a model to advocate for practical fluoride use in other regions of the world.

We hope that all speakers, facilitators and participants will enjoy this workshop, and could find some time to appreciate the nature of the beautiful beach in Khao Lak, Phang-Nga.

Prathip Phantumvanit
Chair, LOC
110301
Objectives:

- To review the basic principles in prevention of dental caries
- To actively promote the integration of fluoride into national health promotion programs and for incorporation into health policies
- To administer appropriate fluoride measures to the diverse local situations within in Asia
- To advocate effective use of fluoride to the national health authorities, dental practitioners and within dental schools, and to the general public
- To develop national strategies for effective use of fluoride as emphasized by the WHA60.17 Resolution: Action Plan for Oral Health (2007)

Expected outcome:

- Participants understand modern principles in dental caries prevention—with an emphasis on the mechanisms and importance of use of fluoride in public health
- Recommendations for appropriate fluoride use in the participant’s country
- Participants will understand how to work collaboratively with respect to implementation of fluoride programs and policies within their country.
- Support to implementation of WHO policies in oral health promotion as outlined in the WHA60.17
Access to sessions and social events
   To gain access to all sessions including meals, badges will be checked for admission.

Accompanying persons and guests
   Children are not allowed access to the workshop sessions. Children are welcome to both
   morning and afternoon breaks, lunches and dinners if they are accompanied by an adult.
   Adult accompanying persons with badges are allowed to all plenary sessions except “invited
   only” and “workshop” sessions.

Cell phones and pagers
   Please turn “sound off” during sessions.

Continuing education credits
   Thai participants are eligible to receive continuing education credits for attending the
   workshop. One hour of program time is equivalent to one credit hour. A total of 20 credit hours will
   be received for all participants who attended this workshop.
   Please locate the certificate of attendance in the bag. Participants are responsible to complete
   their own forms. Do not return the blank certificate to LOC. Contact the LOC information/registration
   counter for further assistance.

Dress
   Smart casual dress is required for all sessions. A light jacket will be adequate in all air-
   conditioned rooms.

General information and onsite services
   Please contact the LOC information/registration counter in the lobby (March 21) and in front
   of the plenary room (Mar 22-24). Onsite services include pre-registered document pick-up, onsite
   registration, information for speakers, and returned transportation to the airport. Please contact the
   hotel reception for all other services, e.g., business services, WIFI, laundry, medical emergency,
   local tours, and available hotel facilities.
Meeting site

All events will be held at the Le Meridien, Khao Lak Beach & Spa Resort. The address is as follows:

9/9 Moo 1, Tambon Kuk Kak, Amphur Takua Pa
Phang Nga 82190, Thailand
Tel: +6676 427500
Fax: +6676 427501
Email: lemeridien.khaolak@lemeridien.com

Name Badges

Badges must be worn at all time and may be required for security check. To gain access to all sessions, badges will be checked for admission.

Badges of LOC members will be in purple.

Photography and other AV recording

Taking photographs of presenters may occur at the beginning, between presentations or the end of the session. For educational purposes, LOC will record videos of all plenary sessions for distributing over the internet.

Smoking policy

This is a smoke-free meeting. By Thai law, smoking is not permitted in the air-conditioned areas, inside the meeting rooms, foyers, lobby area, and all restaurants.

Speaker ready room

The Speaker Ready Room is located in the LOC office on the same floor of the Workshop meeting rooms (Conference Center) and will be open on these dates/hours:

Monday, March 21 13.00-18.00 hrs.
Tuesday, March 22 08.00-18.00 hrs.
Wednesday, March 23 08.00-18.00 hrs.

All invited speakers are requested to check PowerPoint presentations in advance. Once all files are compatible, please copy all files directly onto the computer in the Speaker Ready Room. Then LOC will transfer all files to the computer in the plenary room. Please contact the LOC information/registration counter for more information.
Chronological Listing of Events and Scientific Programs

Monday, March 21

14.00-17.00 Registration (in the lobby)

18.00-21.00 Dinner at the invitation of DAT President (Kuk Kak Bar & Grill)

Tuesday, March 22

10.00-17.00 Registration (in the lobby until 12.00 hrs., then move to the Foyer of Chong Fa Ballroom A)

12.00-13.00 Lunch (Cafe’ Lilawadee)

Plenary 1 (Chong Fa Ballroom A, 13.00-17.05 hrs.)

13.00-13.20 Introduction and Objectives of the Workshop

Prof. Poul-Erik Petersen (World Health Organization) and Dr. Prathip Phantumvanit (Thammasat University, LOC Chair)

13.20-14.50 P11: State of the Science in Caries and Fluoride:

P111: Aetiology of Dental Caries

Prof. Michael Lennon, University of Sheffield, UK

P112: Early Detection of Initial Caries

Prof. Masaki Kambara, Osaka Dental University, Japan

P113: Scientific Rational of Fluoride in Caries Control

Prof. Dominick Zero, Indiana University, USA

14.50-15.05 Break (Foyer of Chong Fa Ballroom A)

15.05-17.05 Sharing experience of Fluoride administration in Asia

Facilitated by Prof. Poul-Erik Petersen, and Dr. Prathip Phantumvanit

- Water fluoridation: Singapore
- Milk fluoridation: Thailand
- Fluoride varnish: Malaysia
- Fluoride toothpaste: Indonesia
- Fluoride mouth-rinse: Japan

19.00-21.00 Reception (Sukhothai Pond Garden)
Wednesday, March 23

**Plenary 2 (Chong Fa Ballroom A, 09.00-12.30 hrs.)**

09.00-10.30  P21: Perspective for Caries and Fluoride:

  P211: The WHO Approach to Effective Use of Fluorides in Public Health
         *Prof. Poul-Erik Petersen, World Health Organization*

  P212: Fluoride and the FDI Global Oral Health Initiative
         *Prof. Roberto Vianna, FDI President*

  P213: Fluoride Research—unfinished task
         *Prof. Livia Maria Andalo Tenuta, IADR-Cariology Group President*

10.30-10.45  Break (Foyer of Chong Fa Ballroom A)

10.45-12.15  P22: Fluoride Administration:

  P221: Community Approach
         *Prof. Ramon Baez, University of Texas at San Antonio, USA*

  P222: Professional administered fluorides
         *Prof. Edward Lo, University of Hong Kong, China SAR*

  P223: The efficacy of self-administered fluorides—A review of the global evidence
         *Dr. Valerie Marinho, Queen Mary University of London, UK*

12.15-13.00  Discussion and Q&A

13.00-14.00  Lunch (Cafe’ Lilawadee)

**Working groups session I (14.00-17.00 hrs.)**

15.00-15.30  Break (Foyer of Chong Fa Ballroom A)

14.00-17.00  Working groups session I:

  Implementation plan for Fluoride administration at the country level:

  Group 1 in Lampi room: Community administration
  Facilitated by *Prof. Poul-Erik Petersen, Prof. Michael Lennon and Prof. Ramon Baez*

  Group 2 in Sairung room: Professional Administration
  Facilitated by *Prof. Edward Lo, Prof. Livia Maria Andalo Tenuta & Dr. Christopher Fox*

  Group 3 in Lamru room: Self administration
  Facilitated by *Dr. Valerie Marinho, Prof. Dominic Zero and Dr. Prathip Phantumvanit*

19.00-21.00  Welcome Dinner (Beachfront, Bamboo Bar)
Thursday, March 24

**Plenary 3** (Chong Fa Ballroom A, 09.00-10.30 hrs.)
09.00-09.30 Recap of Day 1
   *Prof. Poul-Erik Petersen and Dr. Christopher Fox*

09.30-10.30 Feedback from Working Group session I
   Workshop participants
   Facilitated by *Prof. Roberto Vianna*

10.30-10.45 Break (Foyer of Chong Fa Ballroom A)

**Working groups session II** (10.45-12.45 hrs.)
10.45-12.45 Working Groups session II:
   Implementation plan for Fluoride administration at the country level
   
   Group 1 in Lampi room: Community administration
   Facilitated by *Prof. Poul-Erik Petersen, Prof. Michael Lennon & Prof. Ramon Baez*

   Group 2 in Sairung room: Professional Administration
   Facilitated by *Prof. Edward Lo, Prof. Livia Maria Andalo Tenuta & Dr. Christopher Fox*

   Group 3 in Lamru room: Self administration
   Facilitated by *Dr. Valerie Marinho, Prof. Dominic Zero and Dr. Prathip Phantumvanit*

12.45-13.45 Lunch (Café’ Lilawadee)

**Plenary 4** (Chong Fa Ballroom A, 14.00-16.30 hrs.)
13.45-14.45 Feedback from Working Group Session II
   Workshop participants
   Facilitated by *Prof. Roberto Vianna*

14.45-15.30 General Discussion and networking
   *Dr. Arif Alvi and Dr. Prathip Phantumvanit*

15.30-16.00 Closing Remarks
   *Prof. Poul-Erik Petersen (WHO)*
   *Prof. Roberto Vianna (FDI)* and
   *Dr. Christopher Fox (IADR)*

16.00 Break (Foyer of Chong Fa Ballroom A)
Meeting adjourned
CALL TO ACTION TO PROMOTE DENTAL HEALTH BY USING FLUORIDE

Eighty experts from thirty countries gathered for a Global Consultation on Oral Health through Fluoride, jointly convened by the World Health Organization (WHO), FDI World Dental Federation and the International Association for Dental Research (IADR) on 17-19 November 2006 in Geneva and Ferney Voltaire, expressed their deep concern about growing disparities in dental health and the lack of progress in tackling the worldwide burden of tooth decay (dental caries), particularly in disadvantaged populations.

The burden of tooth decay affects children, adults and the elderly, disrupts life and causes considerable pain, suffering and economic hardship. Much of the disease still remains untreated, particularly in low and middle-income populations. Prevention by using fluoride is the only realistic way of reducing this burden in populations.

Taking account of the scientific evidence, as well as several WHO World Health Assembly Resolutions1 and other technical reports2, the experts reaffirmed the efficiency, cost-effectiveness, and safety of the daily use of optimal fluoride. They confirmed that universal access to fluoride for dental health is a part of the basic human right to health.

Recognising the magnitude of the problem, and in order to achieve this the experts convened by the WHO, FDI and IADR urge governments and other influential bodies to take the following actions:

- Develop effective legislation, necessary directives3 and programmes ensuring access to fluoride for dental health in all countries;
- Include fluoride in health communications, health promotion strategies and programmes;
- Include fluoride for dental health when promoting health through healthy diets;
- Encourage governments to reduce or remove taxation and tariffs on fluoride products for dental health; and
- Encourage suppliers to improve availability of effective affordable fluoride toothpaste for disadvantaged populations.

These actions will improve quality of life and enhance the achievement of the Millennium Development Goals by reducing the high dental disease burden of populations, especially children in disadvantaged populations.

The convening organisations of this consultation offer advice and technical support on any aspect of these recommendations.

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1 Resolutions of the World Health Assembly related to fluoride (WHA 22.30/ WHA 28.64/WHA42.39/ WHA53.17/)
2 WHO Technical reports related to fluoride use for dental health: WHO Technical Reports n 846 (1994) / 916 (2003); FDI Policy Statement Fluoride and Dental Caries (G2000); The York review—a systematic review of public water fluoridation (British Dental Journal, Volume 192, No. 9, 2002); Topical fluoride (toothpastes, mouthrinses, gels or varnishes) for preventing dental caries in children and adolescents, Cochrane Database of Systematic Reviews 2006 Issue 4
3 WHO Essential Medicines List, 14th edition, March 2005
BEIJING DECLARATION:

CALL TO ACTION TO PROMOTE ORAL HEALTH BY USING FLUORIDE IN CHINA AND SOUTHEAST ASIA

Subsequent to the Global Consultation on Oral Health through Fluoride, jointly convened by the World Health Organization (WHO), the FDI World Dental Federation and the International Association for Dental Research (IADR) in November 2006, a follow-on conference was convened jointly with the Chinese Stomatological Association (CSA). The conference took place on the 18th and 19th September 2007 in Beijing, China, and was attended by more than 70 experts from 12 countries including more than 40 experts from the People’s Republic of China.

The experts in oral health stomatology noted that in both China and Southeast Asia:

• Changes in diet and lifestyle are exposing people to a greater risk of diet-related tooth decay as well as chronic diseases including diabetes, cardiovascular disease, and cancer.
• The increasing burden of tooth decay affects children, adults and the elderly, disrupts life and causes considerable pain, suffering and economic hardship.
• The prevalence of tooth decay is particularly high in children and that most tooth decay remains untreated which can result in dangerous infection, pain and loss of school days.

Taking account of the scientific evidence, as well as several WHO World Health Assembly resolutions and other technical reports, the experts in oral health reaffirmed the following:

• Prevention of tooth decay by using fluoride is the most realistic way of reducing the burden of tooth decay in populations.
• The efficiency, cost-effectiveness, and safety of the daily use of optimal fluoride.
• The inadequate exposure in the Region to appropriate levels of fluoride for the prevention of tooth decay.
• The importance of national policies and programmes for the automatic administration of fluoride (such as water and salt fluoridation) and/or the topical use of fluoride (such as affordable and effective fluoride toothpaste).

The experts in oral health confirmed that:

• Fluoride toothpaste remains the most widespread and significant form of fluoride used globally and the most rigorously evaluated vehicle for fluoride use.
• The effectiveness of fluoride toothpaste has been assessed since the 1940’s in over one hundred clinical trials and the anti-tooth decay (anti-caries) efficacy of fluoride toothpaste has been confirmed.
• Fluoride toothpaste is safe to use irrespective of low, normal or high fluoride exposure from other sources.

The experts in oral health strongly recommended:

• Promoting the use of effective fluoride toothpaste twice a day for the prevention of tooth decay.
• Toothbrushing with a pea-size amount of fluoride toothpaste in young children up to the age of 6 years should be supervised by a responsible adult to ensure that large quantities of toothpaste are not swallowed.
• Specific recommendations for the use of fluoride toothpaste in very young children should follow guidelines from the respective national authority.
• Governmental institutions promoting oral health and general health, the medical and dental professions, the educational system (e.g. health promotion in schools) and industry should take action to ensure that populations know the benefits of regular use of fluoride toothpaste and that fluoride toothpaste is made accessible and affordable.

Exposure to appropriate fluoride, in particular through fluoride toothpaste, will improve quality of life and enhance the achievement of the Millennium Development Goals by reducing the high dental disease burden of entire populations, especially children.

References:
1. Resolutions of the World Health Assembly related to fluoride (WHA 22.30/WHA 28.64/WHA42.39/WHA53.17/WHA60.17)

Note: The four convening organisations of this conference offer advice and technical support on any aspect of these recommendations.
PREVENTING DISEASE THROUGH HEALTHY ENVIRONMENTS

INADEQUATE OR EXCESS FLUORIDE: A MAJOR PUBLIC HEALTH CONCERN

Fluoride intake has both beneficial effects—in reducing the incidence of dental caries—and negative effects—in causing tooth enamel and skeletal fluorosis following prolonged exposure to high concentrations. The ranges of intakes producing these opposing effects are not far apart. Public health actions are needed to provide sufficient fluoride intake in areas where this is lacking, so as to minimize tooth decay. This can be done through drinking-water fluoridation or, when this is not possible, through salt or milk fluoridation. Excessive fluoride intake usually occurs through the consumption of groundwater naturally rich in fluoride or crops that take up fluoride from high-fluoride irrigation water. In these areas, means should be sought to manage intakes by providing drinking-water with a moderate (i.e. safe) fluoride level or using alternative sources of water for irrigation. Although removal of excessive fluoride from drinking-water may be difficult and expensive, low-cost solutions that can be applied at a local level do exist.

Sources of exposure to fluoride

Fluoride can be released to the environment in a number of different ways:

- natural activities, such as volcanic emissions, weathering of minerals and dissolution, particularly into groundwater and marine aerosols;
- human activities, such as the production of phosphate fertilizers, the manufacture and use of hydrofluoric acid, the production of aluminium, steel and oil, and the burning of fluoride-rich coal, especially indoors;
- remobilization of historic sources, such as water flow and sediment movement from aluminium production plants.

Natural sources

Elemental fluorine almost never occurs in nature, but fluoride is widely distributed in Earth’s crust, mainly as the minerals fluorspar, fluorapatite and cryolite. Some regions have particularly high concentrations of fluorine. Fluoride can exist in the atmosphere in gaseous form, attached to particles or in aerosols that can be transported by wind over large distances before being deposited. Fluoride can also be transported by water, usually complexed with aluminium, but it is immobile in soil.

Industrial processes

Most airborne fluoride in urbanized areas comes from industrial sources. Of this, 10% derives from the aluminum industry, and high concentrations can be found around aluminium smelters. Another major source of environmental fluoride is phosphate fertilizer production, where much of the associated fluoride is lost to the atmosphere. Use of phosphate fertilizers contaminates soil with fluoride, as does use of fluoride-containing pesticides. Other sources include glassworks, exhaust fumes and the production of metals (e.g. steel, copper and nickel), bricks, ceramics and adhesives. Hydrogen fluoride is used in the semiconductor industry and in commercial laundries. It is highly soluble in water, forming hydrofluoric acid, which is very corrosive. Sulfuryl fluoride is used as a fumigant—for example, in flour mills.
Drinking-water

In certain parts of the world where groundwater naturally contains high fluoride levels, intake of fluoride via drinking-water exceeds that via food. The intake is determined by the fluoride level in the water and the daily water consumption.

Water fluoridation has been adopted by several countries as a cost-effective public health measure for the prevention of dental caries. The dental health benefits are obtained when the concentration of fluoride in drinking water is 0.8-1.0 mg/l.\textsuperscript{3,4}

Food

In most parts of the world, food is the primary source of fluoride intake. While almost all foodstuffs contain trace amounts of fluoride, levels can be high in the bones of canned fish, such as salmon and sardines. Levels in meat, fruit and vegetables are usually low. However, tea leaves may contain high levels of fluoride, and consumption of brick tea (popular in parts of Asia) can lead to high fluoride intake.\textsuperscript{1,5}

The use of fluoride-rich fuel (e.g. coal) for cooking can lead to fluoride intake from the cooked food, as well as inhalation exposure.

Fluoride is sometimes added to cooking or table salt for dental caries prevention in countries or regions where drinking-water fluoridation is not feasible.\textsuperscript{4,5} The optimal concentration of fluoride ranges from 200 to 250 mg/kg salt.\textsuperscript{6} In some countries, fluoride is also added to milk for dental caries prevention.\textsuperscript{7}

Dental care products

In many countries, dental care products, such as toothpaste, mouthwash and mouth rinse, contain fluoride. The contribution of fluoride-containing dental products to overall fluoride intake is minimal.

Health effects\textsuperscript{1,2}

Beneficial effects of adequate fluoride

- Fluoride is a micronutrient. Adequate intake has a beneficial effect on oral health in both children and adults. Fluoride prevents caries by several different actions. When present in saliva constantly and at low concentrations, fluoride hastens the remineralization of tooth enamel lesions. Fluoride also interferes with glycolysis, the process by which cariogenic bacteria metabolize sugars to produce acid. In addition, it has a bactericidal action on cariogenic and other bacteria. Finally, when fluoride is ingested during the period of tooth development, it makes the enamel more resistant to later acid attacks.\textsuperscript{4,6,9}
Adverse effects of excess fluoride

- The toxic effects of high fluoride intake are due to the fact that it is a direct cellular poison, which binds calcium and interferes with the activity of proteolytic and glycolytic enzymes.

- Ingested fluoride reacts with gastric acid to produce hydrofluoric acid in the stomach. Thus, acute exposure to high concentrations of fluoride results in immediate effects: abdominal pain, excessive saliva, nausea and vomiting. Seizures and muscle spasms may also occur. Death due to respiratory paralysis is a possibility.

- The acute effects of inhalation of hydrogen fluoride are severe irritation of the respiratory tract, with coughing, choking and pulmonary oedema. Severe burns or prolonged visual defects may result from skin or eye contact. Inhalation or dermal exposure can be fatal.

- Repeated or prolonged exposure via inhalation of aluminium fluoride, primarily in occupational settings, may cause asthma.10

- The main effect of long-term ingestion or inhalation of high concentrations of fluoride is fluorosis:
  - Enamel fluorosis can develop only in children, as it results from intake of high levels of fluoride during the period of tooth development. It is characterized by the appearance of white areas in the enamel and in this form is considered an aesthetic issue. In the more severe form, reduced mineralization of the enamel results in stained and pitted teeth.
  - In 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. There is an elevated risk of skeletal effects at fluoride intakes above 6 mg/day. These intake levels occur in many areas of the world because of naturally high fluoride levels in the groundwater, notably in the Rift Valley of East Africa and in China.
  - While the global prevalence of dental and skeletal fluorosis is not entirely clear, it is estimated that excessive fluoride concentrations in drinking-water have caused tens of millions of cases of dental and skeletal fluorosis worldwide over a range of years.11

Risk mitigation recommendations

Two worldwide public health problems need to be addressed: the necessity to reduce dental caries and the need to mitigate the effects of excessive fluoride intake. Thus, public health actions are required to provide sufficient fluoride intake where this is lacking, so as to minimize tooth decay, and drinking-water with a moderate (i.e. safe) fluoride level in areas where groundwater contains high fluoride levels.1,3,4

The following actions are needed:
Adequate fluoride

- Reduce the incidence of dental caries by:
  - fluoridating low-fluoride drinking-water where possible, as well as considering alternatives, such as salt or milk fluoridation\(^3,4,6,7\);
  - developing effective and affordable fluoridated toothpastes for use in developing countries;
  - promoting optimal oral hygiene, based on the use of effective fluoridated toothpaste;
  - advocating a low-sugar diet in accordance with the recommendations of WHO and the Food and Agriculture Organization of the United Nations (FAO) that free (added) sugars should not exceed 10% of energy intake and that food or drinks containing free sugars should be consumed no more than 4 times per day.\(^12\)

Excess fluoride

- Carefully consider the causes of fluorosis to select the best and most appropriate means of dealing with excess fluoride exposure, taking into account the local conditions and sensitivities.
- Provide drinking-water with fluoride levels that do not produce adverse health effects, by:
  - seeking alternative water sources in areas with fluoride-rich groundwater, particularly where water consumption is high due to elevated temperatures\(^5\);
  - defluoridating water for drinking and cooking, using methods such as bone charcoal adsorption, contact precipitation, coagulation–flocculation, sedimentation using aluminium sulfate (Nalgonda process) and activated alumina adsorption.\(^5\)
- Research the appropriateness of various community fluoridation schemes in view of natural fluoride levels in water.
- Monitor fluoride levels in the environment, especially in areas where there is exposure to elevated fluoride levels due to human activities, and determine the overall exposure to fluoride.
- Encourage mothers to breastfeed, even in areas with high fluoride intake, as breast milk is optimal for infant health and usually low in fluoride.
- Discourage the use of fluoride-rich coal for cooking purposes.

References


In this presentation I will describe two models of dental caries:
• The Ionic See-saw; and,
• Stephan’s Curve

A model may be defined as a simplified description of a system or process to assist calculations or predictions (Oxford Dictionary of English) or, as I prefer, a simplified version of the truth.

The first of these two models (Figure 1) emphasises the exchange of calcium and phosphate ions between the enamel surface and the plaque. The loss of calcium and phosphate ions from the enamel surface is accelerated at the low pH caused by the interaction of plaque bacteria and simple sugars from the diet; so called, demineralisation. On the other hand re-deposition of calcium and phosphate ions back into the enamel surface (remineralisation) is encouraged by a ready flow of saliva and by the availability of fluorides at the enamel-plaque interface. This alternating two-way process of demineralisation and remineralisation gives the model its title ‘The Ionic See-saw’.

The second of our two models, Stephan’s Curve (Figure 2), was first published over sixty years ago (Stephan 1940; Levine and Stillman-Lowe 2009). It describes the fall in plaque pH following the ingestion of or rinsing with sucrose solutions. There are four key elements:
• The resting plaque pH at around pH=7;
• The rapid fall in plaque pH within 2-5 minutes of a sucrose (2-10%) rinse;
• The critical pH at around pH=5.5, below which we see loss of calcium and phosphate ions from the enamel surface; and,
• The slow increase in plaque pH back to the resting level over a period of 15 up to 120 minutes.

The models are also useful in considering the aetiology and prevention of root caries (Steele et al, 2001; Griffin et al, 2007; Tan et al, 2010) which is now recognised as a significant public health problem. The only significant modification to the models is that the critical pH for root caries is closer to pH=6 than the pH=5.5 for enamel caries. The risk factors for root caries include xerostomia, institutionalised living, poor oral cleanliness, frequent intakes of sugar containing foods and drinks, and wearing a partial denture.

Both these models of dental caries are useful in that they allow us to consider the mechanisms by which fluorides exert their influence over the caries process (Hardwick et al 1982) and in particular fluorides’ role in:
• promoting the formation of fluor-hydroxyapatite at the enamel surface enamel which is more resistant to demineralisation;
• reducing the breakdown (glycolosis) of dietary sugars; and,
• promoting the remineralisation of enamel.
Ionic See-Saw

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Hardwick J, Teasdale J and Bloodworth G (1982). Caries increments over 4 years in children aged 12 at the start of water fluoridation. *British Dental Journal;* **153:**450-454


Stephan RM (1940). Changes in hydrogen ion concentration on tooth surfaces and in carious lesions. *Journal of the American Dental Association;* **27:**718-723

Early Detection of Incipient Caries
Masaki Kambara,
Osaka Dental University

Dental Caries are decreasing in the world. In Japan, the number of DMFT at 12 years of age show around one in 2010. This means that almost all teeth are sound, and we dentist need to make effort to keep teeth sound and protect against dental caries through a whole life.

Therefore, dentistry has to change to focus on sound teeth and the quality of teeth, not dental caries. ICDAS (International Caries Detection and Assessment System) which focused on the early stage of dental caries was developed and spread.

Dental science has been developing the machine for estimating early detection of incipient caries, quantitatively, Diagnodent, QLF (Quantitative Light-induced Fluorescence), Forti et al.

The following word is going to express caries scientifically more in detail by those improvements.

- Caries Lesion: a progress stage of caries in a certain point in time
- Caries Process: the interaction of Biofilm, tooth surface and enamel surface
- Caries Detection: an objective method to decide whether there are caries
- Caries Assessment: The thing which was aimed for a characteristic of caries after search or monitor

1. Progression of Caries: caries in a state getting larger will spread even deeper.
2. Arrestment of Caries: caries in the state that does not move or change
3. Regression of Caries: caries which are going to return soundly

- Caries Diagnosis: all technical data and effective judgment including a prediction of objectivity in the future.

We have been conducted fundamental and clinical study using QLF.

1. Effect of fluoride on remineralization of artificial incipient caries in vitro
2. Effect of Fluoride contained dentifrice on incipient caries
3. Clinical Study of management of oral health in elementary school

New evidence will be possible to be obtained by those clinical studies using the method of detection for incipient caries. We can establish new dentistry which focuses on sound teeth followed by obtaining the evidence.
The prevalence of dental diseases which dentistry has focused on treating for lot of dental caries in 20th century is decreasing in 21st century. One of main target in Japanese oral health was one DMFT at 12 years old till 2010 and it is predicted to be achieved within this year in Japan. The reason of this change is generally thought to be the Japanese original system for oral health which is composed of 8020 campaign, a system of school dentistry, the National Japanese Health Insurance system and so on contributed to the promotion of oral health. And also, the use of fluoridated dentifrices, and fluoride rinse in school have been increasing over 95% and 30%, respectively.

In a already developed country, a new action started after 2000. One of this is to combine GCI (Global caries initiatives) in FDI and ICDAS (International caries diagnosis and assessment system). The Global Caries Initiative is a profession-led “call to action” to eradicate caries, and improve the oral and general health of populations globally by the year 2020. Dental caries affects the lives of billions of people around the world, posing an enormous public health challenge in its complexity, scale and impact, both at an individual and community-wide level. The Global Caries Initiative aims to establish a broad alliance of key influencers and decision-makers from research, education, clinical practice, public health, government, and industry, partnering in a common goal: to effect fundamental change in health systems and individual behavior to achieve the 2020 goal.

For this situation, we are pressed to build a new dental care system immediately. This must be concentrated on oral health centered dentistry which is based on evidence-based dentistry, lifestyle-oriented dentistry and community-oriented dentistry.

I want to exchange the fundamental information of education, research, dental care system and insurance system.
The Effective Use of Fluorides in Public Health

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Introduction

According to the World Health Organization (WHO) (1, 2), dental caries continues to pose an important public health problem across the world (Fig. 1-2). In several high income countries, an improvement in dental health has taken place over the past decades in parallel to the introduction of preventive dental health services. Meanwhile, the disease affects 60-90% of schoolchildren and the vast majority of adults, and dental caries has contributed to an extensive loss of natural teeth observed in older people. Dental caries is also the most prevalent oral disease in several countries in Asia and Latin America. Although dental caries appear to be less common and less severe in most of Africa at the moment, WHO anticipates that, in the light of changing living conditions and dietary habits, the incidence of dental caries will increase in many of the low income countries in this continent (Fig. 3). The principal reasons for this increase appear to be increasing consumption of sugars and inadequate exposure to fluoride (3). Few low and middle income countries have large-scale fluoridation programmes in operation. Some countries in Latin America have introduced water and salt fluoridation, but exposure to fluoride is still fairly limited. In the African region, salt fluoridation has been implemented in Madagascar with the support of UNICEF and WHO. In Asia, Thailand introduced fluoridated toothpaste and demonstration programmes on milk fluoridation are established in

Mean DMFT of older people 65 years or more by WHO Region

Dental caries trends in 12-year-olds

Fig. 1. Levels of dental caries in 35-44-year-olds in countries as measured by the DMFT index, WHO Global Oral Health Data Bank (1)

Fig. 2. Dental caries experience (DMFT) among older people (65+ years) across WHO regions of the world, as measured by the DMFT index, WHO Global Oral Health Data Bank (1)

Fig. 3. Changes in dental caries experience (DMFT) among 12-year-old children in developed and developing countries, WHO Global Oral Health Data Bank (1)
Background

Research on the effects of fluoride on oral health started about 100 years ago. For about the first 50 years it focused on the link between waterborne fluoride - both natural and adjusted - and dental caries and dental fluorosis. In the second half of the 20th century this focus gradually shifted to the development and evaluation of fluoride toothpastes and mouth rinses and, to a lesser extent, public health alternatives to water fluoridation. More recently, efforts have been made to summarize these extensive data sets through systematic reviews, such as those conducted on water fluoridation by the University of York National Health Service Centre for Reviews and Dissemination (8), on fluoride ingestion and bone fractures (9), and on fluoride toothpastes and mouth rinses by the Cochrane Collaboration Oral Health Group (10, 11).

These systematic reviews concluded that:

- Water fluoridation reduces the prevalence of dental caries, i.e. the percentage of the population with decayed, missing and filled primary teeth (dmft)/Decayed, Missing due to caries, and Filled permanent Teeth (DMFT) > 0 - by an average of 15%, and reduces the incidence of dental caries by an average of 2.3 dmft/DMFT in children aged 5-14 years (12).

- Fluoride toothpastes and mouth rinses reduce the DMFT 3-year increment (the number of new dental caries developing over 3 years) by 23% and 24%, respectively (10, 11).

- Water fluoridation (fluoride, 1 mg/l) is associated with an increase of 13% in the risk of unaesthetic enamel fluorosis (8), although further analysis suggested that the risk might be substantially higher in areas in which the water is naturally fluoridated, and lower...
in areas in which the concentration of fluoride in water has been adjusted (12, 13).

Water fluoridation

The first community programme for water fluoridation was instituted at Grand Rapids in the United States of America (USA) in 1945 and the first results were published by Arnold et al. (14). Other major evaluation programmes followed: in the USA in Newburgh in 1945, and in Evanston, Illinois in 1946; in Canada in Brantford, Ontario in 1945; in the Netherlands in 1953; in New Zealand in 1954; in the United Kingdom in 1955; and in the German Democratic Republic in 1959. The results of these programmes were published mainly in the 1950s and 1960s (15-21). As a result, many community water fluoridation programmes were introduced in the largest cities of the USA, including Indianapolis (1951), San Francisco (1952), Philadelphia (1954), Chicago (1956), New York (1965), Dallas (1966), and Detroit (1967). The average cost of water fluoridation in the USA has been estimated at the level of 1 US$ per person per year (22). Worldwide, extensive fluoridation programmes have also been introduced in Australia, Brazil, Chile, Colombia, Canada, Hong Kong Special Administrative Region of China, Ireland, Israel, Malaysia, New Zealand, Singapore, the United Kingdom, and elsewhere. More recently, new programmes have been introduced in large conurbations in the south and west of the USA, including Los Angeles (in 1999), Las Vegas (in 2000), Sacramento (in 2000), and San Antonio (in 2002).

Salt fluoridation

One of the objections to water fluoridation is that it limits consumers’ choice. If the public water supply is fluoridated, a consumer has few practical alternatives other than to purchase bottled drinking-water that does not contain fluoride. One of the attractions of fluoridated salt is that it can be sold alongside a non-fluoridated alternative. When most salt for human consumption is fluoridated, the effectiveness of salt fluoridation approximates that of water fluoridation. The first studies of the effects on the incidence and prevalence of dental caries of fluoride added to alimentary salt were carried out from around 1965 to 1985 in Colombia, Hungary and Switzerland, with rather similar results to those observed after the introduction of water fluoridation (27, 28). These reports also explain that fluoridated salt reaches the consumer through several channels, including domestic salt, meals at schools, large kitchens, and in bread. In Colombia, Costa Rica, Jamaica, and the Canton of Vaud in Switzerland, most, if not all, of these channels are used; in France and Germany the focus is on fluoridating domestic salt. Jamaica provides another interesting setting, because virtually all salt destined for human consumption in the country has been fluoridated since 1987 (29, 30).

The concentration of fluoride in salt used around the world ranges from 90 mg/kg to 350 mg/kg, although later studies suggest an optimal concentration of around 250 mg/kg (31). One concern expressed is that promotion of the dental benefits of fluoridated salt would be unacceptable and contradictory to public health messages that encourage the reduction of consumption of salt and thus decrease the risk of hypertension. However, populations are not encouraged to consume more salt to improve their dental health; rather, the “automatic” or passive effect of fluoridated salt is accepted. In other words, people do not need to change their usual behaviour to benefit. Indeed, reduced consumption of salt could and should be encouraged and, where this is successful, the concentration of fluoride in salt could simply be increased appropriately. In addition, iodization of salt has been successfully used to prevent iodine deficiency diseases and is now being promoted in all parts of the world. It is emphasized by WHO that iodization and fluoridation of salt should be combined (27).
Milk fluoridation

The fluoridation of milk is another example of an attempt by public health dentistry to provide the benefits of fluoride without requiring the consumers to take on particular responsibilities or change their behaviour. The potential of milk as an alternative vehicle for fluoride was first reported from Switzerland by Ziegler in 1962 (33). Further programmes were reported by Stephen et al. (34) in Scotland, and by Banoczky et al. in Hungary (35). The results of these and other programmes targeted at children have been summarized by Ketley et al. (36). Various channels have been used, including programmes distributing milk in kindergartens (37), and schools (38), and powdered milk and milk-cereal distributed as part of the National Complementary Feeding Programme in Chile (39). In all these studies, it is emphasized that it is important to start the programme in early childhood to ensure an optimal effect on the deciduous teeth (39), and to maintain the consumption of milk for at least 180 days per year (40). Interesting initiatives such as sending school milk home on a Friday evening for consumption over the weekend have been reported by Bian et al. in Beijing, where milk consumption has been maintained for more than 300 days per year (41). To date no milk fluoridation programmes have been targeted at and evaluated in adult populations. As of to day, WHO is involved in comprehensive milk fluoridation programmes in several countries such as Thailand and Bulgaria.

Fluoride toothpastes

Probably the most widespread and significant vehicle used for fluoride has been toothpastes. Introduced in the late 1960s and early 1970s, their rapid increase in market share was remarkable. The consensus view from high income countries was that the introduction of fluoride toothpastes was the single factor most responsible for the massive reduction in dental caries seen in many countries during the 1970s and 1980s (43). Furthermore, of the various vehicles for fluoride, toothpaste has been the most rigorously evaluated. Marinho et al. (10) included 74 randomized, controlled clinical trials of good quality in their systematic review of fluoride toothpastes. However, an important limitation is that the effectiveness of these toothpastes depends upon the behaviour of the individual and the family in purchasing and regularly using the products. Studies have shown that use toothpaste containing fluoride are not uniform and is less likely among underprivileged groups (44, 45). The fall in the incidence of dental caries after the introduction of fluoride into toothpaste formulations, although seen in all social classes, was particularly noticeable in higher social classes; consequently a very marked social-class gradient exists in many other countries.

In response to the social equities in dental caries found in many parts of the world, the WHO Oral Health Programme has promoted the development and use of “affordable” fluoride toothpaste (46). An “affordable” toothpaste is one that is available at a price that allows people on a low income to purchase it. Important elements in the cost of production are the choice and availability of raw materials. Critically, the abrasive agent and the fluoride source should be compatible over time. Precipitated calcium carbonate is the abrasive agent of choice because of its low cost and ready availability in developing countries (47). It is the experience that companies can manufacture effective toothpastes that are also of low cost. However, it remains to be seen whether the marketing of such toothpastes will increase demand and use among low-income groups. Meanwhile, to encourage use it might be in the interest of countries to exempt these effective fluoride toothpastes from the duties and taxation that are imposed on cosmetics (46, 48).
WHO policy on use of fluoride for prevention of dental caries

The WHO policy on effective use of fluoride is reflected in four World Health Assembly Resolutions: WHA22.30 (1969) and WHA28.64 (1975) on fluoridation and dental health; WHA31.50 (1978) on fluoride for prevention dental caries, and the most recent WHA60.17 (2007): Oral Health: Action Plan for Promotion and Integrated Disease Prevention”. The 2007 Resolution urges Member States to ensure that populations benefit from appropriate use of fluoride (49) and the statement reads as follows:

(4) for those countries without access to optimal levels of fluoride, and which have not yet established systematic fluoridation programmes, to consider the development and implementation of fluoridation programmes, giving priority to equitable strategies such as the automatic administration of fluoride, for example, in drinking-water, salt or milk, and to the provision of affordable fluoride toothpaste;

The WHO Oral Health Programme continues to emphasize the importance of public health approaches to the effective use of fluorides for the prevention of dental caries and the Programme is involved with support, guidance, and practical assistance to several countries. Accordingly, people should be encouraged to brush their teeth daily with effective fluoridated toothpaste, i.e. fluoride recommended at the level of 1500 ppm. It is worth noting that “topical” fluorides such as toothpaste can also have a “systemic” effect when they are inadvertently ingested by young children. Dispensing a pea-sized amount of toothpaste, encouraging parents to supervise tooth brushing by their young children, and the use of toothpastes containing less fluoride by young children are approaches to ameliorating this problem. Countries may recommend toothpastes with low concentration of fluoride, i.e. 500 ppm or less specifically for such young age groups (1-3 years of age).

Where the incidence and prevalence of dental caries in the community is high to moderate, or where there are firm indications that the incidence of caries is increasing, an additional source of fluoride (water, salt or milk) should be considered. Where the country (or area of the country) has a moderate level of economic and technological development, a municipal water supply reaching a large population, trained water engineers and favorable public opinion, water fluoridation using fluoride at a concentration of 0.5-1 mg/l is the method of choice (48).

Salt fluoridation may be applicable to countries where the technical facilities for water fluoridation are not available. Salt fluoridation is an effective alternative that has the advantage of allowing consumer choice; this may be important in certain countries or cultures. An overview of some practical aspects relating to the implementation of salt fluoridation programmes has been published (27).

In 2009, WHO issued a comprehensive manual on milk fluoridation which highlights the rationality of milk as a vehicle for administration of fluoride; the biological basis; the opportunities for integration with other national or community programmes on diet and nutrition, community and school health, programme development, challenges in practical implementation, and monitoring and evaluation of programmes. The evidence on the use of milk fluoridation is outlined in this manual and further supported by country experiences (50).

It is recommended that dental fluorosis be monitored periodically to detect increases in or higher-than-acceptable levels of fluorosis. Action, such as adjusting intake of fluoride from water, salt, milk or other sources, should be taken when the prevalence of fluorosis is found to be excessive (48,51). In 2010, WHO issued a publication on inadequate or excess fluoride prepared within the context of preventing
disease through healthy environments; this document focuses on the sources of exposure to fluoride and health effects (52).

It is important to maintain and foster a programme of health-services research that might seek to:

- update our information on the cost-effectiveness of water, salt and milk fluoridation against a background of the now widespread use of fluoride toothpastes;
- continue to develop and update our knowledge of the health effects of ingested fluoride;
- further develop affordable techniques for the removal of fluoride from the public water supply in communities where natural concentrations of fluoride are above the guideline value of 1.5 mg/l set by WHO (53);
- better understand of the public perception of dental fluorosis; and
- evaluate the effects of the introduction of affordable fluoride toothpastes on purchase and use by the public.

Such a programme of health-services research will help to maintain and develop the outstanding progress made over the past half century in harnessing the beneficial effects of fluorides.

References


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Fluoride and the FDI Global Oral Health Initiative

Roberto Vianna
President of the FDI

The FDI has established the Global Oral Health Initiative (GOHI), a multi-stakeholder partnership to address the burden of non communicable diseases, with a special responsibility for oral diseases, dental caries, periodontal disease and oral cancer. Its objective is to provide strategic leadership to co-ordinate and synergize policy, strategy and programmes within a common stakeholder framework, so as to implement a model of oral health care based on health promotion, disease prevention and preventive disease management worldwide. Recognizing that implementation of such a model will require a coordinated multi-stakeholder effort, FDI is leading the creation of a Global Oral Health Alliance (GOHA); a broad alliance of key influencers and decision-makers from research, education, clinical practice, public health, government, business and the Public partnering in a common goal: to effect fundamental change in health systems and individual behavior through the introduction of a new paradigm of oral health care. FDI launched the Global Caries Initiative (GCI) in 2009, which focused on caries, with a first task to the design and development of a prevention oriented caries classification and management system (CCMS) including Fluoride usage as an important factor in preventing dental caries and promoting Global Oral Health. The GCI has achieved great success enabling FDI and key international stakeholders to develop an overarching Global Oral Health Improvement Matrix (GOHIM), which aims to integrate oral health into health, thereby establishing a collaborative, prevention orientated model of oral health care, ultimately resulting in measurable improvements in oral health and thus health in all communities. The GOHI vision is: “to improve oral health through the implementation of a new paradigm for managing oral diseases and their consequences, one that is based on our current knowledge of disease processes and their prevention, with a focus on global oral health improvement, so as to deliver optimal oral and thus general health and well being to all peoples”.

Fluoride Research-unfinished task
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For more than 50 years fluoride has been used as the main agent to control caries worldwide. Numerous studies during these decades definitely revealed the mechanism of action of fluoride to control caries, i.e. to interfere with the de and remineralization processes involved in lesions development while available in the oral cavity. But dental caries is a unique disease, and cannot be merely explained by the frequent episodes of mineral loss in a given dental surface; caries results from an interplay of many factors, of which two, biological, are of significant importance: biofilm accumulation and its exposure to fermentable carbohydrates (sugars). These are the two fundamental factors needed for caries development. Since fluoride does not interfere with these biological factors necessary for caries development, but only significantly reduces caries progression rates, an unfinished survey for supplemental anticaries therapies, which could be used in addition to fluoride, still endures. The challenge is how to improve fluoride significant anticaries effect.

On the other arm of the balance of appropriate fluoride use for caries control, is the challenge of using fluoride while minimizing the risk of fluorosis development. Dental fluorosis will result from the exposure of the tooth being formed to fluoride, during amelogenesis. To be implicated in fluorosis development, fluoride must be available in the bloodstream. Different methods of fluoride use, such as fluoridated water, salt, or fluoride toothpaste, result, either compulsorily or inadvertently, in distinct patterns and availabilities of fluoride in the blood; research in this field, to unveil the detailed role of each of them to fluorosis development, is urgently needed. Moreover, the development of effective ways to reduce the risk of dental fluorosis while maintaining the anticaries properties of fluoride agents is a continuous research challenge.

Finally, dental caries cannot be exclusively defined on the basis of factors involved in its initiation and progression, because it is regarded as a social disease. The current caries epidemiological scenario in populations which have access to fluoride use reveals a polarization of the disease prevalence, with most of the lesions concentrated in few individuals, with a clear socioeconomic bias. Considering the continuous change in the epidemiology of dental caries over the last 50 years, monitoring the role of different methods of fluoride use to caries decline is an incessant challenge. The rates of caries reduction by the isolated use of fluoridated water or fluoride toothpastes are no longer valid when they are used in combination, or associated with other fluoride therapies. Thus, those involved in caries research are continuously challenged by the monitoring and deeper understanding of the efficiency of each method of fluoride use, especially on a population basis.

In conclusion, given the indubitable role of fluoride to control caries, its particular mechanism of action and the endless need for continuous balance of the benefits and risks of its use, aiming at gathering the best from its anticaries effect on a population basis, fluoride research must be regarded not only as an unfinished, but also as an “unfinishing” task.
Use of Fluoride as a Public Oral Health Measure in Brazil

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Dental caries as a biosocial disease

Dental caries can be defined as a biofilm/sugar-dependent disease, which involves the progressive demineralization of dental substrates until clinically visible lesions develop. The disease has a dual-component nature since the presence of dental biofilm is necessary for the demineralization to occur, but it is not enough; exposure of the biofilm to fermentable sugars from our diet, especially in a high daily frequency (Gustafsson et al., 1954), is a key factor for the disease development. The multifactorial nature of the disease allows for the interference of other factors in the caries process, such as salivary flow rate and composition, the bacterial species composing the biofilm, which could me more or less cariogenic, and the type of dental substrate being affected, i.e., enamel or dentine, from deciduous (more prone to demineralization) or permanent teeth.

Apart from the biological process involved in dental caries development, the disease has a strong social background, given that procedures to control it involve access to knowledge related to health promotion (i.e. oral hygiene procedures, diet counseling) and access to fluoride use, at the community or individual level. This is particularly important for developing countries where social inequalities tend to be higher, and underprivileged rely more on government policies to maintain their oral health (Antunes and Narvai, 2010).

In this regard, it is noteworthy that the significant caries decline observed worldwide in the last four decades resulted from the use of fluoride in different ways (Gonzalez-Cabezas, 2008; Tenuta & Cury, 2010), according to the country oral health policy. In developing countries, community programs of fluoride use have been of utmost importance for the caries decline observed at different socioeconomic population strata. The case of Brazil is presented in this article.

Epidemiology of dental caries in Brazil

Brazil is a continental country with approximately 8.5 million Km², being the fifth country in the world in size (IBGE, 2011). Its population is also de fifth biggest in the world, with more than 190 million people according to a 2010 national census (IBGE, 2011). Of these, 84% lives in cities and 16% in rural areas. The country is divided in 5 macro-regions, the north, northeast, central-west, southwest and south (figure 1), with the southwest and the south regions representing the most developed ones, concentrating the higher gross domestic product (table 1).
Table 1: Brazil regions according to area, population and socioeconomic development (IBGE, 2011; Wikipedia, 2011).

<table>
<thead>
<tr>
<th></th>
<th>North</th>
<th>Northeast</th>
<th>Central-West</th>
<th>Southeast</th>
<th>South</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (thousands of Km²)</td>
<td>3,869</td>
<td>1,561</td>
<td>1,612</td>
<td>927</td>
<td>577</td>
</tr>
<tr>
<td>Population (million)</td>
<td>15.9</td>
<td>53.1</td>
<td>14.1</td>
<td>80.4</td>
<td>27.4</td>
</tr>
<tr>
<td>GDP (billion USD)</td>
<td>10</td>
<td>48</td>
<td>40</td>
<td>1345</td>
<td>356</td>
</tr>
<tr>
<td>Human Development Index</td>
<td>0.764</td>
<td>0.716</td>
<td>0.818</td>
<td>0.817</td>
<td>0.831</td>
</tr>
</tbody>
</table>

Figure 1: Brazil and its regions and states (source: Wikipedia, 2011).

Figure 2: DMFT in 12 years-old Brazilian children in the last decades; data of 2003 and 2010 represent national surveys (Narvai, 2000; Brazil Ministry of Health, 2003; Brazil Ministry of Health, 2010).

Due to the continental dimensions of the country, only few national epidemiological researches were conducted to monitor the prevalence of dental caries along the years (figure 2). Some of these (in 1986 and 1996) involved only state capitals. The two recent ones (in 2003 and 2010) represent data from almost 200 municipalities, including all state capitals, chosen to participate in the national survey based on their population and socioeconomic level to be representative of their region and state, and thus to correspond to the country scenario. In 2010, 38,000 people were examined. These two recent surveys mark the beginning of a historical series of epidemiological data on oral health conditions in Brazil, to be followed by surveys in 2020, 2030, and so on.

From figure 2, it can be observed that the recent history of the epidemiology of dental caries in Brazil is not different from what was observed in other countries worldwide. Taken as a whole the data clearly show a significant decrease in caries prevalence, starting at the very high 8.3 DMFT at 12 years-old in 1968, and reaching 2.1 DMFT at the same age in 2010. The
percentage of caries free children at this age is also continuously increasing, and has gone from 31% in 2003 to 44% in 2010. The reasons for this decline will be discussed in the next section.

According to the different Brazilian regional development, differences can be observed in the prevalence of caries among the Brazilian macro-regions, as can be seen in figure 3. This can be partly explained by the assess to fluoridated water, as will be discussed in the next section. Irrespective of the region, differences in socioeconomic level can play a major role in caries prevalence. This social component of caries has been consistently observed in epidemiological surveys (Peres et al., 2006; Pereira et al., 2007; Piovesan et al., 2010). The polarization of the disease, with a low number of individuals concentrating a high prevalence of lesions, is a reflection of inequalities in the access to general and oral health preventive policies (Narvai et al., 2006).

During the decline observed in figure 2, different oral health policies were prevailing in Brazil; in the 1980s, water fluoridation was expanded; in the 1990s, the fluoride toothpastes became widely available. The country always had a focus on preventive and oral health promotion strategies. The two recent epidemiological surveys investigated oral health among different age ranges, and identified the poor oral conditions of the older population and the necessity of specialized dental treatment to alleviate the sequelae of caries and periodontal disease, such as the need for total and partial prosthesis (table 2). The older population still represents those who did not have access to fluoride as the young generations have today. This data was the basis for the implementation of specialized clinics (CEOs, Centros de Especialidades Odontológicas (Dental Specialized Centers)) all over the country (853 available as of 2011). They offer free dental treatment to the population including endodontic, periodontal and prostodontic treatment.

The current policy for oral health in Brazil, implemented in 2003, include not only the CEOs for caries treatment, but continues the focus on caries prevention. Apart from the fluoridation of water as a community oral health policy (to be discussed in the next section), the public policy for caries prevention is based on the work of 20,300 oral health teams in 85% of Brazilian cities, comprising of a dentist, a technician in oral health and an auxiliary in community health. They visit houses and schools emphasizing the education in oral health, distributing oral hygiene kits (including toothbrush and fluoride toothpaste) and offering low complexity caries treatment. These oral teams are part of a bigger health system compromising of medical doctors and nurses, aiming to reach all the population, named Family Health.

It is worth mentioning that the Brazil Ministry of Health has a special division for oral health, the Coordination for Oral Health, ensuring the independence of policy makers to address oral health problems. Moreover, historically oral health policies have been discussed first at municipal conferences.

Table 2: Percentage of the population in need for oral rehabilitation (from one dental element to total prosthesis) for the upper or lower arch, according to the age range (Brazil Ministry of Health, 2004).

<table>
<thead>
<tr>
<th>Age</th>
<th>15 to 19</th>
<th>35 to 44</th>
<th>65 to 74</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper</td>
<td>9.3%</td>
<td>35.8%</td>
<td>32.4%</td>
</tr>
<tr>
<td>Lower</td>
<td>23.4%</td>
<td>71.0%</td>
<td>56.1%</td>
</tr>
</tbody>
</table>
followed by state and national conferences, which guarantees that the consensus among all levels is reached and applied as a national policy.

**Public use of fluoride in Brazil**

The significant caries decline observed in Brazil since 1968 (figure 2) has been explained by three preventive policies, all based on fluoride use: fluoridation of water, widespread use of fluoride dentifrices, and expansion of preventive programs at schools (Narvai, 2000; Narvai et al., 1999, 2000; Cury et al., 2004).

*Fluoridated water*

The fluoridation of public water supply has been the cornerstone of dental caries prevention in Brazil. The first city to be fluoridated was Baixo Guandu, in the state of Espírito Santo, southeast of Brazil, in 1953. This was only eight years after the beginning of fluoridation in Grand Rapids, Michigan USA, in 1945. In 1974, water fluoridation was implemented as a federal law (Brazil Ministry of Health, 1974), which advised that water should be fluoridated in all cities having water treatment systems. Due to technical or political problems, water fluoridation is not yet available for all population receiving treated water. In 1996, 65.5 million people received fluoridated water, corresponding to 42% of Brazilian population (Narvai, 2000). Unfortunately, the distribution of water fluoridation is not equal among Brazilian regions, with the southeast and south with the higher coverage (Antunes and Narvai, 2010), which help explain the differences in dental caries among them (figure 3). This inequality reflects not only the access to fluoridated water, but also to pipe water supply (Antunes and Narvai, 2010). The great challenge of all wide-range preventive policies is to overcome these disparity barriers, and for fluoridated water this is also true. In a detailed revision of the 2003 national survey database, Peres et al., (2006) observed that richer towns were more likely to have fluoridated water, and richer people in these towns were more likely to benefit from it.

In the last 10 years, a great expansion of water fluoridation happened, with many capitals in the northeast region implementing the benefit. It is estimated that from 2005 to 2008, 7.6 million people started receiving fluoridated water. The results of this expansion in terms of caries prevalence will be observed in future epidemiological surveys.

The cost of fluoridated water in Brazil is extremely low, which reinforces its use as an effective oral health promotion strategy at the community level. It is estimated that water fluoridation costs only R$0.08 (approximately US$0.05) per capita per year (Frias et al., 2006).

The reduction of dental caries attributed to water fluoridation can be assessed in epidemiological surveys at two distinct periods: before and after other methods of fluoride use (e.g. fluoride toothpastes) were widely available. In several cities implementing water fluoridation before fluoride toothpastes were widely available, the reduction in the prevalence of caries ranged from 40 to 60% after 10 years of fluoridation (Narvai, 2000). This impressive result tended to level off by the concomitant availability of fluoride toothpastes; however, according to the 2003 survey (data of 2010 not yet available), the DMFT index in 12 years-olds in cities having fluoridated water was 2.3,
more than 30% lower than the 3.4 index in cities without fluoridated water. This difference of one teeth affected by caries at 12 years reinforced the need for expansion of the population covered by fluoridated water.

**Fluoride toothpastes**

The benefit of fluoride toothpastes to the caries decline observed worldwide is unquestionable (Brathall et al., 1996; Marinho et al., 2004). In Brazil, the same effect has been observed since fluoride toothpastes became widely available in 1989 (Cury et al., 2004). In fact, figure 2 clearly shows that a sharp decline in caries prevalence could be observed during the years 1990. Although the isolated effect of fluoride toothpastes on this decline cannot be assessed, revisited epidemiological data shows that they were of significant importance (Cury et al., 2004). For instance, a 50% reduction in dental caries was observed between years 1986 and 1996 in Brazilian capitals of the north and northeast regions which did not have fluoridated water at that time (Cury et al., 2004), suggesting that fluoride toothpastes had a significant role in the caries decline observed. Also, the difference in caries prevalence between cities with or without fluoridated water, which in the past ranged around 50%, is of about 30% nowadays.

The history of fluoride toothpastes in Brazil is peculiar, because in the years 1980, one toothpaste brand (named Kolynos) was responsible for 50% of the sales. Following a worldwide tendency, in September 1988 this toothpaste was fluoridated, followed by other brands, which increased the percentage of fluoride toothpastes available from 25% to 90% in about one year (Cury et al., 2004). This is to be considered the faster wide range oral health promotion measure ever observed in the country.

Brazil is a large producer of toothpastes and related oral hygiene products. Toothpastes produced in Brazil are exported to Latin America and Africa. Also, in Brazil, multinational oral hygiene companies share the market with national manufacturers of toothpastes and toothbrushes. These local manufacturers offer low-price products to the public, and in auctions, usually place more competitive bids.

In Brazil, the majority of the toothpastes use precipitated calcium carbonate as the abrasive component, which demands a compatible fluoride salt (e.g. sodium monofluorophosphate, MFP) to be added in order to avoid the reaction of fluoride with calcium causing insolubilization of fluoride, with no anticaries effect. These formulations based on precipitated calcium carbonate are less expensive and allow the price of some fluoridated toothpastes to be around USD 0.50. Toothpastes containing sodium fluoride and silica as the abrasive are also widely available. Of the five toothpastes that led the sales in 2009, four are formulated with MFP and calcium carbonate as the abrasive and one with sodium fluoride and silica as the abrasive (Kusano et al., 2010).

The frequent evaluation of soluble, anticaries-effective fluoride concentration in Brazilian toothpastes is advisable since the regulation for fluoride toothpastes in Brazil and Mercosur only determines that they should have a maximum of 1,500 ppm F, without specifying the amount that should be soluble. The availability of soluble fluoride in Brazilian toothpastes and the stability of toothpastes formulations have been investigated over the years, showing that toothpastes have quality to be regarded as responsible for the caries decline (Cury et al., 2004). Recently, fluoride toothpastes used by children of a typical Brazilian city were investigated for soluble fluoride concentration, confirming their anticaries potential (Cury et al., 2010).

Considering the continental dimensions of Brazil and the differences in annual mean temperature between the north and the south, which could result in differences in the stability of soluble fluoride in toothpastes, recently, the five toothpastes leading the national sales, purchased at the five Brazilian macro-regions, were assessed for soluble fluoride concentration (Kusano et al., 2010), with a minimum of 1,000 ppm soluble F, necessary for the anticaries
Figure 4. Soluble fluoride concentration (as F ion and MFP) found in the five brands of toothpastes leading the sales in the Brazilian market, all of them formulated with 1450 ppm F (Kusano et al., 2010).

The effect of the fluoride toothpastes (Walsh et al., 2010) being found for all of them (figure 4). This recent investigation confirmed similar analysis made more than 10 years ago with the top-selling toothpastes at that time (Duarte et al., 1999).

Besides being available in the market, the current oral health national policy provides free fluoride toothpastes and toothbrushes at every 3 months for children at schools with low development index and for families in cities with a low human development index. In the last 7 years, 72 million oral hygiene kits were freely distributed, according to these criteria. This measure aims to diminish inequalities in the access to fluoride toothpaste among people from different socioeconomic levels.

Caries preventive programs

The sharp caries decline during the years 1990 in Brazil is not only concomitant to the wide availability of fluoride toothpastes in the market, but also to a dramatic change in the health policy in the country (Narvai et al., 1999). From 1990, each city became responsible to plan its expenses with health measures, which gave them flexibility to propose actions specifically needed for their population. Also, at the public dental services, there was a change in types of treatments funded, with the inclusion of preventive programs based on topical fluoride application and instructions of oral hygiene, and not only restorative treatment as occurred in the past.

The current preventive programs focus on caries prevention in children at schools, with each municipality being responsible for managing its own specific measures, which range from instructions of oral health and supervised toothbrushing (that could include the distribution of fluoride toothpastes and toothbrushes), to fluoride rinses performed weekly (using 0.2% sodium fluoride) and to professional fluoride application (using 1.23% F, acidulated phosphate fluoride gel). Usually these measures are not applied uniformly in the city, but tend to concentrate in neighborhoods with lower socioeconomic levels, identified by each municipality oral health team.

Lessons learned and future steps

Currently in Brazil there is a considerable challenge to improve oral health of older people and diminish the need for treatment. This has been addressed by the Oral Health Coordination of the Ministry of Health via the expansion of specialized centers for dental treatment.

As for caries prevention, the current oral health national program is expected to be followed in the upcoming years, with expansion of water fluoridation, emphasis on the use of fluoride toothpastes and specific preventive measures based on fluoride use applied at the municipality level. The success of these strategies for improving oral health in younger generations has been demonstrated (figure 2).

Fluoride use has been central in oral health policies in Brazil and this policy is expected to be maintained. The effort of the Oral Health Coordination of the Brazil Ministry of Health to support preventive strategies based on fluoride use has been recently documented in a Guideline for Fluoride Use in the country, with an up-to-date review of the scientific basis behind each method of fluoride use (Brazil Ministry of Health, 2009).
However, although water fluoridation as a wide-range measure, and directed population strategies, focusing the preventive efforts to high risk areas, can help reduce social inequalities, they cannot eliminate the inequity of caries as a biosocial disease.

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Fluoride Administration-Community Approach
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This presentation aims to provide a very general information on currently available methods for administering fluoride at the community level.

It is now worldwide recognized that fluoride has significantly contributed to a reduction of dental caries and that population wide automatic fluoridation measures are considered the most effective for the prevention of dental caries (1).

Water and salt are recognized as the two vehicles that can be used in automatic fluoridation methods to reach the entire population. Milk has also been acknowledged as a practical method for administering fluoride to population groups particularly children enrolled in schools that have a milk distribution system. The addition of fluoride to drinking water was the first breakthrough in preventive dentistry to be followed by several forms of topical applications (2). Caries prevention, effective on a public health scale, began with the introduction of water fluoridation in the 1940s (3). Industrial production of fluoridated salt started in Switzerland in 1955 (4, 5).

Since the mid 1980s, the Borrow Foundation has been instrumental on developing the methodology and demonstrating the viability and feasibility of using fluoridated milk as a dental public health measure. The first community based milk fluoridation scheme was implemented in Bulgaria in 1988 (6).

The success of fluoridation systems for preventive dental caries has been corroborated in several countries. However, it is very important to recognize that each fluoridation method has specific requirements and careful planning is necessary to select the most appropriate for the country or region. Each fluoridation system has indications and limitations that need to be taken into consideration by oral health planners contemplating implementation. This presentation will attempt to give a brief historical overview, general requirements for implementation, indications, limitations, estimated population coverage, effectiveness, cost, monitoring and recommendations for selecting the most appropriate fluoridation method.

Water fluoridation
The history of water fluoridation can be divided into three periods. The first period from 1901 to 1933 that focused on investigating causes of mottled enamel (Colorado brown stain, first reported by Frederick McKay). The second period between 1933 and 1945, attempted to study the relationship that might exist between fluoride concentrations, fluorosis and dental caries, and established that moderate levels of fluoride prevent dental caries. The third period, from 1945 to the present focused on adding fluoride to community water supplies (7). On 1945 January 25 the first controlled experiment of water fluoridation was started by H. Trendley Dean in the city of Grand Rapids, Michigan USA. Five years later Dr. Dean reported that there were significant reductions in dental caries (8). Over the next sixty years several countries have implemented water fluoridation. In the United States Fluoridation became an official policy of the U.S. Public Health Service by 1951, and by 1960 water fluoridation had become widely used in the U.S. reaching about 50 million people (9). In 2008, 72.4% of the U.S. population
on public water systems, or a total of 195,545,109 people, had access to fluoridated water. The Healthy People 2010 objective was to increase coverage so that 75% of the population would receive water with the optimum level of fluoride for prevention of tooth decay (10). Other countries have implemented water fluoridation, among these, Australia, Brazil, Canada, Chile, Greece, Finland, Ireland, New Zealand, Spain, United Kingdom, the former USSR. About 350 million persons worldwide regularly consume artificially fluoridated water (11). In recent decades “mineral” water has become fashionable, and among parts of the population drinking water is being replaced by bottled water. It must be considered, however, that drinking water continues to be used in kitchens for preparation of a large variety of foods, notably tea, syrups, pastes, soups etc. (12).

In various countries, fluoridation was used and then discontinued either because of lack of funding (13), low caries risk or, for having been replaced by other fluoridation method (14). In April 1999, the Centers for Disease Control and Prevention (CDC) proclaimed community water fluoridation as one of 10 great public health achievements of the 20th century (15).

Effectiveness

A survey conducted in the US in during 1986-1987, indicated that the prevalence of caries among children with a history of lifelong exposure to optimally fluoridated water decreased 18% when compared with the prevalence among children with no exposure to optimally fluoridated water. Prevalence decreased 25% when the analysis excluded children with any history of fluoride therapy (e.g., dietary supplements or professionally applied topical treatments). In addition, recent studies have found consistently lower caries prevalence, both on coronal and root surfaces, among adults who live in communities with optimal or greater fluoride than among those from communities with lower fluoride levels in the water supply (16). Studies have proved that water fluoridation continues to be effective in reducing tooth decay by 20-40%, even in an era with widespread availability of fluoride from other sources, such as fluoride toothpaste. The American Dental Association (ADA) continues to endorse fluoridation of community water supplies as safe and effective for preventing tooth decay (15).

Cost

The direct cost of fluoridating the water depends of size of the community, number of wells and treatment plants, amount and type of equipment, amount and type of fluoride chemical, and personnel costs. The cost per person is inversely affected by community size, the larger the community the lower the cost for fluoridating the water; in the US this cost approximately ranges from 12 cents to 21 cents for water systems serving populations greater than 200,000 persons; from 18 to 75 cents for systems serving 10,000-200,000 persons, and 60 cents to $5.41 for systems serving fewer than 10,000 persons; the mean national weighted estimate is 51 cents. Of all persons receiving optimally fluoridated community drinking water, approximately 85% are served by water systems for which the annual per capita cost of fluoridation is 12 cents-75 cents (17). More recent estimates indicate that the mean cost per person may be around $1.00 per year. Even at this cost, it is estimated that for each dollar invested in fluoridating water it results in about $80 dollars saved in dental treatment costs.

Requirements

In order to properly implement water fluoridation programmes a central water distribution system is indispensable. In addition, the full support of the top health authorities and of the government is essential; some countries have secured laws, decrees or regulations. Adequate budget for initiation and maintenance of the program is indispensable to ensure sustainability. The Choice of equipment and chemicals depend of the circumstances and various systems are
available for example, a) the saturator system: a 4% saturated solution of sodium fluoride is produced and injected at the desired concentration at the water distribution with the aid of a pump. b) Dry-feeder: sodium fluoride or silicofluoride in the form of powder is introduced into a dissolving mechanism. c) Solution-feeder: volumetric pump permitting the addition of a given quantity of hydrofluorosilicic acid in proportion to the amount of water treated. d) Venturi fluoridator system: activated by the flow of water in the main line. It is important that the selected equipment has been demonstrated to be safe and maintain its precision in extreme weather conditions that may prevail in the country; lastly, it should be easy to maintain. The agency in charge of the fluoridation process must also ensure that an adequate stock of parts are available. As part of quality control procedures, the quantity of fluoride compound to be added must be carefully proportioned and determination of the concentration of fluoride in water must be performed regularly. The advice of an expert on water fluoridation and the support of the local agency executing the fluoridation program are vital for the success of the program.

Limitations

A well established centralized piped water distribution system. Support of the top health authorities, the government and the agency in charge of water system. The initial investment on setting up the fluoridation system is relatively high and should be balanced with the prevalence and severity of dental caries in the community or country. Installation of a single unit may cost several thousand dollars; the cost per person can initially be calculated by adding the cost of the equipment to the installation cost, plus one year of supplies and divide this figure by the number of persons that will benefit from the program. Water fluoridation has been recognized as the “gold standard” for community administration of fluoride.

Corollary

Water fluoridation is considered the “Gold Standard” and one of the greatest Public Health achievements. A well established centralized piped water distribution system is indispensable and the support of the top health authorities and government (laws, decrees, regulations, budget allocation), suitable equipment and F supplies, adequate resources: human and economic for operation, monitoring and maintenance.

Salt fluoridation

The idea of using salt as a vehicle for fluoride in caries prevention arose from experience with iodized salt in goiter prevention. It is worth quoting Dr. Hans J Wespi’s remarks about the role of fluorides and the relationship with sea water: “Fluorides are required for the crystallization of apatite from calcium solutions in biological concentrations; so without fluoride, bone formation in animals and man would be impossible. The high acid resistance of fluorapatite compared to hydroxyapatite, as well as the fluoride concentration in plaque and its role in remineralization and the inhibition of sugar-converting and acid producing enzymes are salient points here”. “Iodides and fluorides occur naturally in seawater, and sea water is the cradle of life. The composition of our blood serum still reflects the composition of seawater. The ratio of sodium chloride to fluoride in seawater is about 10,000:1, and crude sea salt contains fluoride in a concentration of about 40 ppm. If we add fluoride and iodine to salt, we re-create the conditions that existed at the dawn of animal life-conditions that persist in our blood serum.” Dr. Wespi a Swiss obstetrician, was the first to begin production of a salt containing iodine and fluoride in 1946 (18). In the past 80 years, salt has proved a reliable, safe, cheap and stable carrier to correct iodine deficiency on a large scale. Salt is available and consumed everywhere in the world and the per capita daily consumption is

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constant (approximately 8 to 12 grams) (19). Industrial production of fluoridated salt started in Switzerland in 1955. The initial concentration of fluoride was 90 ppm F by addition of NaF first produced by Swiss Rhine Salt Works. However, with the equipment used in those days it was not possible to obtain precise levels of fluoridation that are now regarded as adequate on the basis of recent evidence. In 1969 the Canton of Vaud began fluoridation in its own saltworks and produced a salt containing 250 mg F for the Canton of Glarus (Wespi). In 1970 F salt at 250 ppm F was produced by Saline de Bex packed in 1-kg packages, as well as 50-kg sacks for bakeries; later in 1974 Swiss Rhine saltworks began a small-scale production containing 250 ppm for the Canton of Glarus. The rationale for increasing the concentration of fluoride from 90 ppm to 250 ppm was that salt containing 90 ppm of fluoride was only a minor source of the element, as demonstrated from data on urinary fluoride levels conducted in areas of Switzerland by T M. Marthaler from 1974-1977 (20). In 1980 the general Health Office recommended Cantons to increase the concentration to 250 ppm. In 1983 most cantonal governments resolved to authorize the sale of domestic salt. After the concentration had been increased to 250 ppm in 1983, the use of fluoridated salt gained further acceptance (21).

The interest on using salt fluoridation expanded to other countries. Extensive research on all aspects of salt fluoridation was conducted in Hungary by K. Toth during 1966 to 1984 but attempts to introduce it in the country had had little success. Sal fluoridation was implemented in the Czech and Slovak Republics in the mid-nineties (22). In 1985, the production and use was authorized in France. Domestic salt both with added fluoride and without fluoride has been on the market since 1986. In 1993 the market share reached a highest 60% and has since declined to 27% (23). In Since 1991, fluoridated salt has been on sale in household size packages in Germany. The market share by 2005 had risen to 63% (24). Romania initiated salt fluoridation in 2010.

A fluoridated salt trial was initiated in Colombia, South America in 1963 and upon successful completion with preventive results comparable to water fluoridation, the approach was introduced to other countries and was supported by resolutions from WHO, PAHO regional health groups and the FDI (25). In 1987, Costa Rica implemented a national salt fluoridation programme using sodium fluoride (225-275 mg F/kg) (26). In 1987, Jamaica started to fluoridate the salt to a concentration of 250 mg/kg (27). At the end of 1988 and beginning of 1989, the State of Mexico, one of 32 states, launched a program to fluoridate salt at a concentration of 250 mg of F per Kg (28). Peru and Colombia started in 1989, Ecuador and Uruguay in 1992 and Mexico’s program went national. Venezuela and Bolivia then followed suit in 1993 (29). Fluoridated salt is available to over 200 million people. Other countries in the region of the Americas and the Eastern Mediterranean have initiated baseline studies and others in Asia and Europe have demonstrated such interest.

Effectiveness

Various studies conducted in countries that have implemented fluoridated salt substantiate that salt fluoridation is an effective method for reducing dental caries. The studies in Hungary showed that the preventive effect on caries was most pronounced at fluoride concentrations of 250 ppm and 350 ppm (5). In Switzerland, initial investigations showed that a fluoride concentration of 90 ppm was insufficient and later studies confirmed the positive effects on dental caries with a fluoride concentration at the level of 250 ppm (30). A Survey conducted in Jamaica in 1995 indicated a caries reduction in 12 year-olds of 84% (31). The most important factor in the reduction of dental caries in Jamaica was consumption beginning in 1987 of fluoridated salt (32). In Costa Rica dental caries
reduction between 1988 and 1992 was 42%; between 1988 and 1999 it was 72%. In the State of Mexico, the reduction between 1987 and 1996 was 46%. (33).

**General requirements**

Salt should be free-flow with particle size between 0.1 and 1.5 millimeters and a humidity ranging from 0.3 to 0.5%. Usually, it is also necessary to add an anti-agglutinating or anti caking agent. Cost of implementing a salt fluoridation program varies with the type of equipment available at the processing plant, the method for adding the fluoride compound, cost of the fluoride compound, necessary training of personnel, quality control equipment and supplies, etc. Cost of equipment and other inherent costs for initiating a salt fluoridation program depend on the size of processing plant and amount of salt to be processed. Estimates conducted by the Pan American Health Organization indicate that cost per person per year is approximately US $0.06.

**Limitations**

Addition of fluoride to salt is technically possible in salt refineries but not feasible in cases of preferred use of “crude” salt. For effective caries prevention, fluoride must be present in ionic form when salt (NaCl) is dissolved in water. Calcium carbonate and certain heavy metals strongly reduce the ionic form of fluoride. This problem must be checked at the earliest stages of the salt fluoridation planning process. Factors that may pose problems relate to coarse salt with strongly varying grain size, use of either NaF (cheap, fine powder) or KF (hygroscopic), and variable humidity in the production plant. There are essentially two different salt production processes: batch processing or continuous processing. I quote Professor Marthaler on explaining reasons for possible segregation of fluoride. “There has been some concern about possible segregation of the fluoride (NaF or KF) from the sodium chloride crystals. NaF is normally a very fine powder and consequently has a tendency to accumulate at the bottom of any package of whatever size. While the mixture may have been homogeneous at the conclusion of the production process, the small NaF-particles tend to fall through the empty spaces between the coarser NaCl-crystals. Humidity is an important factor. When it is 2, 3 or 4 percent, segregation is greatly reduced. For domestic use, however, a very dry salt is usually preferred.

The size of NaCl granules typically varies within 0.2-1.0 mm in diameter. In a few countries, notably France, a segment of consumers prefers a fairly coarse salt a few millimeters in grain size. This type is very difficult to fluoridate, as the surface area to which the fluoride should remain attached is substantially reduced. French salt factories (producing since 1986) have been able to overcome this difficulty. Segregation is not a problem as long as the salt is distributed in bags of not more than 1.5 kg. When large amounts of fluoridated salt, e.g. over 10 kg, are contained in bags or sacks, considerable amounts of NaF or KF accumulate at the bottom. Segregation is unlikely to occur during storage but may arise during transportation from the production site to the end user” (34). At least one country in the Americas (Uruguay) uses granular salt because of people’s preference. Salt fluoridation where it is feasible can contribute to improvement of oral health of population groups that cannot benefit from water fluoridation.

**Corollary**

Salt is consumed by virtually all populations and the amount consumed is constant (+8 g/day). The overdose is virtually excluded, therefore it is very safe. Salt fluoridation has been used successfully for over 50 years. The Fluoride addition is inexpensive and various techniques for addition in various settings have been developed and these are accessible to small and large processors. The cariostatic effect has been demonstrated to be between 40-84%. Salt fluoridation is ideal for countries or regions with few central water systems and in which salt production and distribution can be
controlled. It should be noted however, that addition of fluoride to salt not feasible in cases of preferred use of “crude” salt particularly in large grains.

Milk Fluoridation

Fluoridated milk was first investigated in the early 1950s, almost simultaneously in Switzerland, the USA and Japan. Numerous peer-reviewed publications in international journals showed clearly the bioavailability of fluoride in milk, and increased concentrations of fluoride in saliva, dental plaque, dental enamel and dentine, and urine, after consumption of fluoridated milk (35). Milk fluoridation, as an alternative vehicle for automatic population directed administration of fluoride, began in Switzerland some fifty years ago. In 1988 the first community based scheme was introduced in Bulgaria and reached some 15,000 children. By 2000 this figure had increased to 114,000 children as programmes were introduced in four other countries. More recently there has been further expansion particularly in Thailand and Chile and there are now 800,000 children in five countries participating in the international programme. As milk fluoridation mostly targets the child population, milk fluoridation schemes have been established within the context of school health programmes (WHO, 2003), and programmes for healthy diet and nutrition”.

Effectiveness

Early clinical studies were conducted in Japan by Imamura in 1959; he reported a caries reduction range between 29 to 34%. In the USA trial was conducted by Rusoff et al. in Baton Rouge, Louisiana in 1962; an overall caries reduction of 35% in permanent teeth was recorded. In Switzerland, by Ziegler in 1953. Reports indicated a caries reduction in temporary teeth of 17% and 64% in permanent molars. A major change in research into and promotion of fluoridated milk for children’s caries prevention occurred in 1971 when Edgar Wilfred Borrow of Padnell Farm, Cowplain, Portsmouth, U.K., established a charitable foundation (36). The Foundation has remarkably contributed to development and expansion of milk fluoridation for prevention of dental caries. Milk fluoridation schemes were started in Bulgaria in 1988, United Kingdom in 1993, Chile 1994, China 1994, Russia 1994 and Thailand in 2000. Caries reduction reported was greater in permanent than in temporary dentition varying between 40 to 78%. The Republic of Macedonia, introduced a milk fluoridation programme in October 2009. In Peru the scheme which was introduced in 1999 was discontinued in 2004 and discontinued due to increased use of fluoridated salt (37, 38, 39).

As for other methods for administering fluoride to the population, it is indispensable to acquire basic information during the planning process. These data includes oral health status of the children, sources of fluoride exposure, availability of milk, disposition/commitment of the dairy company and existence of a distribution system (i.e. government or private subsidy), number of children to be included in the scheme; it has been recommended that a minimum of 4,000 to 5,000 children are needed to make the project viable, whether liquid or powdered milk is contemplated. Arrangements for collaboration with the local school administration and school staff are also critical. Further information on “Development of a Milk Fluoridation Scheme for Prevention of Dental Caries: Preliminary Assessment of Feasibility” is available either from the Borrow Foundation or the WHO Global Oral Health Program (39).

Although it has been noted that the Borrow Foundation provides assistance for developing milk fluoridation schemes, it is important that other sources of funding be identified. Typical questions that are asked refer to direct costs for initiating the program and how much is estimated that will cost per capita per year. A publication from R Mariño and M Morgan, “Manual on economic evaluation of dental caries prevention programs using milk fluoridation...
as an example” provides useful information on this topic (40). Generally, the additional cost of providing fluoridated milk, compared with non-fluoridated milk, is approximately two to three US dollars per child per year (42).

The number of children using fluoridated milk is well over 800,000 worldwide and it is anticipated that the number will increase. The Borrow Foundation has supported the program since its inception and continues to offer assistance for developing milk fluoridation schemes. Grants are available for conducting research on a variety of subjects focusing on clinical effectiveness by increasing concentration of fluoride, frequency of ingesting fluoridated milk, age of participants, possible remineralization in cases of root caries, possible reduction of, effect of sugar added to milk, etc. Further information on all areas of milk fluoridation can be found at the Borrow Foundation website http://www.borrowfoundation.org/html/news.asp

Monitoring community programs using fluoride for prevention of dental caries

**Water fluoridation:** In the US, The Centers for Disease Control and Prevention (CDC) in partnership with the Association of State and Territorial Dental Directors (ASTDD) developed the Water Fluoridation Reporting System (WFRS) to provide states with a management and tracking tool. “: Each water system in the WFRS database includes basic demographic information including utility name, address, population served, fluoridation status (e.g., not adjusted, adjusted, natural, variable, or consecutive), natural fluoride concentrations, counties and communities served, system type, and which systems buy or sell water to other systems. Water systems that adjust the fluoride in their water to the optimal level for decay prevention also collect data to monitor fluoridation quality. This information includes average fluoride concentrations, results of daily testing, and laboratory split sample results. The dates of facility inspections, operator training, and other relevant information also can be included.” (41).

**Salt fluoridation:** These programmes require strict quality control at the processing plant on the physical and chemical properties of the fluoride compound being used, toxicity, purity, etc. In the Americas, the Pan American Health Organization has developed a series of recommendations for monitoring the biological and chemical aspects of salt fluoridation programs and has specific elements for feasibility assessment and program implementation, first evaluation (5-7 years) and long term evaluation (14 years) (33). Specific aspects for surveillance of salt fluoridation programmes will be presented.

**Milk fluoridation:** The WHO publication “Milk fluoridation for the prevention of dental caries” include precise recommendations for monitoring the quality of milk, biological monitoring, determination of fluoride in milk and urine; further a section is devoted to program evaluation, effectiveness, economic evaluation, process evaluation, etc. (43).

**Attributes to Water or Salt Fluoridation**

Inexpensive, effective, eminently safe, equitable—entire population benefits, requires no cooperative effort or direct action, benefits continue for a life time if consumption continues, reduces cost for dental treatment. Does not depend on professional services. With water and salt: lifelong topical contact is warranted.

**Milk fluoridation**

At present, milk fluoridation programs are running continuously in about ten countries of the world. Fluoridation of milk can be recommended as a caries preventive measure where the fluoride concentration in drinking water is suboptimal, caries experience in children is significant, and there is an existing school milk program (35). A special section
for requirements has not been included in this abstract since “fluoridated pasteurized milk is readily produced by adding an aqueous solution of sodium fluoride to milk in a fixed ratio, so as to achieve the required concentration of fluoride in the product. Other methods available are fluoridated UHT milk which is a UHT milk is a long-life liquid milk which is preserved by ultra high temperature processing to eradicate, as far as possible, all microorganisms and fluoridated sterilized milk the term which is given to milk which is preserved by heat-treatment applied when it is in its final container and fluoridated powdered milk is manufactured by fluoridating the liquid milk from which the powder is to be produced” (43).

According to the WHO International Milk Fluoridation Program, milk fluoridation is recommended where F in water is suboptimal, caries experience in children at significant levels, existence of a school milk program and it should be administered 200 days per year at a concentration of 0.65 mg/l/day; with these parameters the anticipated caries reduction would be in the order of 24-27%.

Occupational Health

Whichever method is chosen for administering fluoride to the community, it is important to take into consideration occupational health of persons handling the fluoride compound.

It is indispensable to institute precautions. KI could be toxic: Acute Probably Toxic Dose 5 mg/kg (Whitford 1990). If larger amounts are ingested or inhaled the subject must be taken to the emergency facility and provide treatment. Products that have been recommended are Ca effervescent tabs and milk.

It is highly recommended to institute education and enforce good manufacturing practices. Workers handling fluoride should be monitored periodically; for example, conducting renal excretion analysis every six months maximum. The tolerable urinary fluoride concentration is 7 mg/l (Schlatter and Steineger 1988).

Choice of most appropriate Fluoride vehicle

The information available indicate that water, salt and milk are efficient for dental caries prevention. However, health administrators face the question of what vehicle should be utilized. A careful situation analysis must be conducted in order to decide the most feasible method. It is known that water fluoridation is the gold standard and as such should be considered; the analysis should start by corroborating whether a central water distribution system is available in the community, province, region or country to reach the majority of the population contemplated to be served. Other requirements noted above should also be examined. The in-country situation analysis should also take into consideration assessment of caries levels, national, regional or local, sources of fluoride and any fluoride exposure studies that may have been available and if not existent, such studies must be conducted, diet and nutrition information, human and economic resources, facilities and technology available. It is very important obtain estimates of cost of project and feasibility of implementation, education and required technical assistance, existence or need for establishing epidemiological surveillance system, country legislation, respective time table and plans for evaluation and communication.

The following information is recommended to be obtained when considering salt fluoridation: Identification of main producers, distribution network, type of salt preferred by the community, properties of salt as regards to quality, does salt comply with Codex Alimentarium standard for food grade salt, grain size and humidity, processing facilities, population coverage. Other specific details regarding feasibility studies will be addressed in the presentation.

Conclusion

The GWHO Global Oral Health Programme has concluded that water fluoridation, where technically feasible and culturally acceptable, has substantial
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advantages in public health; alternatively, fluoridation of salt and milk fluoridation schemes may be considered for prevention of dental caries. Since dental caries is a growing public health problem in many countries, the WHO Global Oral Health Programme advocates the effective use of fluoride as an essential approach to prevent dental caries in the 21st century, as part of the WHO Global Oral Health Strategy (1). Public health administrators are encouraged to consult in depth information about the particular method or system considered to be developed in the country or region.

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Use of Fluoride as a Public Oral Health Measure in the United States

E. Angeles Martínez-Mier, DDS, PhD

Historical background of fluoride uses
Multiple epidemiological studies conducted by Dean and coworkers from the 1930s to the 1940s, which linked fluoride in the drinking water to reductions in dental caries, laid the basis for the community water fluoridation programs in the United States (US) (1-4). Based on the results of these studies, researchers determined that 1 ppm fluoride in drinking water was the optimal concentration for climates similar those found in the Midwest region of the US (3, 5). It was proposed that this concentration would substantially reduce the prevalence of dental caries, while achieving a low prevalence (10% to 12%) of very mild and mild enamel fluorosis and no moderate or severe enamel fluorosis (1, 6).

As a consequence, the first community water fluoridation program was implemented in January, 1945 in Grand Rapids, Michigan. Since then, community water fluoridation has been named one of the top ten great public health achievements of the last century in the US and an objective for water fluoridation has been included among the Healthy People national objectives since 1979 (7, 8). Since its implementation, community water fluoridation has been closely monitored in the US. The first surveys on water fluoridation status were conducted by the American Dental Association Council on Dental Health and the American Water Works Association in 1952 (9). The US Public Health Service has reported water fluoridation statistics since 1956 and the Centers for Disease Control and Prevention (CDC) has been the lead agency in this effort since 1975 (10).

Currently used fluoride regimens
In the US, the decision whether or not to add fluoride to drinking water is made at the state or local level, most commonly by direct vote (9). For those communities where water fluoridation is elected, the Department of Health and Human Services (HHS) sets the recommendations for fluoride use including the concentration of fluoride in community drinking water optimal to maximize caries prevention and limit enamel fluorosis (8). In 1962, HHS determined that
community drinking water should contain 0.7 - 1.2 ppm fluoride, depending on an area’s average maximum daily air temperature (11). These temperature-related guidelines are still in effect today. They were determined using a formula for calculating optimal fluoride concentrations based on the results of epidemiological studies conducted in the 1950s (12-13).

Recently, HHS convened panels of scientists to review new information related to fluoride intake and to develop new recommendations for community water fluoridation. These reviews led HHS to propose changing the recommended level for community water systems to 0.7 ppm regardless of the average maximum daily air temperature of the area. Public comment on the new proposed optimal fluoridation level is currently being sought (14).

The Environmental Protection Agency (EPA), which is responsible for the safety and quality of drinking water in the US, has set a maximum allowable limit for fluoride in community drinking water at 4 ppm and a secondary limit at 2 ppm (15-16). These values are also currently under review (14).

**Evaluation outcomes (including availability, accessibility, affordability and acceptability of the fluoride regimens)**

As of 2008, more than 195 million persons in the US had access to community fluoridated water (64.3 % of the total population and 72.4% of those receiving municipal water supplies) (17). Approximately 9 million of these persons receive water with naturally occurring fluoride at a concentration of ≥0.7 ppm. The Healthy People 2020 Objective OH-13 indicates that at least 79.6% of the US population served by community water systems should be receiving the benefits of optimally fluoridated water by 2020. This represents a 10% from the baseline value of 72.4% reported for 2008 (18).

Effectiveness of water fluoridation in the US has been thoroughly documented. Early studies reported caries reductions ranging from 50% to 70% (19, 20). More current estimates set those reductions close to 10% to 25% (21, 22). Reductions in caries prevalence have been observed in the US in communities with and without fluoridated water. This trend has been attributed to the availability of foods and beverages processed in fluoridated areas in areas where community water fluoridation is not optimal (23).

Two studies have been conducted by the CDC on the benefits of community water fluoridation. Results of these studies showed that community water fluoridation continues to prevent dental caries and is a cost effective measure both at the
individual and community levels (24, 25). Economic analysis under modern conditions of widespread availability of fluorides has found that for communities of less than 5,000 and more than 20,000 inhabitants, every $1 invested yielded approximately $16 and $19 in savings in dental treatment costs, respectively (25). Although fluoridation has been endorsed by the American Dental Association and several governmental agencies in the US (26), an active opposition to water fluoridation exists. This opposition has existed since its initiation in the 1940s. Those opposed, include health professionals as well as the lay public and argue that water fluoridation imposes ethical issues and claim it causes health problems ranging from mild to serious (27). In the US, community water fluoridation has been the subject of many law suits where opponents have sued municipalities, contenting that their rights to consent to medical treatment and due process are infringed by water fluoridation or asserting that a large number of illnesses have been caused by water fluoridation (28). To date, no federal appellate court or state court of last resort has found water fluoridation to be unlawful (29).

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fluoridation of water is a reasonable and proper exercise of the police power
in the interest of public health. The matter is no longer an open question."
The efficacy of self-administered fluorides (toothpaste and mouthrinses) – An overview of the evidence

Prepared for: Workshop on Effective Use of Fluoride in Asia, 22-24 March 2011, Phan-Nga, Thailand
Prepared by: Dr Valeria Marinho, Barts and The London School of Medicine and Dentistry, QMUL, UK
Date: 15 March 2011

STRUCTURE

This concise overview is divided into two main sections: Evidence Summary and Annex. The Summary contains a Background, an overview of the Main Findings of systematic reviews - Cochrane reviews mainly, compiling the evidence on the caries preventive effects of self-applied fluoride interventions - toothpastes and mouthrinses, and Conclusions – implications for practice and research. An Annex tabulates the main quantitative findings from the relevant reviews, which are published in full in the CDSR, in The Cochrane Library. Plain Language Summaries and Abstracts of the relevant reviews are available online at http://www.cochrane.org/reviews/index.htm

EVIDENCE SUMMARY

Background

There is a long history of widespread use of fluoride toothpaste and mouthrinse in caries prevention, and fluoride toothpaste in particular is the most significant and widespread form of caries control used globally. Supported by more than half a century of research, the benefits of these self-administered fluoride interventions in preventing dental caries are firmly established, as demonstrated by an increasing number of systematic reviews compiling the research evidence on this topic.

Systematic reviews attempt to collate all empirical evidence that fits pre-specified eligibility criteria in order to answer a specific research question; explicit, systematic methods that minimize bias are used, thus providing reliable findings
from which conclusions can be drawn. Systematic reviews of randomized controlled trials (RCTs) are the gold standard for decision making and appear at the top of the hierarchy of evidence about effectiveness. As reliable summaries of accumulated knowledge they can and should inform decisions about the appropriate use of fluoride to prevent caries and make clear the scientific justification for future relevant research. Cochrane reviews are systematic reviews that employ rigorous research methods, and are published in full in *The Cochrane Library* following a detailed editorial process which is common to all reviews. Cochrane reviews have already answered important questions regarding the effects of fluoride on caries prevention. Consequently, they are becoming very influential as a foundation for preventive practice and policy in dentistry.

The main findings from Cochrane reviews on the caries-preventive efficacy of fluoride toothpaste and mouthrinse in children are presented here. Apart from confirming the relative effectiveness of fluoride toothpaste and mouthrinse for caries prevention the reviews address several issues of interest for clinicians, researchers and policy makers.

**Cochrane reviews of self-administered fluorides (toothpaste and mouthrinses)**

The relevant Cochrane reviews on the effects of topical fluoride self-administration – toothpastes and mouthrinses, used alone or in conjunction with one another – have been published from 2003 to 2010 (Marinho et al., 2003a,b,c, 2004a,b; Walsh et al 2010; Wong et al 2010) (Table 1). These systematic reviews are based upon thorough searches of published and unpublished experimental evidence, from RCTs mainly.

Whilst a variety of study designs have been used over the past five decades to evaluate the effects of fluorides in preventing caries, the various topical fluoride interventions, including toothpaste and mouthrinses, have been subjected to intensive clinical testing in controlled trials, the type of evidence regarded as the best to be included in systematic reviews of effectiveness, because they are considered the strongest study design for prospective research into effectiveness.

Major issues that have been considered in the Cochrane fluoride reviews on the effects of self-applied fluorides include:

- the potential benefits to be expected of fluoride treatments in the form of toothpastes and mouthrinses (mainly in terms of reduced overall caries increment);
• how the benefits of these fluoride treatments may vary according to the influence of potentially important effect modifiers (including initial level of caries severity, background exposure to other fluoride sources, frequency of application, and, more specifically, fluoride concentration, which has been the focus of a review looking at the relative effectiveness of fluoride toothpastes of different concentrations);

• whether the benefits differ among these interventions or when these are used in combination;

• the potential adverse effects, especially dental fluorosis (which are however rarely investigated or reported in conjunction with effectiveness estimates in experimental studies, hence the production of a review on the relationship between the use of topical fluoride, mainly toothpaste, in young children and the risk of developing dental fluorosis, which considers evidence from experimental and observational studies).

Main findings

• The evidence on the beneficial effects of self-applied fluorides is consistent and strong. Research involving more than 50,000 children and adolescents in over 100 trials shows a clear reduction in caries increment with regular use of fluoride toothpaste or mouthrinse (Table 2).

• It is shown in the reviews that use of fluoride toothpaste or mouthrinse can reduce dental caries irrespective of exposure to water fluoridation. It is also shown that supervising a child's use of self-administered fluoride (toothpaste or mouthrinse) leads to greater benefits.

The caries preventive effect of fluoride toothpaste may increase with higher initial levels of caries in the population, and it increases when higher fluoride concentration is used in the formulation (dose-response from 1000 ppm F), but the effectiveness of low fluoride concentration is unclear, since benefit is only significant for fluoride concentrations of 1000 ppm and above (Table 3).

The effect of fluoride mouthrinse was not shown to be dependent on baseline caries or fluoride concentration and application frequency, although a larger effect was indicated with increased intensity of application (frequency times F concentration) – considering the two most commonly used mouthrinse regimens there might be little to choose when the weaker (230 ppm F) is used
as a daily rinse and the stronger (900 ppm F) as a weekly rinse in terms of efficacy.

- It is also indicated in the reviews that fluoride toothpaste can protect against dental caries as much as fluoride mouthrinse or other topical fluoride and that children are more likely to persist with using toothpaste than with using any other topical fluoride treatment.

As regards their combined use, it is shown that fluoride mouthrinse or other topical fluoride treatment used in addition to fluoride toothpaste achieve a larger reduction in caries compared to toothpaste used alone, although the additional effect may not be substantial.

- There is weak, unreliable evidence that starting the use of fluoride toothpaste in children under 12 months of age may be associated with an increased risk of fluorosis. The use of higher concentration fluoride toothpaste (>1000 ppm), when evaluated in RCTs, was found to be associated with an increase in fluorosis.

Conclusions/implications

The evidence reviewed shows that a clear reduction in caries increment in children is associated with supervised regular use of fluoride toothpaste of 1000 ppm and above and of mouthrinse at two main strengths and rinsing frequencies, and emphasizes the role of fluoride toothpastes and mouthrinses as effective approaches for caries prevention in children in various settings. The decision of what fluoride levels to use for children under 6 years should be balanced between the risk of developing dental caries and that of mild fluorosis. The best balance between risk and efficacy of self-applied fluorides, especially toothpaste, for young children can be achieved by using small amounts of effective fluoride concentrations under close supervision, since the reviews findings support the international standard level of 1000 ppm fluoride toothpaste and supervised use of self-applied fluoride treatments. The need for further research on the potential benefits and on the risk of fluorosis for young children with toothpaste of differing fluoride contents is highlighted.
ANNEX

Table 1. Cochrane Reviews on the caries-preventive efficacy of fluoride toothpaste and mouthrinse, in the CDSR (The Cochrane Library, Issue 2, 2011).

<table>
<thead>
<tr>
<th>Citation</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marinho et al, 2003a</td>
<td>Fluoride toothpastes for preventing dental caries in children and adolescents</td>
</tr>
<tr>
<td>Marinho et al, 2003b</td>
<td>Fluoride mouthrineses for preventing dental caries in children and adolescents</td>
</tr>
<tr>
<td>Marinho et al, 2003c</td>
<td>Topical fluoride (toothpastes, mouthrineses, gels or varnishes) for preventing dental caries in children and adolescents</td>
</tr>
<tr>
<td>Marinho et al, 2004a</td>
<td>One topical fluoride (toothpastes, or mouthrineses, or gels, or varnishes) versus another for preventing dental caries in children and adolescents</td>
</tr>
<tr>
<td>Marinho et al, 2004b</td>
<td>Combinations of topical fluoride (toothpastes, mouthrineses, gels, varnishes) versus single topical fluoride for preventing dental caries in children and adolescents</td>
</tr>
<tr>
<td>Walsh et al, 2010</td>
<td>Fluoride toothpastes of different concentrations for preventing dental caries in children and adolescents</td>
</tr>
<tr>
<td>Wong et al, 2010</td>
<td>Topical fluoride as a cause of dental fluorosis in children</td>
</tr>
</tbody>
</table>

Table 2. D(M)FS pooled estimates of self-applied fluoride treatment effects (measured as prevented fractions)

<table>
<thead>
<tr>
<th>Self-applied fluoride type (Placebo comparisons)</th>
<th>Prevented fraction</th>
<th>95% CI</th>
<th>Self-applied fluoride type (no treatment comparisons)</th>
<th>Prevented fraction</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rinse (34)</td>
<td>26%</td>
<td>23–30%</td>
<td>Rinse (30)</td>
<td>26%</td>
<td>22–29%</td>
</tr>
<tr>
<td>Toothpaste (70)*</td>
<td>24%</td>
<td>21–28%</td>
<td>Toothpaste (70)</td>
<td>24%</td>
<td>21–28%</td>
</tr>
</tbody>
</table>

CI = confidence interval; *Placebo comparisons only
**Table 3.** D(M)FS pooled estimates of fluoride toothpastes of different concentrations (measured as prevented fractions)

<table>
<thead>
<tr>
<th>Fluoride concentration (ppm F)</th>
<th>Direct comparison</th>
<th>PF (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Placebo vs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>250</td>
<td></td>
<td>8.90 [-1.62, 19.42]</td>
</tr>
<tr>
<td>440/500/550</td>
<td></td>
<td>7.91 [-6.11, 21.94]</td>
</tr>
<tr>
<td>1000/1055/1100/1250</td>
<td></td>
<td>22.20 [18.68, 25.72]</td>
</tr>
<tr>
<td>1450/1500</td>
<td></td>
<td>22.07 [15.26, 28.88]</td>
</tr>
<tr>
<td>1700/2000/2200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2400/2500/2800</td>
<td></td>
<td>36.55 [17.46, 55.64]</td>
</tr>
</tbody>
</table>

CI = confidence interval
References


Scientific rational of fluoride in caries control
Expanded Abstract
The benefits of fluoride in a wide variety of formulations and delivery vehicles are generally accepted by dental researchers and practicing professionals worldwide. These include community-based methods of fluoride delivery (water, milk and salt fluoridation) and a broad range of fluoride agents (paste, gel, foam, rinse, solution, varnish, drops, tablets). The mechanism of action of fluoride has been the subject of scientific investigator and debate for over 60 years. Early work centered on fluoride reactivity with tooth mineral and its incorporation into the developing tooth structure forming a more stable mineral phase, fluorapatite, thus decreasing its acid solubility. However, the importance of the pre-eruptive effects of fluoride have been largely discounted by more recent studies and the post-eruptive (topical) interaction of fluoride with the tooth structure accounts for the vast majority of fluoride’s clinical benefit.

At very low concentrations (below 1 ppm) in oral fluids fluoride has been shown to decrease rate of enamel demineralization and increased rate of enamel remineralization. Perhaps more importantly, enamel that has been remineralized in the presence of fluoride is more resist to subsequent caries (acid) challenges. The main clinical benefit of low levels of fluoride is most likely mediated by fluoride’s ability to concentrate in dental plaque associated with caries prone tooth sites at higher concentrations than in saliva, and thus increase the fluoride levels in plaque fluid in direct contact with the target tissue. At slightly higher concentrations (~ 10 ppm) fluoride can inhibit microbial enzyme systems decreasing acid production; however, this effect is probably not clinically important because these higher levels of fluoride do not persist very long in the oral cavity after topical fluoride application.

Although much emphasis has been placed on how effective fluoride is at low concentrations, clinically studies have provided support for the use of high concentration fluoride regimens for individuals who are caries active or at higher risk of developing caries. Fluoride use at high concentrations provides the driving force to penetrate the dental biofilm adjacent to the tooth surface, delivering fluoride to tooth surface and more importantly concentrates it in incipient lesions. There is also a relationship between higher fluoride concentration and prolonged retention of fluoride in the oral cavity. High fluoride levels are necessary for the formation of fluoride reservoir (CaF$_2$-like deposits) on the tooth surface and in dental plaque. Very high fluoride levels can also have a transient
bactericidal effect, but this would require repeated frequent applications of professionally applied high concentration fluoride which isn’t practical.

The clinical evidence in support of the various fluoride agents have been the subject a several systemic reviews covering professional applied and home delivery fluoride agents. There is reasonably strong evidence supporting the frequent use of dentifrice products with fluoride concentrations of 1000 ppm and above, fluoride mouthrinses, and professional applied varnishes and gels.

Delivering fluoride in the public domain can be accomplished by several means, but the most widely accepted approach has been community water fluoridation in areas with suboptimal levels of fluoride. The main advantage of water fluoridation is that it is the generally the most cost effective, equitable method of delivering fluoride at the population level. Other approaches that can be considered when water fluoridation is not practical involve salt and milk fluoridation and school-based fluoride mouthrinsing programs.

At an individual patient level there is a need to match the level of fluoride exposure (vehicle, concentration and frequency) with his/her caries risk status, while recognizing that in some cases the goal of completely preventing dental caries cannot be achieved without also addressing the etiological factors. Recent studies have indicated that with higher frequency of dietary sugar challenge higher concentrations and frequencies of fluoride use are needed for caries control. The optimal level of fluoride exposure is the lowest level that will render an individual caries free without safety concerns; however there is no one optimal fluoride exposure for all individuals.

Fluoride in its multitude of forms of delivery will likely remain the cornerstone of caries control for the foreseeable future because of its proven effectiveness and safety. However, there remains the need to determine the most effective method of fluoride utilization in the children and adults who remain caries active. Strategies that optimize the retention of fluoride in the oral cavity while minimizing fluoride ingestion will have obvious benefits. The use of fluoride in combination with other remineralizing agents such as calcium as a pre-rinse or as a complex have some potential; however, any agent which interferes with the ability of ionic fluoride to interact with a tooth surface undergoing a caries challenge will likely be ineffective and possibly detrimental.
Professional Administered Fluorides
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Summary
Fluoride is commonly and widely used in various forms by dental professional workers to prevent and to remineralize dental caries lesions. Fluorides can be delivered topically onto the teeth in various ways by dentists and dental auxiliary staff, the common ones include painting of fluoride solution or varnish, and application of gel/foam in tray. Different fluoride compounds are used in the topical fluoride agents. Sodium fluoride can be used in a neutral pH environment or can be acidulated and buffered with a phosphate to form acidulated phosphate fluoride (APF). The concentration commonly used in fluoride gel is 1.23%. A Cochrane systematic review of fluoride gels found an average reduction of 21% in caries increment in the permanent teeth of children in placebo-controlled clinical trials. Little information on its effectiveness in the primary dentition of young children is available. Because a relatively large amount of fluoride is present in the gel delivered in a tray, risk of excessive ingestion by young children leading to mild toxic side-effects is a potential problem for its use. Fluoride foam is developed to address this problem. The content and use of fluoride foam are similar to those of fluoride gel. However, as the amount of fluoride in the foam is much less than that in gel form, the risk of excessive fluoride ingestion by young children is much lower but little information from clinical trials on its effectiveness in caries prevention is available.

Fluoride varnish, commonly containing 5% sodium fluoride, is quick and easy to apply. It sets rapidly and can adhere to tooth surfaces even in the presence of saliva. Results of a Cochrane systematic review of fluoride varnish show an average reduction of 46% and 33% in caries increment in the permanent and primary teeth of children, respectively. Advantages of using fluoride varnish include its safety and ability to be applied onto specific tooth surfaces or sites with higher caries risk. Besides, prevention of new caries, regular applications of fluoride varnish onto active caries lesions can revert the caries process, leading to remineralization and arrest (halting) of the caries.

Application of silver fluoride or silver diamine fluoride (SDF) solution at a concentration of around 40% has been shown in clinical trials to be able to prevent new caries as well as to arrest active carious lesions in children. Similar effects on root surface caries in elderly have also been reported. SDF is found to be highly effective in arresting active dentine caries lesions in primary teeth in children which makes it a valuable agent for caries arrest treatment.

The recommended frequency of topical fluoride application depends on the assessed dental caries risk of the individual or population. A higher frequency of application, for example every 3 months, is recommended for people with a higher caries risk while application at a longer time interval is recommended for people with moderate risk. Use of professionally applied topical fluoride may not be justified for people with low dental caries risk, especially when they are exposed to fluorides from other sources such as water fluoridation or regular use of fluoridated toothpaste.
The Effective Use of Fluorides in Public Health

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Part 1.

In the land of Gross National Happiness (GNH), oral health care has taken a back seat reminiscent of other south Asian countries struggling to contain infectious diseases in the forefront. Bhutan, with an area of 38,394 km² is a tiny land locked country located at the southern foothills of the Himalayas between two neighboring countries, China in the north and India in the south. The country was in isolation from the outside world for centuries until it opened the way for modern development in early 1960s with launch of the five-year development plans. In 2005, the total population was 634,982, with 333,595 males and 301,387 females; about 80% resides in the villages. The life expectancy at birth is 66 years; 59% are literate. The economic development was rapid since the start of 5 year plan in 1962 with present per capita income of US $1,414 as the highest in South Asia.1,2

In the social sector, the advancement of modern health care services was given great importance beginning the development plans. Over the years, the annual health budget has been increasing exponentially and is second to education ministry in terms of fiscal outlay.3,4 The royal institute of health sciences, erstwhile health school was established in 1972 to train basic health care workers viz. health assistants (HA), nurses, basic health worker (BHW) technicians among others. Some of the certificate level courses have now progressed with introduction of bachelor of nursing and bachelor of public health recently. Higher level education for health care personnel like doctors, until recently sent to other countries might soon come to an end when the Bhutan Institute of Medical Health Sciences (BIMHS), the first medical college in the country opens in a year or two. Presently, Bhutan has 212 hospitals, including 181 Basic health Units (BHU), 24 District hospitals (DH), 518 out reach clinics, 37 indigenous or traditional health units, 2 regional referral hospitals and a national referral hospital in Thimphu as the apex treatment center in the country. In 2009, 3756 worked in the ministry of health with 176 doctors that included 8 dentists, 41 indigenous physicians, 1938 technical staff like nurses, pharmacists, technicians and assistants with 1601 as administrative and support staff. Dental Department at Jigme Dorji Wangchuk National Referral Hospital, in Thimphu comprises 43 staff with 10 dentists, 17 dental hygienists, 13 dental technicians and 3 dental assistants. Presently there is an acute shortage of all categories of clinical staff, including that of dental.1,4,5

Dentistry in Bhutan first began in 1970s as a small dental unit attached to the first hospital in Thimphu with limited manpower and equipments. After four decades, the hospital now has a well equipped Dental department at the Jigme Dorji Wangchuk National Referral Hospital. Bhutan presently has 10
dentists including a specialist each in orthodontics, pediatric dentistry, prosthodontics, endodontics and oral surgery. Like in medical fields, there is acute shortage of dentist as well which necessitates the government to hire 4 Indian expatriates for a monthly pay package of US$1,400. At the beginning of 2011, there are 43 Dental Hygienists, 25 Technicians and 3 Dental Assistants which totals 81 dental health care human resources as shown in Table 1. It is an enormous increase in dental manpower from 58 dentist and 2,100,000 for dentist to population in 2004. This figure is a misnomer as dental hygienists and technicians were clubbed together with then only 6 dentists. Oral health care services in the districts are taken care of by the dental hygienist and some technicians in the hospital setting and school oral health programs. However, oral health status at the national level among the Bhutanese population is still unknown although it is stated that dental care is one of most needed yet most unmet for the Bhutanese population and one of the top ten morbidity recorded in the Bhutan.

Part 1(a)

Bhutan doesn’t have communal water fluoridation or other fluoridated consumer products like milk or biscuits. The data on the use of fluoridated toothpaste among the general population is nonexistent. However, 95% of survey participants among a group of 11-13-year-old Thimphu school children were using fluoridated toothpastes of various brands despite only 50% of participants knew anticaries effect of fluoride. The fluoride levels in these toothpastes were uncertain and not investigated. As majority of Bhutan’s population is the younger age groups, 44% in 0-19 age group and another 40% in 20-40 age groups, it is likely that greater than 85% of the people are exposed to this cheap and readily available form of fluoride from toothpaste with attendant beneficial protection from dental caries. With the increasing urban population and literacy, the number of people being exposed to toothpaste fluoride is most likely to increase at the pace of rapid modernization of the country. At home topical fluoride exposure in the form of rinses is not popular either. This could be due to poor knowledge on fluoride benefits, not getting oral health education related to fluoride use from a very small number of dentists or that the sale of fluoride solutions are not available readily in the pharmacy shops that number only a few in the country.

A high number of patients visiting the dental department in Thimphu hospital are pediatric patients (35%) and of those more than 80% are symptom driven, coming to the dentist with pain and swelling, grossly rampant caries, nursing caries a few trauma and a very few for checkups without no known complaints. The lone pediatric dentist has to manage such hopeless cases with pulpectomy, extraction and oral hygiene instruction and diet counseling. The nonpainful arrest of caries technique (ACT) management using professionally applied fluoride varnishes in any form is nonexistent. The pediatric dentist who joined the department recently after his studies abroad has completed preparation of inventory list for the drugs, vaccines and equipment division in the ministry to acquire various forms of fluorides (APF1.23% gel, 0.05% fluoride mouthwash, 0.25mg/0.50mg/1 mg fluoride tablets and 5% fluoride varnish) that could become available to patients by end of July 2011.

Part 1(b)

The dental caries status of the general population for all age groups is not available. The past studies were conducted on the schoolchildren in various age groups. In 1985, the caries prevalence in Thimphu and Paro for the urban and rural areas among 15-19-year-old children was 73% and 76% respectively. The WHO goal for 2000 for 12-year olds with 1.4 DMFT had already been achieved ahead of 15 years and still was without significant change at 1.2 DMFT in 2008 after more than two decades of socioeconomic development with associated changes in lifestyle including diets. In the former study, they stated that dietary habits, chewing
of betel nut, irregular tooth brushing habit, poverty and lack of knowledge on oral health were some of the possible contributing factors for poor oral health.

The most recently completed study by Ngedup S. et al (2008) had shown that the Thimphu municipal drinking water fluoride level is very low (0.002-0.06 ppmF). They also found caries prevalence of 58% among 461 11-13-year-old schoolchildren in Thimphu city. The children in the study had adequate knowledge, attitude and practice (KAP) for oral health. However, only half of participants knew anticaries effect of fluoride although a high percentage of students use fluoridated toothpaste (95%) of various brands. However, fluoride levels in these toothpastes were uncertain and not investigated. The dental attendance frequency within the past year of the study was low (40%) inspite of free dental services to school children across the country. The obstacles to dental visits could be due to poor oral health awareness in the general population like for general health checkup visits. Lack of transportation, long distance to reach health care centers or long waiting time before getting series are other possible reasons. The oral hygiene procedure in the form of brushing were poor with less than 50% of the subjects brushing less than twice a day and night time brushing done by less than 40% of children. In 2010, Wangchuk S.R et al. initiated a three year longitudinal study on effectiveness of fluoride containing toothpaste and oral health education on caries experience in preprimary schoolchildren. This Danish funded study is a pilot project with 684 participants among 5-6 and 7-8-year-old schoolchildren. The study sites are in Thimphu, Zhemgang and Trashing that represents western, central and eastern regions respectively. The study participants comprised 317 (46%) kindergarten children as study group and 367 (54%) grade two children as controls. The authors plan to evaluate the caries incidence after three years to check the effectiveness of supervised fluoride mouth rinsing and a half hourly oral health education through classroom lecture given to interventional group every alternate week for 36 months. The baseline overall caries prevalence was 80% (61% -100% range) and 85% (73%-97% range) in the study and control groups respectively. Thimphu and Trashigang children had more caries than those from the central region, possibly due to exposure to refined diets and parental affordability for pockets money to children than better self oral hygiene measures or more dental visits while central has more traditional form of diets other factors being the same. The decayed was the dominant index irrespective of regions with less than 15% filled similar to many studies. Better oral health condition is expected from such oral health promotion measures similar to other studies. Dental diseases are better prevented than treated as treatment is time consuming and expensive, although cost in Bhutan is likely borne by the state. The dental health organizations, for preventive purposes, recommends 0.6-1.4 ppm fluoride supplement without fluorosis and that needs to be tailored to the level of drinking water fluoride as displayed in Table 1.2.

Part 2

Although national fluoride mapping was attempted some years ago by the public health laboratory, it was not published to be available to the community and could not be traced. Worse, the data was not used to frame dental public policy for preventive programs. Thimphu city municipal drinking water fluoride level study by Ngedup S.et al. was the first study of the kind in recent years. The fluoride levels at the tap water was very low (0.002-0.06 ppmF) to be of any useful anticaries effect. The Oral Health programme first began in 1978, but became effective only a decade later. Since then dentists or dental hygienists have been visiting schools and communities in the country annually once or twice depending on the resources including budgetary. Preventive services comprise oral health education talks while Fuji IX glass ionomer cement was used as restorative material following ART technique.
Extractions were done to correct over retention of primary dentitions, relieve pain and swellings. Since the oral health program activities are being conducted without any reliable data and target achievements, it becomes pertinent to study the oral health status of Bhutanese to plan oral health programs for better oral health care services. It also calls for mechanisms to evaluate oral health program effectiveness and that it is important component of overall health as they impact self esteem necessary in smiling and social contact, career advancements; eating, nutrition, speech etc. Uncared oral health leads to swelling, pain, sensitivity and anxiety out of dental caries and oral ulcers.24

Part 3

Dentistry in Bhutan has already started treading well on the path to modern ways with latest technology and materials, short of fluoride supplements and studies related to dental caries. The arms of the techno-based dental care would universally be available in nook and corners of the country when electrification of the country completes by 2013.39 More and more of caries epidemiology studies is likely as the oral health programs expands in successive plans and with literacy of people rising on oral health. The number of dentist rises by 4 to 7 annually, would disseminate the people correlation between general and oral health as inseparably linked. The pharmacy shops in the country are also expected to expand with increasing demand and the government agency, the drug regulatory authority looking for all possible means to control spurious drugs and medicines coming to the country to ensure that people have access to quality drugs.

The present oral health program conducted without any data as to the cause and effect of the disease, evaluation and progress study, needs to gear up to the reality of future challenges as those activities without caries data, monitoring system and evaluation are bound to fail to reach the goal like a blind man walking in the darkness. With rapid modernization on track fuelled by power generation and high end tourism on one side and insufficient manpower to meet the demands of dental care on the other, calls for caution. The present attitudes of parents to oral health of the children needs to change with increasing education level although, that might not always guarantee the changes in attitudes and habits of the population. The dental care personnel has to come up with audiovisual oral health programs targeted to the general population; unhappily there is no such educative programs except a few in topical health diseases like malaria, dengue, drugs, mental health, substance abuses and the dreaded HIV & AIDS. As a developing country with both financial and human resource constraints, Bhutan needs to be helped, assisted and guided by developing countries in general. The WHO in particular needs to extend technical expertise to start feasibility study for communal water fluoridation. The probability of salt fluoridation is bleak as salts are already iodized that brought goiter cases to zero after about three decades of its use; and milk fluoridation is not feasible for many years as majority of Bhutanese children cannot afford to consume milk. An effective action would be to start school brushing programs across the country that might have lasting impact in the oral health outcomes. Oral health education in the form of lectures should also be conducted by professionals. The present dental education curriculum in science books for children should be increased on selective topics like cariology and its factors. Pit and fissure sealants needs to be introduced into the oral health program as the caries on the occlusal surfaces was more than 50% of which 43% was seen on first permanent molars compared to 18% for the approximal caries.5 The sale of nonfluoridated toothpaste should be restricted by the government so that there is universal fluoridated toothpaste, the only cheap and reliable source of fluoride to the public. As many schools and institutions do, the sale of carbonated drinks and sugary snacks needs to restrict sales near the premises. In 2008, 50% mothers of survey children were uneducated.8 Increasing literacy of mothers could bring improvement in children’s oral health and that 70% believed in treatment by dentist to
be best for the tooth problems. Although 76% of past study group brushed 1-2 daily, the calculus detected in 60% shows that brushing is ineffective; there is no supervision or education on proper techniques. On the human resources, the government needs to increase the dental workers and allow private practices so that there is opportunity for those who can afford to avail the services for fees. In 2009, more than 30,000 extractions were done which was the dominant treatment modality; there were no data for root canal or any minimal intervention therapies undertaken in hospitals.

The annual health government expenditure is between 10%-15% which is more than those of other Asian countries who spend on an average of 8%. As health care is free in Bhutan, personal expenditure on health by the general population is almost less than 1% and that too, accounted for by the rich elite flying outside the country for tertiary level cares. The present poor attitude for oral health among Bhutanese needs a paradigm shift as the dental attendance are still symptom driven with extractions as the treatment of choice. This is alarming equally for both the planners and care givers as there is no difference in attitude for good oral health irrespective of education, occupation or income levels and such others explanatory variables. Presently there is hardly any health messages related to oral care although a weekly health talks on TV airs only medical topics. The oral health professionals should provide effective and appropriate messages on oral health through various media like the print (news papers, magazines or journals), TV or radio. The reaching messages for education are pertinent in light of rugged geographic terrain and scattered village settlements. A few mobile dental van equipped with all gadgets is likely to benefit those distant from health care units. The Non Formal Education (NFE) which mainly benefits women needs to be sustained so that present 13,018 learners across the country raise the literacy level beyond 59%. Children and adolescents, who are easily mislead by advertisements for refined western diets detrimental to oral health, needs to be targeted so that they become oral health conscious future citizens able to take the country forward into the next millennium and beyond. Through such concerted efforts by professionals and awareness on the part of people can break the chain of infectivity from permanent to deciduous dentitions as latter are indication to future caries.
### Table 1.1. National Dental Healthcare personnel

<table>
<thead>
<tr>
<th>Category of Oral Health Professional</th>
<th>Number of staff</th>
<th>Station hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthodontist</td>
<td>1</td>
<td>Thimphu</td>
</tr>
<tr>
<td>Prosthodontist</td>
<td>1</td>
<td>Thimphu</td>
</tr>
<tr>
<td>Oral Surgeon</td>
<td>1</td>
<td>Thimphu</td>
</tr>
<tr>
<td>Pediatric Dentist</td>
<td>1</td>
<td>Thimphu</td>
</tr>
<tr>
<td>Endodontist</td>
<td>1</td>
<td>Thimphu</td>
</tr>
<tr>
<td>Dental Surgeon</td>
<td>5</td>
<td>Thimphu &amp; Districts</td>
</tr>
<tr>
<td>Dental Hygienist</td>
<td>43</td>
<td>Thimphu (17)</td>
</tr>
<tr>
<td>Dental Technician</td>
<td>25</td>
<td>Thimphu(13)</td>
</tr>
<tr>
<td>Dental Assistant</td>
<td>3</td>
<td>Thimphu</td>
</tr>
</tbody>
</table>

### Table 1.2. Recommended F supplement according to the water F level.

<table>
<thead>
<tr>
<th>Age in years</th>
<th>Water fluoride level</th>
<th>Water fluoride level</th>
<th>Water fluoride level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 0.3 ppm</td>
<td>0.3-0.6 ppm</td>
<td>&gt; 0.6 ppm</td>
</tr>
<tr>
<td>0-0.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.5-3</td>
<td>0.25</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>0.25</td>
<td>0</td>
</tr>
<tr>
<td>6-18</td>
<td>1.0</td>
<td>0.5</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 1.1. National Dental Healthcare personnel

Table 1.2. Recommended F supplement according to the water F level.
References

Effective Uses of Fluoride in Negara Brunei Darussalam

Mary Cheong,
Head of Oral Health Promotion, Department of Dental Services,
Ministry Of Health, Negara Brunei Darussalam

Brunei Darussalam is an independent sultanate on the northwest coast of the island of Borneo in the South China Sea, wedged between the Malaysian states of Sabah and Sarawak. Brunei is a Southeast Asian country consisting of two unconnected parts with the total area of 5,765 square kilometers (2,226 sq mi). It has 161 kilometers (100 mi) of coastline next to the South China Sea, and it shares a 381 kilometer (237 mi) border with Malaysia. It has 500 square kilometers (193 sq mi) of territorial waters, and an 200 nm exclusive economic zone.(1)

Most of Brunei is within the Borneo lowland rain forests ecoregion that covers most of the island but there are areas of mountain rain forests inland.

The climate of Brunei is tropical. The average annual temperature is 26.1 °C (79.0 °F), with the April-May average of 24.7 °C (76.5 °F) and the October-December average of 23.8 °C (74.8 °F)

Brunei Darussalam:

The following table illustrates the general, geopolitical and demographic profile of Negara Brunei Darussalam Table 1

<table>
<thead>
<tr>
<th>Capital and largest city (2003 est.)</th>
<th>Bandar Seri Begawan, 78,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other large cities</td>
<td>Kuala Belait 27,800, Seria 23,400</td>
</tr>
<tr>
<td>Administrative District</td>
<td>Brunei Muara, Tutong, Temburong, Kuala Bel</td>
</tr>
</tbody>
</table>

Community water fluoridation

Current community water fluoridation status in Negara Brunei Darussalam

The first water fluoridation plant was installed in the Layong water treatment plant, Tutong district, in 1987. Since then 3 more water fluoridation plants have been commissioned throughout the country. About 95% of the population receives fluoridated water.

Lessons learned

Lessons learned from the water fluoridation / recommendations for improving delivery systems by Mr. Thomas Reeves, national Fluoridation engineer, division of oral health, centre for disease control & prevention, USA.

• All fluoride chemicals used in Brunei Darussalam should meet the American water works association specifications for each chemical used.
• All the dry fluoride chemicals should be in the granular form and not powder form. It should be at least 98 % pure and free of debris.
• The use of batch system (which is used in Brunei Darussalam) of feeding fluorides should be discouraged and the use of dry feeder is recommended.
• The fluoride testing equipment used in all water treatment plants in Brunei Darussalam should be checked with a national known reliable set of standards( if not, many of the test results showing the fluoride levels in the Brunei Darussalam are probably not accurate.

The Workshop on “Effective Use of Fluoride in Asia” _60
Topical Fluorides
  a) Professionally applied topical fluorides

Fluoride Varnish
  School based fluoride varnish programme for primary 1 school children

Goal: to reduce the prevalence of dental caries especially in the permanent teeth of primary school children through the application of fluoride varnish twice a year in schools.

Rationale:
  • Fluoride varnish is effective if applied twice a year. It is easy to apply and is tolerated even by young children
  • This school based fluoride programme is one of the strategies recommended by the oral health task force to improve the oral health of the population of Brunei Darussalam especially that of children. It is also one of the key tasks listed in the oral health agenda 2008-2012 to reduce the prevalence of dental caries in children.

Objective:
  In 2011, to apply fluoride varnish to 70% of the all primary 1 children (approx 5000 children) and 3800 primary 2 children (continue application on those children who received this application when they were in primary 1 in 2010.
  • Total no. of children to receive fluoride varnish in 2011 = 8800

Components of the school based programme:
  • Explanation of programme to the school authorities and parents, to distribute and collect consent forms from the parents prior to application of the fluoride varnish

  • Implementation of the programme by school dental nurses on primary 1 & 2 children as part of the oral health screening programme of these children
  • Second application to the same children 6 months after the 1st application.
  • Monitoring and evaluation of the programme.

Target groups in the fluoride varnish programme:
  1. School based programme
     (for primary 1 & 2 children) 8800 children applied biannually
  2. Toddler programme
     1600 children twice a year in 2011
  3. High risk children’s clinic
     1200 children applied twice a year

Specification of the fluoride varnish compound:
The high fluoride varnish must contain 5% sodium fluoride which is equivalent to 22,600 parts per million (ppm) of fluoride ions

b) Self applied topical fluorides

Rolling Toothpaste Program

Introduction:
  Dental caries is a major public health problem in Brunei. The prevalence of dental caries in 5-6-year olds is 89% with 7.1 dmft and in 10-12-year olds the prevalence is 87% with 4.8 DMFT (Lee 2001) With this caries data, Brunei Darussalam is among the countries with the highest caries levels in children (WHO, 2009). About 86% of decayed primary teeth remained untreated (not extracted, not restored) and 82% of decayed permanent teeth in 12-year-olds remained untreated (Lee 2001).

  The high prevalence of dental caries and the high percentage of untreated decayed teeth in Brunei’s child population pose a threat on their physical and mental development, their ability to learn and their productivity and mobility.
Causes of high caries levels in Brunei
1. Bottle feeding
2. High consumption of sugary food and drinks
3. Poor oral hygiene practices

The rolling toothpaste program
The main aim of the Rolling toothpaste program is to improve the oral health of five year old children through the implementation of a health promotion program based in community clinics. The program is aimed at 8 month old children who will be followed for five years with a targeted fluoride intervention, and education.

The evidence
Based on the study done in Manchester, United Kingdom in 2004, the prevalence of early childhood caries in children who had received the interventions in Primary Care Groups was 16.6% compared with 23.5% of children in the control area, a reduction of 29% (p=0.003). The mean dmft (1.17) and prevalence of general caries experience (28.7%) in the test children were also significantly lower than for children in the control Primary Care Groups. (1.72: 39.2%) (p=0.001). Analysis from a community perspective, which included data from all children examined in both areas, showed the prevalence of early childhood caries in the test and control Primary Care Groups was 21.3% and 22.8% respectively and the mean dmft 1.47 and 1.72 (Davies et al 2005)

Conclusion of study:
The parents who received this multi stage intervention were more likely to:
- Report cessation of bottle use (33% vs. 18%)
- Use of sugar free drinks (49% vs. 24%)
- Commencement of brushing before first birthday (45% vs. 27%)
- brushing twice daily (52% vs. 34%)
Parents were more likely to report adoption of three positive oral health behaviors, using a trainer cup from one year of age, using safe drinks and brushing twice daily with fluoride toothpaste.

From a recent study (Cheong 2004) done in Brunei Darussalam there were three parental factors that were statistically significant i.e.:
1. Children who started having their teeth brushed below the age of 2 years had better oral health status than those who started after the age of 2 yrs.
2. There was a significantly higher proportion of Caries free Mouth (CFM) among those children who had stopped bottle-feeding before 3 years old than those who were still bottle-feeding after 3 years old. Therefore it appears that bottle feeding above three years of age is a potential risk factor for developing caries.
3. Consumption of sugary snacks/drinks more than three times a day was significantly associated with poorer dental caries status.

Based on the findings of the study conducted the ‘rolling toothpaste program’ is therefore an evidenced based program addressing and intervening in all three aspects of the significant parental factors on the oral health of the infant until 5 years old.

The factors are simply categorized into:-
1. Bottle feeding to be stopped and changed to feeder cup as early as possible (one year old).
2. Early tooth brushing with adult fluoridated toothpaste 1100 to 1400 ppm (From a study done by A.S Blinkhorn et al, children toothpaste 500 ppm were not effective in reducing early childhood dental caries and adult toothpaste 1100 to 1400 ppm were found to be effective in reducing early childhood caries).
3. Sugary snacks/drinks to be discouraged.

Current evidence suggests that the main thrust for community-based caries control programmes should be concentrated on maintaining children in a caries free state. Thus whole population strategies are essential.
as the high risk theory of caries prevention has not been successful. Hence the rationale for selecting candidates that cannot afford feeder cups, toothbrush and toothpaste only for the programme will not be successful in reducing early childhood caries.

This program is linked in with changing social behavior on oral hygiene through health promotion. In this way, the benefits of a clean, healthy mouth will be understood by a new generation of Brunei residents and as a consequence teeth and

And it is imperative that the mother be given this low cost programme of “rolling toothpaste” so that for the first time a whole new generation of new born (about 7,000 each year) be given the golden opportunity to have good oral health habits and behavior instilled in them as early as possible. This will make the rest of their year’s caries free with sustainable good oral health behavior. They will be able to go into their school years and adulthood with good oral health through self care that has already been instilled in them since early childhood by their mother’s intervention instigated by the ‘rolling toothpaste programme’ instead of starting out the uphill dental caries fight with “toothbrushing drills” in schools.

The “rolling toothpaste programme” is supported by education programme’s for expectant mothers to build on this pre-school initiative. This antenatal programme has already been in effect since 1st September 2007 and is going through monitoring stage. This programme will be evaluated in 3 years time. This focus will deliver benefits over a relatively short time frame of five years. Oral Health Education programmes will be implemented alongside to reinforce the ‘Rolling Toothpaste Programme’ in the health care centres i.e. the “Toddler Programme” and the “Pre school programme”.

The expected result- - Aim to reduce mean dmft in 5 years time by 30% to 50 %.

To evaluate the effectiveness of the program, an oral survey will be conducted on 5 years olds.

School based daily fluoride tooth brushing programme for primary school children (DFTB)

Goal: to reduce the prevalence of dental caries especially in permanent teeth of primary school children and to improve the oral health of primary school children through daily tooth brushing in schools using a fluoridated tooth paste.

The aims of implementing this school based daily fluoride tooth brushing programme are to:

1. Teach and instill good oral hygiene habits among children, both in schools and at home.
2. Promote the use of fluoridated tooth paste daily as a cheap and effective way to prevent or reduce tooth decay or gum disease amongst the children.

Rationale:

• Dental caries amongst school children is still a major oral health problem in Brunei Darussalam.
• Oral disease has a major impact on the person’s general health and well being.
• Treatment of these diseases by conventional curative methods can be stressful and expensive for the individual and society as a whole, expensive and strain on the valuable manpower.
• School fluoride brushing is one of the strategies adopted by the dental services department to reduce the amount of dental decay and gum disease amongst school population as part of the oral health agenda 2008-2012.

Objective:

• In 2011, to implement this programme in all government primary schools in Brunei Darussalam
• Estimated total no. of children to brush with fluoridated paste in schools in 2011→32,000
(using Polypaste fluoride tooth paste)

Components of the DFTB school based programme:

The programme must be carried out in various stages with the inputs and contribution from various stakeholders at various levels from the children to the health and education authorities.

The components of the programme consist of:

1. Advocacy and explanation of the programme to stakeholders e.g.: MOH & MOE authorities at the state, district and school level, teachers, parents & the school children, manufacturers and suppliers of the tooth paste & tooth brushes.
2. Conduct oral health seminars and workshops for teachers and students
3. Implementation of the programme in the schools with the children organizing the activity. Teachers mainly supervises and coordinates only.
4. Monitoring and evaluation of the programme by the relevant stakeholders may include a small study to show the effectiveness of the programme.

Expected outcome & benefits:

1. Experience a reduction in tooth decay and thereby direct & indirect costs of dental treatment
2. Have an improvement in the general health.
3. Better education outcome and school performance, better self esteem and healthy functional teeth

Introduction of the programme:

4 schools one in each district was identified for the pilot project. Department of dental services, ministry of health in collaboration with department of schools, ministry of education.

A) The pilot project was carried out in the following 4 primary schools in April and May 2008:
   1) SR SOAS, Belait District
   2) SR Selangan, Temburong district
   3) SR Sinaut, Tutong District
   4) SR Dato Mohd Yassin, Brunei- Muara district

B) Conducting oral health seminars for teachers and practical hands-on session for. Brunei 1

An oral health seminar was held for 215 teachers from 13 primary schools in Brunei 1 on 29th June 2010. The seminar was conducted by staff of department of dental services, ministry of health and department of 2 schools, and ministry of education.

This was followed by practical hands-on session in the above schools in Brunei 1 which were carried out on 12th and 13th July 2010. A total of 329 teachers and some students from 2 classes of each of the 13 schools participated which were conducted by dental nurses and dental officers from the department of dental services.

Brunei 2A

Following this, a similar oral health seminar was held for schools teachers from the primary schools in Brunei 2A on 4th Nov.2010 from 1.45 to 4.30 pm.

C) Monitoring and evaluation of school-based DFTB programme

An important and crucial of this programme is the monitoring and evaluation of the programme. The reason for doing this because through regular process monitoring, it will be possible to indicate the:

1) Status of implementation of this programme in the targeted schools.
2) Extend to which tooth brushing have a routine in daily school life.
3) Problems that the school authorities, teachers, and children may encounter in relation to this programme.
Various methods of monitoring and evaluating this program exist:

1) By school authorities, teachers and children
   a) Monitoring the status of implementation of this programme in the school.
      A standardized form was filled by the teachers every school day.
   a) Monitoring the extent to which tooth brushing has become a routine in daily school life and the problems that the school authorities, teachers and children may encounter in relation to this programme.

Lessons learned:

- The success of the programme is a collective process with the participation of the stakeholders with enthusiasm being of cardinal importance.
- To ensure sustained effectiveness suitably trained School dental nurses have to be mandated into “squads” of 5 a team and be delegated the responsibility of being the facilitators and administrators of the DFTB programme at the school level.

Fluoride Dentifrice
Choice of toothpaste

It has been recognized worldwide that fluoride toothpaste is very effective in preventing dental caries. The fluoride present in toothpaste reacts with other components of the toothpaste. For toothpaste to be effective in preventing dental caries, fluoride must be freely available and not bound to other ingredients (abrasives) of the toothpaste. This is the main reason why the ASEAN cosmetic Products Regulation withholds that all fluoride toothpaste in the market must contain free available fluoride. The present investigation shows that 11 of the 22 fluoride toothpastes did not contain sufficient total fluoride or less than 70% of total fluoride as free available fluoride.

To determine whether fluoride toothpastes on the local market met the requirements of the guidelines of the ASEAN Cosmetic Products Regulation, the Department of Dental Services in Brunei decided to screen all toothpastes available locally. The main reason for doing so was the finding in a report that part of the fluoride toothpastes available on the market in Asia and Africa contained no fluoride or lower levels of available fluoride than indicated on the package (van Loveren et al., 2006).

Twenty two different fluoride toothpaste brands and types were collected from shops in the capital.

Information provided on the package

The information on the package was checked for descriptive names of the fluoride compound, and its concentration in parts per million (ppm F). In case only percent w/w NaF and SMFP/Na2FPO3 were declared, the ppm F was calculated. Descriptive names of abrasives on the package were considered and for each toothpaste the least compatible abrasive with fluoride mentioned on the package was recorded. Thus for instance if silica and calcium carbonate were both mentioned, then calcium carbonate was included in the information in the table. The expiry date on the package was also checked. The samples were sent to ACTA in Amsterdam for fluoride analysis.

The results concluded that out of the 22 different types of fluoride toothpastes that were manufactured in Australia, Canada, China, Indonesia, Japan, Malaysia, Thailand and Vietnam; only thirteen toothpastes contained a soluble calcium abrasive, calcium carbonate or dicalciumphosphate dehydrate of which 12 were SMFP toothpastes and for one the type of fluoride compound was not mentioned. Of the 22 different types of fluoride toothpaste, 13 did not indicate the expiry date on the package. All 9 toothpastes with an expiry date were tested within the expiry period. Seven did not indicate the type of fluoride compound or the fluoride
Fluoride concentration on the package according to the ASEAN Cosmetic Products Regulation. Of these 7 toothpastes, 3 contained almost no fluoride and the remaining 4 contained between 922-1060 ppm F. Of those 15 toothpastes indicating sufficient information regarding fluoride concentration to enable calculation of ppm F, all contained the indicated amount of fluoride. Of the 19 different types of fluoride toothpaste, that contained at least 922 ppm F, 8 toothpastes contained less than 70% of total fluoride as free available fluoride (Table 7).

The following chart shows the fluoridation schemes in operation in Brunei Darussalam:

Chart 1
Table 1 The following table illustrates the general, geopolitical and demographic profile of NegaraBrunei Darussalam

<table>
<thead>
<tr>
<th>Capital (and largest city)</th>
<th>Bandar Seri Begawan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Official language</td>
<td>Malay</td>
</tr>
<tr>
<td>Official scripts</td>
<td>Malay-alphabet</td>
</tr>
<tr>
<td>Demonym</td>
<td>Bruneian</td>
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<tr>
<td>Government</td>
<td>Monarchy</td>
</tr>
<tr>
<td>Sultan</td>
<td>Hassanal Bolkiah</td>
</tr>
<tr>
<td>Crown Prince</td>
<td>Al-Muhtadee Billah</td>
</tr>
<tr>
<td>Formation</td>
<td>14th century</td>
</tr>
<tr>
<td>End of British protectorate</td>
<td>January 1, 1984</td>
</tr>
<tr>
<td>Area</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5,064 km²</td>
</tr>
<tr>
<td>Water (%)</td>
<td>2,226 sq.mi</td>
</tr>
<tr>
<td>Population</td>
<td></td>
</tr>
<tr>
<td>2019 estimate</td>
<td>395,027</td>
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<tr>
<td>2001 census</td>
<td>332,844</td>
</tr>
<tr>
<td>Density</td>
<td>67,33/km²</td>
</tr>
<tr>
<td>174.4/sq mi</td>
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</tr>
<tr>
<td>GDP (PPP)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$19.674 billion</td>
</tr>
<tr>
<td>Per capita</td>
<td>$49,100</td>
</tr>
<tr>
<td>GDP (nominal)</td>
<td>2009 estimate</td>
</tr>
<tr>
<td>Total</td>
<td>$19.546 billion</td>
</tr>
</tbody>
</table>
Table 2 illustrates the fluoridation plants in Brunei Darussalam and the population areas covered by the public water supplies:

<table>
<thead>
<tr>
<th>Fluoridation Plants</th>
<th>Year of commencement &amp; areas supplied</th>
<th>Average % readings that are within optimal fluoride levels of 0.5 to 0.7 ppm. (2002 to 2005)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layong</td>
<td>1)1987most of tutong district upto Jln. Jerudong, Brunei muara district</td>
<td>63.1%</td>
</tr>
<tr>
<td>Bukit Barun</td>
<td>2)1996 Most of Brunei-Muara district</td>
<td>37.2 %</td>
</tr>
<tr>
<td>Seria</td>
<td>3)2000 Most of Kuala Belait District except Labi area</td>
<td>6.7%</td>
</tr>
<tr>
<td>Mengkabau</td>
<td>4)2000 Whole of Muara area upto Kg.Kapok kanan in the Kota baru area</td>
<td>71.4%</td>
</tr>
</tbody>
</table>

Note: for any fluoridation plants, 90% of the readings must be within optimal.

Table 3 The following table outlines the fluoride concentration in water collected at the designated end points

<table>
<thead>
<tr>
<th>No.</th>
<th>counter</th>
<th>PH</th>
<th>Fl, mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Sungai Asam dental clinic, Daerah Brunei-Muara</td>
<td>7.2</td>
<td>0.87</td>
</tr>
<tr>
<td>2.</td>
<td>Muara Dental clinic, Daerah Brunei-Muara</td>
<td>7.7</td>
<td>0.74</td>
</tr>
<tr>
<td>3.</td>
<td>Tutong Dental clinic Daerah Tutong</td>
<td>7.4</td>
<td>0.66</td>
</tr>
<tr>
<td>4.</td>
<td>Seria Dental clinic</td>
<td>7.8</td>
<td>0.56</td>
</tr>
</tbody>
</table>
Table 4: The following table outlines the dmft status after 10 years of water fluoridation.

<table>
<thead>
<tr>
<th>Age groups</th>
<th>Dental decay status 1987</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-6 years</td>
<td>3% caries free</td>
<td>11.3% caries free</td>
</tr>
<tr>
<td>10-12 year olds</td>
<td>DMFT = 4.91</td>
<td>DMFT = 4.82</td>
</tr>
</tbody>
</table>

*Note: Mean no. of teeth that are decayed, missing and filled due to tooth decay*

Table 5: Fluoride varnish programme in Brunei Darussalam:

<table>
<thead>
<tr>
<th>Total no. of primary schools</th>
<th>Total no. of schools involved</th>
<th>Total no. of students involved</th>
<th>Total fluoride varnish applied</th>
<th>Total fluoride varnish not applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>121</td>
<td>25</td>
<td>40</td>
<td>1,676</td>
<td>2443</td>
</tr>
<tr>
<td>Nongovernment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>6</td>
<td>10</td>
<td>1,046</td>
<td>1,259</td>
</tr>
<tr>
<td>Grand total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>202</td>
<td>31</td>
<td>50</td>
<td>2,722</td>
<td>3,702</td>
</tr>
</tbody>
</table>
Table 6 Programme Timeline

<table>
<thead>
<tr>
<th>Age of child</th>
<th>Summary of Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Feeder cup; toothpaste</td>
</tr>
<tr>
<td></td>
<td>Tooth brush &amp; leaflet</td>
</tr>
<tr>
<td>2.</td>
<td>Toothpaste</td>
</tr>
<tr>
<td></td>
<td>Toothbrush</td>
</tr>
<tr>
<td></td>
<td>leaflet</td>
</tr>
<tr>
<td></td>
<td>Questionnaire</td>
</tr>
<tr>
<td></td>
<td>check for caries/refer to dental nurse</td>
</tr>
<tr>
<td>3.</td>
<td>Toothpaste</td>
</tr>
<tr>
<td></td>
<td>Toothbrush</td>
</tr>
<tr>
<td></td>
<td>leaflet</td>
</tr>
<tr>
<td>4.</td>
<td>Examine the child</td>
</tr>
<tr>
<td>5.</td>
<td>Toothpaste</td>
</tr>
<tr>
<td></td>
<td>Toothbrush</td>
</tr>
<tr>
<td>6.</td>
<td>Toothpaste</td>
</tr>
<tr>
<td></td>
<td>Toothbrush</td>
</tr>
<tr>
<td>7.</td>
<td>Examine the child</td>
</tr>
<tr>
<td>8.</td>
<td>Toothpaste</td>
</tr>
<tr>
<td></td>
<td>Toothbrush</td>
</tr>
<tr>
<td>9.</td>
<td>Toothpaste</td>
</tr>
<tr>
<td></td>
<td>Toothbrush</td>
</tr>
<tr>
<td>10.</td>
<td>Toothpaste</td>
</tr>
<tr>
<td></td>
<td>Toothbrush</td>
</tr>
<tr>
<td>11.</td>
<td>Toothpaste</td>
</tr>
<tr>
<td></td>
<td>Toothbrush</td>
</tr>
<tr>
<td></td>
<td>Examine child</td>
</tr>
</tbody>
</table>

*mths= months*
Table 7 Toothpastes from Brunei, collected in October 2007 and analysed in March 2008

<table>
<thead>
<tr>
<th>Tooth Paste</th>
<th>Produced in</th>
<th>Calcium Abrasive</th>
<th>Fluoride On label</th>
<th>Calculated From label</th>
<th>Total F in analysis</th>
<th>Free Fl. In analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Colgate Kayu Sugi</td>
<td>China</td>
<td>CaCo3</td>
<td>SMFP 1.1%</td>
<td>1450</td>
<td>1450</td>
<td>1024</td>
</tr>
<tr>
<td>2. Colgate herbal white</td>
<td>Vietnam</td>
<td>CaCo3</td>
<td>SMFP ?%</td>
<td>??</td>
<td>1060</td>
<td>870</td>
</tr>
<tr>
<td>3. Colgate fresh</td>
<td>Thailand</td>
<td>-</td>
<td>NaF 0.22%</td>
<td>995</td>
<td>962</td>
<td>711</td>
</tr>
<tr>
<td>4. Colgate total 12</td>
<td>Thailand</td>
<td>-</td>
<td>NaF 0.22%</td>
<td>995</td>
<td>1023</td>
<td>735</td>
</tr>
<tr>
<td>5. Colgate PCP regular flavor</td>
<td>Thailand</td>
<td>Ca2PO4</td>
<td>SMFP 0.76% NaF 0.1%</td>
<td>1450</td>
<td>1441</td>
<td>614</td>
</tr>
<tr>
<td>6. Colgate PCP cool mint</td>
<td>Thailand</td>
<td>Ca2PO4</td>
<td>SMFP 0.76% NaF 0.1%</td>
<td>1450</td>
<td>1509</td>
<td>577</td>
</tr>
<tr>
<td>7. Unilever pepsodent Pencegah</td>
<td>Indonesia</td>
<td>CaCo3</td>
<td>SMFP 1.18%</td>
<td>1555</td>
<td>1659</td>
<td>944</td>
</tr>
<tr>
<td>8. Unilever pepsodent gum care</td>
<td>Indonesia</td>
<td>CaCo3</td>
<td>NaF 0.32%</td>
<td>1448</td>
<td>1312</td>
<td>990</td>
</tr>
<tr>
<td>9. Unilever pepsodent Herbal</td>
<td>Indonesia</td>
<td>CaCo3</td>
<td>SMFP 0.8%</td>
<td>1054</td>
<td>1109</td>
<td>391</td>
</tr>
<tr>
<td>10. Unilever pepsodent whitening</td>
<td>Indonesia</td>
<td>CaCo3</td>
<td>SMFP 0.8%</td>
<td>1054</td>
<td>1114</td>
<td>510</td>
</tr>
<tr>
<td>11. Darlie</td>
<td>China</td>
<td>-</td>
<td>NaF-?%</td>
<td>??</td>
<td>977</td>
<td>768</td>
</tr>
<tr>
<td>12. Sensodyne original Glaxo SK</td>
<td>Thailand</td>
<td>CaCo3</td>
<td>SnF2 ?%</td>
<td>??</td>
<td>3</td>
<td>52</td>
</tr>
<tr>
<td>13. Sensodyne Freshmint Glaxo SK</td>
<td>Australia</td>
<td>-</td>
<td>NaF 0.32%</td>
<td>1448</td>
<td>1364</td>
<td>1176</td>
</tr>
</tbody>
</table>
Tooth Paste | Produced in | Calcium Abrasive | Fluoride On label | Calculated From label | Total Finalysis | Free Fl. Inanalysis |
--- | --- | --- | --- | --- | --- | --- |
14. Sensodyne Gum care Glaxo SK | Thailand | -- | NaF 0.22% | 995 | 1065 | 893 |
15. Systema Lion corp | Japan | -- | NaF?% | ?? | 978 | 691 |
16. Follow me earth chemical Japan | Malaysia | CaCo3 | SMFP?% | ?? | 167 | 92 |
17. Siwaki.F | Indonesia | CaCo3 | SMFP 0.7% | 922 | 1109 | 411 |
18. Sensitive Church & Dwight | Canada | ? | NaF 0.243% | 1100 | 1095 | 925 |
19. Ciptadent Lion Corp | Indonesia | CaCo3 | SMFP 0.8% NaF 0.01% | 1100 | 1049 | 638 |
20. Smile up Lion Corp | Indonesia | - | SMFP 0.8% NaF 0.01% | 1100 | 1035 | 843 |
21. Jaifun | Malaysia | Ca2PO4 | SMFP?% | ?? | 922 | 471 |
22. Safi UNZA | Malaysia | CaCo3 | SMFP?% | ?? | 266 | 82 |

* The 3 big names Colgate, Unilever and GSK are produced in Asian countries except one in Australia. Many tooth pastes contain calcium abrasives in combination with SMFP, which is acceptable but the disadvantage is that with time the PO3 F dissociates allowing F to bind to Ca.

* Applying the criteria that F tooth paste should at least contain 70% of the total amount of F indicated on the package as free available F, or if not indicated on the package 700 ppmF, only the orange shaded ones meets the criteria.

The optimal fluoride exposure is gained only from using any of the nine tooth paste’s shaded in orange.
Public Uses of Fluoride for the Prevention of Dental Caries in Cambodia

Hak S.,

Oral Health Office, Department of Preventive Medicine, Ministry of Health, Cambodia.

Part 1 - Background Information

Cambodia has a population of 13.4 million people (2008), and shares borders with Thailand, Laos, and Vietnam. During two decades of genocide, war and political turmoil in the 1970s and 1980s, the health care system was decimated, but has improved during the past 20 years. Today Cambodia has a young population, with 32.6% of inhabitants under the age of 15 years. Among 90,000 of preschool children attend preschool, 2,262,834 children attend primary school, 605,227 attend secondary school and 292,423 attend high school. The Ministry of Health is committed to follow the Primary Health Care Approach (including adopting the WHO Basic Package of Oral Care (BPOC)), and is supported in its efforts by a range of international organizations and NGOs. However the oral health care system is still poorly developed and receives little local and international support. This includes support for the implementation of fluoride strategies for the prevention of dental caries.

Oral Health Status in Cambodia

There is limited recent data on dmft and DMFT, however the Ministry of Health, with assistance from outside donors, is currently carrying out a National Oral Health Survey of 9 persons from 5 provinces and Phnom Penh. The first National Oral Health Survey conducted in year 1990 showed that dental caries and periodontal diseases were widespread in Cambodia. The DMFT of 12 year-old children was 3.2. Children in the 6 year-old had 9 decayed primary teeth. Oral hygiene was poor and betel quid chewing was common among women while tobacco smoking was common among men. Most of the people never received any kind of dental care. The study of dental status in children in some rural area showed that caries experience (dmft) of 6 year-old was 8.2 and of 12 year old DMFT was 1.2.

Natural fluoride levels in Cambodian drinking water

In recent years the Ministry of Health has investigated the fluoride levels in drinking water from many parts of Cambodia (ref). 92% of samples taken showed sub-optimal levels of fluoride (<0.5ppm), while 6.2% showed levels in excess of recommended amounts (>1ppm). The sources of water with the higher levels of natural fluoride were mostly wells, in 2 provinces. The drinking water in Phnom Penh is taken from the Mekong and Tonle Sap Rivers and has only 0.01ppm fluoride. In some of the districts with higher natural fluoride levels in the drinking water, mild fluorosis has been reported. The Ministry of Health is currently gathering data on the prevalence of fluorosis in some of these areas.

Fluoride in Toothpaste

The most common source of fluoride for most of the population is tooth paste. The Ministry of Health has sent samples of locally available toothpaste for fluoride analysis (in Phnom Penh and overseas). In recently carried out analysis, some brands present bellow standards (<700 ppm) fluoride levels, even when the packaging states 1000 ppm. To address the problem, the MOH recently invited toothpaste importers to meetings at the MOH to inform them about the recommended fluoride levels, and encourage them to meet these
then, depending entirely on donor funding. This support has come from World Concern, ICC, AOI... at various times over the past 20 years. Recently, the Ministry of Health started providing some funds to support fluoride programs in schools.

Although school preventive dental programs have been well-accepted in Cambodia they have been difficult to sustain. When there is paid staff to implement and monitor the program, and the free provision of toothbrushes, toothpaste, fluoride mouth rinse, the programs run well. However, when the support is withdrawn, the programs invariably stop. Some school principals and teachers do not accept that it is their responsibility to conduct these programs in their schools.

Recently there have been discussions with the Head of the Fit for School program in the Philippines regarding the possibility of introducing this excellent basic hygiene and dental health program here in Cambodia, however funding has yet to be found.

A cost-benefit analysis of the school brushing program in Cambodia has not been carried out; however it is clear from overseas studies that the benefits would be very great. Ideally, the Ministries of Health and Education would support such a nationwide program, however, at the present time dental health is not one of their priorities, and funding has not been made available.

The Cambodian National Oral Health Plan

National Oral Health Plans for Cambodia since 1991 has identified fluoride as the most important and appropriate dental public health strategy to prevent dental caries. Target groups have been children and adolescents. Water fluoridation and salt fluoridation have both been considered, however implementation of these strategies did not take place.

Part 2 - The Public Use of Fluorides in Cambodia

A. School-Based Fluoride Programs

School-based fluoride programs have been conducted intermittently in Cambodia since 1990 when an NGO-supported program introduced daily tooth brushing with a fluoride toothpaste, and weekly 2% NaF rinsing in up to 20 Phnom Penh primary schools and three big provinces. The fluoride for rinsing was made up from fluoride powder imported from China at low cost.

Such school-based programs have continued intermittently in some schools (mainly urban) since then, depending entirely on donor funding. This support has come from World Concern, ICC, AOI... at various times over the past 20 years. Recently, the Ministry of Health started providing some funds to support fluoride programs in schools.

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Current Fluoride Strategies in Cambodia

Tooth brushing with fluoride toothpaste and weekly 2% NaF mouth rinsing must be promoted strongly in rural primary schools also. The Ministry of health tries also to promote oral health activities through mother and child health national program, improving tooth brushing habits for small children.
Future Programs

Salt Fluoridation

Salt fluoridation has been demonstrated around the world to be a cost-effective way of reducing dental caries. In Cambodia, since 2007 preliminary studies of the feasibility of salt fluoridation have been carried out. Presently, 80% of salt in Cambodia is iodized. This project was supported by UNICEF, but a lack of restrictions on salt importation, varying standards of iodization, and multiple small local salt producers has made iodization difficult to maintain. The MOH considered setting up a pilot salt fluoridation project. A factory was identified, and the logistics carefully considered. However, it was decided not to proceed at the present time. This was largely because strict monitoring of the fluoridation process to ensure the correct range of fluoride in the salt could not be assured. With multiple salt producers this problem would be magnified, with the possibility of some salt being produced with excessive levels of fluoride. In addition, the added costs of machinery for salt fluoridation, and the costs of monitoring the process, were a barrier to implementation.

Water Fluoridation

In the 1990s the National Oral Health Plans listed water fluoridation for Phnom Penh as a priority. Initially this was not feasible due to the poor reticulated water system. Today however, the situation has improved so that most of the Phnom Penh population now have access to safe piped drinking water. The Ministry of Health is currently investigating the possibility of fluoridating the water supply in Phnom Penh.

School-based brushing program

This is still seen as a priority by the MOH despite the difficulties in implementation and sustainability. The Fit for Schools program is under consideration.

Fluoride varnish

Although fluoride varnish is not available to purchase inside Cambodia, NGO groups providing dental care for children have imported it. Recently, a program called Smiles and Hopes, an initiative of the Global Child Dental Fund, has set up a program to provide basic dental care (including prevention) for children in orphanages in Cambodia. Application twice a year of fluoride varnish is a key part of this program, along with daily brushing with a fluoride toothpaste. The fluoride varnish is particularly appropriate for preschool children who have a high rate of caries. However the costs of the varnish and the present restrictions on sale are impediments to wider use of this fluoride modality.

Fluoride mouthwashes

Although there are several commercial fluoride mouthwashes available in Cambodia for personal use, this strategy is probably not going to be used in the future in any public health programs.

Fluoride tablets

These can be purchased in some pharmacies without prescription, but use appears to be very low in the population.

Fluoride gels

These are used by very few dentists for in-office fluoride treatments, although some supply shops do carry this product. They are not recommended for use in public health programs.

Fluoride toothpastes

The standard child and adult fluoride toothpastes are available; however, the higher concentration pastes are not available. The MOH plans to continue to promote the use of fluoride tooth pastes, starting from a young age, and to cooperate with the industry to ensure that most toothpaste contain adequate levels of fluoride.
Silver diamine fluoride

This caries-arresting product has been brought into the country by the NGO One-2-One CAMBODIA, as is currently in use at the Faculty of Dentistry, International University, as well as at several NGO dental clinics. It is believed to be cost-effective for the arrest of primary tooth caries in children.

Conclusions

Fluoride is recognized by the MOH in Cambodia as a very important public health strategy for the prevention of dental caries. However, although fluoride toothpaste is widely used by the public at home, the public health use of fluorides is still very limited in Cambodia. There is currently no water fluoridation, no salt fluoridation, and only very limited school brushing programs using fluoride toothpaste. The range of fluoride products available for use is limited, but there is increasing public awareness of fluoride due to the promotion of fluoride toothpaste on the TV. In the future, the MOH would like to see a greater emphasis on school based fluoride strategies, and may consider water or salt fluoridation at the appropriate time.

References

The Use of Fluoride in China

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Min Liu¹,
Yan Si¹,
Wenmin Luan²,
Tao Xu¹

¹ Peking University School and Hospital of Stomatology
² Beijing Hospital and Chinese Stomatological Association

Part 1: Brief introduction

China is the largest populated country with cultural diversity and oral care. According to the 3rd National Survey of Oral Health conducted in 2005 in China [1], 66% of 5-year-old children suffered from dental caries, with a mean dental caries experience index (dmft) value of 3.50. Among adults (35-44 years) and older people (65-74 years), the mean caries experience index (DMFT) scores were 4.51 and 14.65 respectively. Oral health condition was poor among those living in the rural areas. This poses a tremendous challenge to public health programs and the continuous development of the oral health system although the incidence of dental caries was decreased for preschool children and adolescent during the past decade according to the 2nd and 3rd National Survey of Oral Health in China [1, 2]. While considering the changing lifestyle and growing consumption of sugars, there is an arduous challenge for Chinese to keep the caries decreasing trend. Considering the fact that many industrialized countries have experienced a dramatic decline in the prevalence and severity of dental caries among children and adolescents, which might result from the increasing use of fluoride products or supplements [3-8], effective use of fluoride has been highly prioritized by Chinese government and NGOs [9]. However, the situation in China is complicated with endemic fluorosis due to water and non-water sources of fluoride in some areas and a considerable dental caries burden in others [10]. Therefore it is important to regulate the appropriate exposure to fluoride in an effort to maximize the benefits and minimize the potential harm, such as controlling fluorosis without jeopardizing the prevention of dental caries in China [11].

Part 2: The public use of fluoride in China

Community level

Guangzhou, the capital city of Guangdong province, had an 18-year experience of water fluoridation. Guangzhou was supplied by tape water mainly from Pearl River and the annual average fluoride concentration was 0.2-0.3ppm before water fluoridation. The project was first implemented in Fangcun District of Guangzhou in July 1965. In November 1965, the project was expanded to the whole urban area of the city with average fluoride concentration of 0.8ppm. In 1972, after 6 years of water fluoridation [12], the dmft index of 5-year-old preschool children decreased from 2.72 to 1.67, and the percentage of caries free children increased from 36% to 51%. The DMFT index of 12-year-old children decreased from 1.44 to 0.57, and the percentage of caries free children increased from 42% to 69%. In 1976, 11 years after the project [13], the DMFT index of 13-14-year-olds had dropped from 1.6 to 0.5, but the prevalence of dental fluorosis was reported to be as high as 63%, with 4% severe, 10% moderate and 49% mild/very mild. Guangzhou Bureau of Health informed Guangzhou Tap Water Company to stop water fluoridation because the caries prevention...
effect was challenged by the high dental fluorosis in September of 1983. Two major problems were found for the project [14]. First, behindhand equipment and techniques at that time caused inaccurate and fluctuate fluoride concentration. The actual fluoride concentration was frequently much higher or lower than the concentration set. Second, the supporters and objectors had different diagnostic criteria and research results on dental fluorosis. Some feasibility studies of water fluoridation have conducted in China but did not come into reality.

Beijing, the capital of China, conducted a set of milk fluoridation programs in order to meet the high caries prevalence in preschool children [15]. The first stage of this program started in November of 1994 and ended in June of 1997. The children in the study group consumed 0.5mg F-/250ml milk/day in kindergartens (5 days/week). While the dmft index did not show statistical difference between study group and control group when evaluated in Jun, 1997. High mount of sugar in milk (7-10%) and the low consumption of fluoride milk (150 days/year) were the possible reasons for this negative result. Another milk fluoridation program [16] was conducted in the same area by the same research team from 1997 to 1999, in which the consumption of fluoride milk was increased from 5 days/week to 7 days/week and the mount of sugar in milk was reduced to less than 2%. The final clinical evaluation showed statistically significant result with the mean of new caries increment (dmft index) as 1.2 for the study group and 1.8 for the control group.

Salt fluoridation is another effective caries prevention method focused on whole population. A salt fluoridation program [17] was conducted in Wuhan city which located in the central area of China in order to evaluate the effect of 200-250ppm salt fluoridation on dental caries in primary teeth over a 3-year period (1988-1991). Altogether 414 3-4 years old children from 2 kindergartens were recruited into the clinical study. All children had three meals in the kindergartens. The average consumption of salt for one child is 3-4g per day. The reduction of new caries increment by dmfs for test group compared to the control group was 54.20%. And the level of urine fluoride between test group and control group were not statistically different. No dental fluorosis was found during the study period.

**Individual consumption**

Toothpaste is the major carrier from which public access to fluoride in China. The first fluoride toothpaste in China was born in 1957 in Tianjin and the dental caries preventive effect of fluoride toothpaste in Chinese children has been approved [18]. However, the quantity of fluoride toothpastes in the market was very low until 90’s. According to the 2nd National Survey of Oral Health (1995) [2], only 18.5% 12-year-old children use fluoride toothpaste. The percentage increased to 46% in 2005 by the 3rd National Survey of Oral Health. The increased use of fluoride toothpaste was proposed to make major contribution to the decline in dental caries for 12-year-old children observed by the last two national surveys of oral health. The actual percentage use of fluoride toothpaste might be higher than 46%. Questionnaire was the popular tool for these investigations, however, half of the teenagers could not recognize whether their toothpaste contain fluoride or not according to an exclusive study [19] focused on the use and associated factors of fluoride toothpaste in Beijing in 2004. The percentage of middle school students in this study who do not know the caries preventive effect of fluoride toothpaste and even thought that fluoride toothpaste might be harmful for health was about 40%. The participants were asked to write down the name of the toothpaste they used currently and whether the reported toothpaste contains fluoride or not according to an exclusive study [19] focused on the use and associated factors of fluoride toothpaste in Beijing in 2004. The percentage of middle school students in this study who do not know the caries preventive effect of fluoride toothpaste and even thought that fluoride toothpaste might be harmful for health was about 40%. The participants were asked to write down the name of the toothpaste they used currently and whether the reported toothpaste contains fluoride or not was checked by professionals. It is different from other studies and hopes to gain more accurate information. The percentage of the students using fluoride toothpaste in this study was as high as 88%. When the students choosing toothpaste in the market, whether the toothpaste contains fluoride or not was a minor consideration for them. Only a few
of them would check the ingredient information. The advertisement effect, taste, and brand effect were the main factors enforcing the participant to buy the toothpaste. According to another investigation conducted at that time in Beijing, 67% of the toothpastes (by brand) for adults and 93% of toothpastes (by brand) for children contained fluoride. Some famous oral health care product factories, such as Colgate and Crest, added fluoride to all their toothpaste, at the same time, the products of these factories occupied high percentage in toothpaste market in China. Therefore, the availability of fluoride toothpaste on market may be an important reason for the increasing use of fluoride toothpaste during the paste decade. The government and some NGOs, such as National Committee for Oral Health, have made great and effective methods to promote the use of fluoride toothpaste in China [9].

Many domestic studies also found the fact that the use of fluoride toothpaste among the whole population increased rapidly during the past twenty years. Although some studies have conducted to investigate caries preventive effect of other tropical fluoride used for public, such as fluoride mouth rinses, the actual use of this kind of tropical fluoride remedy by public is rare in China.

Professional application of fluoride

There are nearly 50 articles published in domestic journals related to the topics of professional tropical fluoride application, such as fluoride gel, fluoride foam, and fluoride varnishes since 80’s. Results showed that topical fluorides products were statistically significant in reducing dental caries both in clinic and in public settings. But the health services in China are treatment-oriented [20-23]. The highest priority of both the health services institution and professional has been given to treatment, such as filling cavities, prosthodontics, and tooth extraction. Few professionals and institutions give attention to prevention issues, such as oral health instruction, diet consultation, and tropical fluoride application. The improper behavior for Chinese is symptom-oriented. The majority of the patients go to hospital for pain relief rather than regular check-up. Beside China is a developing country and health resources are relatively short, so professional application of fluoride would thus have minimal effect on public health and this fact will continue for a long time.

Part 3: Lessons learned and further steps

Lessons from the Community-leveled fluoridation

Water fluoridation and other community leveled fluoridation, such as milk fluoridation and salt fluoridation are economic and effective approaches according to the experiences from many industrialized countries. However, a similar program is not easy to be conducted in China for a long time [24]. It is not only a technique problem, but also a complicated issue consisting of politics, economic, culture, and legal regulations etc. Much effort must be made to strengthen public awareness about fluoride. Sound evidences need to accumulate to prove the effectiveness and safety of these programs in specific areas through careful and scientific feasibility studies. Supportive social background is a key point for government to make relative policies. According to the fact that endemic fluorosis due to water and non-water sources of fluoride in some areas in China still exists, it is important to regulate the appropriate exposure to fluoride to maximize the benefits and minimize the harm of fluorides, controlling fluorosis without jeopardizing the prevention of dental caries.

Promote the use of fluoride toothpaste

During the past two decades, many industrialized countries have experienced a dramatic decline in the prevalence and severity of dental caries among children and adolescents. Although the reasons for the fact might be complex, the consensus view is that the increasing use of fluoride toothpastes is the most significant factor for improved control of dental caries [7]. The decline
of dental caries for 5- and 12-year-old children in China during the past decades is coincident with the rapid increase of fluoride toothpaste in the market which suggests that the use of fluoride toothpaste is appropriate and effective in China and should be given the highest priority. Considering the poor acknowledgement of fluoride in population and the relatively low percentage use of fluoride toothpaste, efforts are need to promote the use of fluoride toothpaste through multiple methods. For example, strengthen public awareness of fluoride by mass media; increase the availability of fluoride toothpaste in the market under the guide of government and NGOs.

**Professional application of fluoride**

Currently, China is strengthening the prevention of chronic diseases, which provides an excellent opportunity to integrate oral disease prevention into the overall non-communicable disease (NCD) prevention programmes. The Ministry of Health in China is developing a basic oral health package for pre-schoolchildren, and tropical fluoride application by professionals is hoped to be included.

**Conclusion**

In summary, China is a country with the largest population, cultural differences and oral health disparity. The situation in China is complicated with endemic fluorosis due to water and non-water sources of fluoride in some areas and a considerable dental caries burden in others. It is important to regulate the appropriate exposure to fluoride to maximize the benefits and minimize the harm of fluorides, controlling fluorosis without jeopardizing the prevention of dental caries. Although the decline of dental caries was observed by the 2nd and 3rd National Survey of Oral Heath, considering the changing lifestyle and growing consumption of sugars, there is a big challenge for Chinese to keep the caries decreasing trend. Effective use of fluoride continues to be given high priority for the control of dental caries.

Community leveled fluoridation has been proved to be economic and effective in controlling dental caries by world experiences, however, conducting this kind of program is a complicated issue consisting of technique, politic, economic, culture, and other social determinants. Although experiences were gained, it is still difficult to conduct such program in large scale in China in the near future.

China is still a developing country and health service resources are relatively short. Moreover, the improper behavior of public in China is symptom-oriented; therefore, the professional application of fluoride only has minimal effect on public health. Currently, China is strengthening the prevention of chronic diseases, which provides an excellent opportunity to integrate oral disease prevention into the overall non-communicable disease (NCD) prevention programs and hopefully professional application of tropical fluoride would be enforced in high dental caries risk groups.

The rapid use of fluoride toothpaste in China during the past decades makes great contribution to the decline of dental caries in preschool children and adolescent. Moreover, according to the experiences from the whole world, especially in the industrialized counties, the highest priority should be given to continue promote the use of fluoride toothpaste in China for now and years to come. Strengthening public awareness of fluoride by mass media and increasing the availability of fluoride toothpaste in market under the guide of government, NGOs would be practical approaches.
References
**Water Fluoridation in Hong Kong**

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Fluoridation of drinking water was introduced by the Hong Kong Government in 1961 following international recognition of its effectiveness and safety as a caries preventive measure. The Department of Health has a Water Fluoridation Monitoring Committee which continuously reviews the volume of water treated, the weight of chemical applied and the average daily fluoride concentration in water samples at water treatment stations. Fluoride concentrations of tap water samples per month, taken randomly from distribution points, are also reviewed. (Appendix 1)

Since the introduction of water fluoridation, the prevalence and severity of dental caries had declined in Hong Kong. The Department of Health (formerly Medical and Health Department) had conducted a number of oral health surveys to monitor the oral health conditions of children during the period. Comparing the results of a pre-fluoridation survey done in 1960 and a survey done in 1987, dental caries of children aged 6-11, both in the permanent and deciduous dentition, had been greatly reduced. In 1987, after 26 years of water fluoridation, there was a sharp reduction in mean DMFT value (82.6%) and mean dmft value (65.1%) when compared with 1960 (Table 1). The latest Department of Health survey was done in 2001. The result of this territory wide oral health survey showed that the mean DMFT value for Hong Kong’s 12-year old students was at a low level of 0.8.

**Use of fluoride toothpaste in Hong Kong**

In addition to water fluoridation, the availability of fluoride containing toothpastes in Hong Kong and its use over the years could have also contributed to the decline in dental caries.

In the Oral Health Survey 2001, it was found that most children at the age of 5 and 12 brushed their teeth regularly with toothpaste. Among the 5 year old children, 36.5% brushed once daily while 54.4% brushed two times or more per day. 84.5% of them always used toothpaste when they brushed their teeth.
Appendix 1
Statistics on Fluoridation of Water Supplies in Hong Kong
2009/10

(i) Natural Fluoride in Hong Kong Water Supplies
Average fluoride level in raw water in 2009/10-0.23 mg/L

(ii) Objective
To increase the fluoride ion concentration in all public water supplies to target level
1961-1967
• During the winter months 1st November to 30th April -0.9mg/L
• During the summer months 1st May to 31st October -0.7 mg/L
1967-1978
• 1.0mg/L throughout the year
• 1978 -1988
• 0.7mg/L throughout the year
1988 onwards
• 0.5mg/L throughout the year
In 2009/10, the average fluoride level in the water supply by analysis of samples was 0.49 mg/L (F⁻)

(iii) Methods
Fluoridation is carried out by means of dry feeder using sodium silicofluoride or solution feeder using sodium fluoride.

(iv) Oral Health Surveys
Pre-fluoridation
• 1960 February/March-8,535 children examined, aged 6-11.
Post-fluoridation
• 1962 February/March -5,686 children examined, aged 6-11.
• 1980 February/April -6,765 children examined, aged 6-11.
• 1987 February/April -7,634 children examined, aged 6-11.
• 1995 February/March -3,163 children examined, aged 6-11.
• 2001 February/March- 4,526 children examined, aged 5, 12.

(v) Distribution
Estimated total of 6.968 million (whole population)
Cost Per Person Receiving Fluoridated Water
HK$1.390 per annum

(vi) Cost Per Person Receiving Fluoridated Water
HK$1.390 per annum
Table 1  
**Dental Caries Status of Hong Kong Children Aged 6-11 in 1960, 1980 and 1987**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Year of Survey</th>
<th>Permanent teeth</th>
<th>Primary teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean decayed, missing and filled (DMF) teeth per child</td>
<td>% of children with one or more DMF teeth</td>
</tr>
<tr>
<td>6-8</td>
<td>1960</td>
<td>2.70</td>
<td>85.4</td>
</tr>
<tr>
<td></td>
<td>1980</td>
<td>0.58</td>
<td>29.5</td>
</tr>
<tr>
<td></td>
<td>1987</td>
<td>0.3</td>
<td>18.8</td>
</tr>
<tr>
<td>9-11</td>
<td>1960</td>
<td>4.36</td>
<td>93.3</td>
</tr>
<tr>
<td></td>
<td>1980</td>
<td>1.22</td>
<td>51.0</td>
</tr>
<tr>
<td></td>
<td>1987</td>
<td>0.95</td>
<td>45.5</td>
</tr>
<tr>
<td>6-11</td>
<td>1960</td>
<td>3.57</td>
<td>89.5</td>
</tr>
<tr>
<td></td>
<td>1980</td>
<td>0.89</td>
<td>40.0</td>
</tr>
<tr>
<td></td>
<td>1987</td>
<td>0.62</td>
<td>31.9</td>
</tr>
</tbody>
</table>

and 12.5% used toothpaste occasionally. As to the 12 year old students, 28.3% of them brushed their teeth once daily and 68.3% brushed two times or more per day. 94.7% of them reported the use of toothpaste every time they brushed their teeth.

Although the use of toothpaste was wide spread, many parents and children covered in the 2001 survey did not know whether or not there was fluoride in the toothpaste. As most of the toothpastes in Hong Kong contained fluoride, the chance of these children using non-fluoride toothpastes was small.

**Other public health measures leading to improvement of oral health in Hong Kong**

There were also other significant milestones in the field of dentistry in Hong Kong which could further contribute to the improvement in the caries picture. In 1980, the Faculty of Dentistry of the University of Hong Kong was established and started its training programme for local dental graduates. Also in 1980, the then Medical and Health Department (now known as the Department of Health) established the School Dental Care Service to provide oral health care to all primary school children. The service now covers 95% of primary school children in Hong Kong. In addition to the School Dental Care Service, the then Medical and Health Department also set up an Oral Health Education Unit in 1989 to fulfill Government’s objective of promoting oral health to the community. The effects from these important developments, no doubt, have collectively contributed to some of the positive changes over the years.
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Fluoride Use in Caries Prevention: The Indian Experience

Naseem Shah
Shoba Tandon

Country profile: India is a vast country with the second largest population of 1.15 billion people. The interesting demography of India is that 50% of its population is below 25 yrs of age and more than 65% is below the age of 35 yrs. India supports more than 1/6th of the world population on a landmass of mere 2.4% of the total landmass of the world. It has 28 states and 7 union territories. 72.2% of the population resides in rural areas. It represents vast diversity in religion, culture, languages, climate etc. In India, there are 22 official languages and 1,652 other local languages with 122 spoken by at least more than 10,000 people. All the major religions of the world are represented in India.

Health infra-structure of India: India spends only less than 2% of its GDP on health. More than 75% cost on health is out of pocket expenditure. India has a vast network of health care facilities with Government emphasis on “Health for all” through primary health care approach. The networks of health care facilities are as shown in Table 1.

In 2005, the government of India launched the National Rural Health Mission (NRHM) to make corrections in health care delivery system. The major thrust was to provide equitable health care, reducing regional imbalances and mainstreaming the Indian system of medicine to facilitate health care to people in

<table>
<thead>
<tr>
<th>Health Education Institutes (tertiary care)</th>
<th>Health Care Resource of India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Colleges</td>
<td>300 (34,595 admissions/year)</td>
</tr>
<tr>
<td>Dental Colleges</td>
<td>290 (23,520 admissions/year for BDS) (2644 admissions/year for MDS)</td>
</tr>
<tr>
<td>Nursing Colleges</td>
<td>1820 (65,109 admissions/year for GNM)</td>
</tr>
<tr>
<td>Pharmacy Colleges</td>
<td>561 (33,625 admissions/year for Pharmacy Diploma)</td>
</tr>
<tr>
<td>AYUSH* Hospitals</td>
<td>3378</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Secondary care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dispensaries</td>
</tr>
<tr>
<td>District Hospitals</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Primary care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community Health Centres (CHC)</td>
</tr>
<tr>
<td>Primary Health Centres (PHCs)</td>
</tr>
<tr>
<td>Sub Centers</td>
</tr>
</tbody>
</table>

*(Indian System of Medicine comprising of Ayurveda, Yoga, Unani, Siddha and Homeopathy)*

Source: http://www.mohfw.nic.in/Rural%20Health%20System%20in%20India.pdf
the rural and remote areas. Under NRHM, Govt. of India has put emphasis on prevention and control of non-communicable diseases (NCDs), which includes Oral Health. It has allocated special budget for National Oral Health Programme to be implemented along with other NRHM programs through District Health Societies.

As mentioned above, due to vast diversity of geographic locations and population, comprehensive data on oral health of the entire country is not available. An attempt was made to evaluate the burden of oral diseases in which all the available studies on oral disease prevalence conducted all over the country was complied and national averages were brought out, which is shown in Table 2.5

The high caries prevalence in India is mainly because the oral health care systems in the country mostly focus on curative care, whereas community-based prevention and oral health promotion have not been systematically implemented. Moreover, changing lifestyle has attracted more consumption of sugar and sugar products, fast food and aerated drinks, especially in urban areas, where socio-economic development is fast. This in conjunction with lack of use of fluoride and awareness about the preventive action of fluorides on dental tissues has lead to a steady rise in caries occurrence. As stated earlier, 65% of Indian population is below the age of 35 years in whom dental caries prevalence is almost 50% and much higher (70%) in elderly population of 60+ years (which comprises of 7.8% of population), mostly as root caries. In actual numbers, this figure is staggering; with an average DMFT of 1.4, number of caries affected teeth is gigantic.

India has endemic zones of high fluoride content in many states; most affected states being Andhra Pradesh, Gujrat, Rajasthan. Out of a total of 609 districts, 220 districts are known to have high fluoride level in ground water. It has been estimated that about 65 million people (6% of the country’s population) are at risk of fluoride toxicity.5

In view of the above, the need for public uses of fluoride for the prevention of dental caries has been challenged repeatedly. However, in the light of changing living conditions and dietary habits, the incidence of dental caries is on increase, and hence merits a relook into uses of fluoride in caries prevention in India.

### The status of fluoride use in caries prevention in India:

**Water fluoridation:** Fluoridation of drinking water remains the most effective and socially equitable means of achieving community-wide exposure to the caries prevention effects of fluoride.7 From a modest beginning in Grand Rapids, artificial fluoridation as a public health measure to curb dental caries has become so widespread that today some 210 million people worldwide receive fluoridated water (World Oral Health Report 2003)8 Centre for Disease Control

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**Table 2. Prevalence of dental caries in different age groups**

<table>
<thead>
<tr>
<th>Age group (in years)</th>
<th>Urban</th>
<th>Rural</th>
<th>Average</th>
<th>DMFT score</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-6</td>
<td>67.23</td>
<td>46.22</td>
<td>56.72</td>
<td>2.1</td>
</tr>
<tr>
<td>12</td>
<td>57.94</td>
<td>36.90</td>
<td>47.39</td>
<td>1.6</td>
</tr>
<tr>
<td>15</td>
<td>55.97</td>
<td>43.28</td>
<td>49.59</td>
<td>1.37</td>
</tr>
<tr>
<td>30-35</td>
<td>45.21</td>
<td>39.27</td>
<td>42.24</td>
<td>1.39</td>
</tr>
<tr>
<td>60-75</td>
<td>79.40</td>
<td>61.90</td>
<td>70.65</td>
<td>-</td>
</tr>
</tbody>
</table>

*DMFT: number of decayed, missing and filled teeth (Source: National Commission on Macro-economics & Health, 2005)5*
Water fluoridation extends its benefit to all the residents of the community, so that all social classes benefit without the need for active participation on the part of individuals. The economic aspect of water fluoridation in India was enumerated by Tewari and Kaur in 1985. However the following limitations have prevented this effective tool from being used in India:

- The crucial requirement for community water fluoridation is a well established, centralized piped water supply. It is not technically feasible for most of India since only 30% of the population have central piped water supply.
- It is also argued that India already has a high concentration of fluoride in drinking water and does not need any community water fluoridation. However, only 6% of the population lives in high fluoride areas or known endemic fluoride belts, about 3% of the population lives in optimal fluoride areas and rest about 90% of population consumes water deficient in fluoride. These results were confirmed by National Oral Health Survey 2002-03 findings, which found that 26.6% of households use water with fluoride levels of 1.5 ppm or more and no more than 6.6% subjects had fluorosis (if questionable fluorosis was excluded).
- Unfortunately, water fluoridation has also been a subject of vigorous opposition. Several arguments are put forth against the use of fluorides in any form for caries prevention, such as fluoride destroys muscle structure, muscle function and depletes muscle energy, destroys bone, teeth, RBCs, blood vessels, lining of the stomach and intestine causing GI problems and even infertility. Such opposition has been faced in other parts of the world such as association of fluoride with increased mortality, cancer, Down’s syndrome, bone fracture etc. However these claims have been refuted by epidemiologic research amongst humans.
- Water fluoridation has also suffered at the hands of medical ethics, it being objected to on the grounds of undesirable side-effects and has been termed as a compulsory medication.

World Health organization has concluded that community water fluoridation is safe, cost-effective and should be done wherever socially acceptable and feasible. The optimal fluoride concentration has been recommended in the range of 0.5-1.0 mg/l. (depending upon climatic conditions). India is a tropical country where water consumption is high and several food articles like fish, tea and various Indian spices like cumin seeds, turmeric, black pepper etc. are rich in fluoride content and consumption of areca nuts, betel quid and tobacco in various forms is common, adds to total fluoride exposure. Considering all the above sources of fluoride being consumed in India, systemic fluoride supplement is desirable only if fluoride content in drinking water is less than 0.3-0.5 ppm till the age of 13 years.

The initial cost of fluoridation plants is miniscule, when compared to health and economic benefits achieved, in terms of saving on restorative treatment needs of the population. Another possible benefit of systemic fluoride is that it could reduce the prevalence of osteoporosis. In India, one in three urban women are at risk of osteoporosis after the age of 45 years. Trace element fluoride is known to enhance deposition of calcium and phosphate ions from blood into the bone and hence improve the bone density. Water fluoridation...
in sub-optimal fluoride area can also provide a great benefit in reducing the incidence of osteoporosis and resultant complications of bone fracture, its associated morbidity and cost to the economy of the country.

**Salt and milk fluoridation**

According to the World Oral Health Report, 2003, 40 million people consume fluoridated salt worldwide. Advantages of salt fluoridation are that it does not require a community water supply and permits individuals to accept or reject it. The results of the caries inhibition studies suggest that the effectiveness of fluoridated salt in inhibiting caries is substantial, of the same order as that of fluoridated water when the appropriate concentration and use are achieved.

Milk fluoridation is the addition of a measured quantity of fluoride to bottled or packaged milk targets especially children, in whom fluoride protection is needed the most. Having both fluoridated and non-fluoridated milk available allows consumers to exercise their choice.

**Feasibility in India:** Though, theoretically milk fluoridation is advantageous, in addition to being the staple food for children and its consumption can be confined to those who need it most, but practically it is not viable and feasible because:

- Majority of children population living in rural and urban areas cannot afford milk daily and moreover there does not exist a central milk supply system in these areas.
- Variation in quantity of milk taken is another factor which cannot be controlled since it depends upon the socio-economic, religious and ethnic factors.
- The distribution of fluoridated milk can be more complicated than that of fluoride supplements in the form of tablets or drops. The production of fluoridated milk requires a high degree of motivation and expertise on the part of the dairy industry to ensure adequate control of the fluoride content.

**Topical Fluorides:** Fluoridated toothpastes and professional fluoride application are the only topical forms of fluoride application in use in India. Fluoride varnish and fluoride gels are the preferred agents by the professionals. These agents are mostly used in tertiary care hospitals only as part of training of professionals.

**Fluoridated toothpaste:** More than 500 million people worldwide use fluoridated toothpaste. It is one of the easiest ways to make fluoride available and is found to reduce dental caries by 30%. The guidelines for use of fluoridated toothpaste were given to prevent its inadvertent systemic effect in children, if any, if swallowed during use (Table 3). The populations in many developing countries do not have access to fluorides for prevention of dental caries for practical or economic reasons. National Oral Health Survey 2002-03 survey data showed that about 2/3 rds of respondents, across ages and both sexes and more in rural areas used non-fluoridated toothpaste/toothpowder, while only 20%, more in urban areas, used fluoridated toothpaste in India.

In WHO Technical Report Series No. 846 on “Fluorides and oral health” (1994), the recommendation on use of fluoridated toothpastes reads as follows: Because fluoridated toothpaste is a highly effective means of caries control, every effort must be made to develop affordable fluoridated toothpastes for use in developing countries. The use of fluoride toothpastes being a public health measure, it would be in the interest of countries to exempt them from the duties and taxation applied to cosmetics.

**Fluoride mouth rinse:** Daily fluoride mouth rinse in the form of 0.044% sodium fluoride has been recommended, which is generally prescribed by the
Table 3. Recommendations for use of fluoridated toothpastes

<table>
<thead>
<tr>
<th>Age in Years</th>
<th>Recommendations on toothpaste use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 4 years</td>
<td>Not recommended</td>
</tr>
<tr>
<td>4-6 years</td>
<td>Brushing once daily with fluoride toothpaste and other two times without paste.</td>
</tr>
<tr>
<td>6-10 years</td>
<td>Brushing twice daily with fluoride tooth paste and once without paste.</td>
</tr>
<tr>
<td>Above 10 years</td>
<td>Brushing three times with fluoride toothpaste.</td>
</tr>
</tbody>
</table>

dentists to patients at increased risk of caries or as a desensitization agent. Fortnightly fluoride mouth rinse by 0.2% sodium fluoride solution, (prepared by dissolving 2 gms of sodium fluoride powder in one liter of cold water) has been used in supervised mouth rinsing programs in schools.

**Professionally applied topical fluorides:** Isolated studies are reported for topical fluoride varnish on small study populations.

Though the opposition to topical fluoride is less than to systemic use of fluoride in India, there are several challenges to its widespread utilization for dental caries prevention.

1. There is widespread misconception that India does not need any additional fluoride, even for topical use, as fluoride in drinking water is already in excess of permissible limit. Fluoride from the topical application, especially from fluoridated toothpaste can be ingested by children, increasing the risk for fluoride toxicity.

2. The toothpaste and toothbrush is only used by urban population which is only 28% of the population. The rest of the population, i.e. 72% is in rural area where use of other indigenous methods of teeth cleaning is more prevalent.

3. Use of fluoride mouth washes and varnishes etc. is limited to a privileged few, as it is only on prescription or done in a Dentist’s office and hence cannot be considered a community based approach.

**Fluoride releasing restorative materials:** Use of Glass ionomer cement, a fluoride releasing restorative material use has increased many folds in recent years due to improvement in its physical and esthetic properties. Its use in ART restoration and pit and fissure sealing for caries prevention is increasingly being practiced, though the exact data on prevalence of its use and efficacy in caries reduction are lacking. Also, fluoride releasing composites are being used for esthetic restoration of anterior and posterior teeth.

Recently, use of silver-diamine fluoride in pit and fissure caries prevention, especially in deciduous teeth is being recommended. Its use is as yet not reported in India.

**Recommendations to prevent dental caries in India**

1. National oral health policy to be adopted by the Govt. of India.

2. Integration of oral health in NCD programme of NRHM and using common risk factor approach with other chronic life-style related
The Workshop on “Effective Use of Fluoride in Asia”

diseases, oral health promotion and disease prevention may be implemented.

3. Massive oral health awareness campaign with appropriate IEC materials to suit different geographic areas, ethnic and linguistic groups.

4. Appropriate use of fluoride for caries prevention should include:
   a. Defluoridation or alternate water supply where F level in drinking water is > 1.5 ppm.
   b. Nutritional prophylaxis to reduce the impact of fluoride toxicity. Adoption of a locally available and practically feasible nutrients supplement through community participation is desirable.
   c. Appropriate fluoride supplement where F level in drinking water is < 0.5 ppm. Advocacy for milk/salt fluoridation which allows persons to exercise their choice for or against its use to be made available in areas with low or negligible fluoride in drinking water.
   d. Promotion of fluoridated toothpaste as a universal topical fluoride method following the prescribed guidelines. (Table 3)
   e. Additional topical fluoride in the form of fluoride mouth rising or fluoride varnish application in dental office to those at high risk of dental caries, such as persons with xerostomia following radiotherapy for head and neck cancers, salivary gland diseases like Sjogren’s syndrome or medication induced.
   f. School based pit and fissure sealing with high fluoride releasing glass ionomer type VII.
   g. Community-based silver diamine fluoride application in deciduous dentition which has been found to be very effective in caries prevention.

Conclusions: Dental caries prevalence is increasing in India like other developing countries, due to shift in dietary practices like excessive consumption of junk food, soft, refined and sweet food items, beverages etc., poor oral hygiene maintenance, lack of awareness and knowledge about oral care and lack of preventive services.

Fluoride has a great role in dental caries prevention. Both systemic and topical fluoride, if made available during tooth development and post eruption can reduce the caries incidence to a great extent. In developing countries with large population and high burden of dental caries, fluoride is the most effective method to reduce dental caries and economic burden related to its curative treatment. In India, effective use of fluoride requires strong advocacy with policy makers, administrators and all stake holders.
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16. Survey by Arthritic Foundation of India. Source:

Fluoride Experiences in Indonesia

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²Faculty of Dentistry, University of Indonesia
³Indonesian Dental Association

A. Introduction

1. Brief Indonesia Profile

Indonesia is a vast country comprised of many islands and is located between two continents, Asia and Australia. According to the Basic Health Research in 2007, the use of drinking water in Indonesia comes from groundwater, rainwater and small in part using tap water. The fluoride level in the groundwater is very different among these islands. State of optimal fluoride in drinking water (0.7 ppm) will strengthen the resilience of dental enamel against dental caries. Research in the East, South and Center of Kalimantan, South Sulawesi, Maluku and Jambi showed that levels of fluoride in drinking water in the area between 0.00 to 0.2 ppm, therefore the prevalence of dental caries in the area is quite high, while the area Ciputat, Situbondo, Madiun, Donggala, Buoi, Toli-toli, Palu, Poso and Banggai, its fluoride level is considered high (0.00 to 3.6 ppm). Therefore, dental fluorosis is very prevalent in those areas. Dental caries prevalence differs geographically. One factor that affects the difference was the fluoride level in the drinking water. It was found in Asembagus village with fluoride level of 0.2 to 2.7 ppm on average by 5% with an average DMF-T 1.00 which followed as many as 83% of patients with fluorosis.

Asembagus study in 1983 found an association between high levels of fluoride to the decrease in dental caries and increased fluorosis. Research in Bandung and Ciputat (1988) found high levels of fluoride (0.75 ppm) with a low prevalence of dental caries (56.46%) and DMF-T score 1.34. Data of drinking water derived from ground water, river and tap water well in Java and outside Java showed low fluoride level (< 0.3 ppm). Results of research on commercial mineral water (> 12 brands) showed fluoride level of 0.07 ppm on average. The situation can be is one factor for the high prevalence of dental caries in Indonesia. The content of fluoride in 20 provinces in Indonesia is as follows:

1. North Sumatera : trace
2. Jambi : 0,15
3. South Sumatera : 0,05-0,2
4. Lampung : 0,1
5. Bengkulu : trace
6. West Java : 0,05-0,75
7. Jakarta : 0,0-0,7
8. Yogyakarta : 0,00-0,4
9. Central Java : 0,01-0,45
10. East Java : 0,05-2,10
11. Bali : 0,2-0,3
12. West Kalimantan : 0,0
13. South Kalimantan : 0,05-0,2
14. Central Kalimantan : 0,05
15. East Kalimantan : 0,00-0,05
16. North Sulawesi : 1,6
17. Central Sulawesi : 0,00-3,6
18. South Sulawesi : 0,08
19. Maluku : 0,2
20. Papua : 0,3
Ministry of Health Republic of Indonesia promoting the use of fluoridated toothpaste, fluoride in drinking water, salt, dairy, etc. In Indonesia, most toothpaste containing fluoride, and it is the easiest method for consuming fluoride. Based on Indonesian Industry Standard (SII), the maximum fluoride compound contained in the toothpaste should not exceed 1,500 ppm, whereas WHO standard for minimum fluoride compound in toothpaste to ensure its active impact is 800 ppm. Most branded toothpaste offered in the market in average containing 1,000 ppm of fluoride.

The Ministry of Health Republic of Indonesia policies on preventing caries by using fluoride have not been fully prepared. There is no report on evaluation of the use of local fluoride such as fluoride rinsing in primary school. According to Zaura, if we compare both methods of providing fluoride by systemic system such as adding fluoride to drinking water for community and adding fluoride for drinking water for primary school student, the cost of providing fluoride tablet in school health promotion is not costly considering its benefits obtained (cost & benefit is measured monetarily).

There is several ways that have been made in the implementation of fluoride such as:

• Fluoride rinsing with 0.2% NaF solution in school dental program at several elementary schools, but this activity does not take place continuously and not evaluated properly.
• This activity is still ongoing at several elementary schools that are under supervision of faculty of dentistry, especially in the activities of dental student internship at the preventive and community dentistry department.
• Implementation trial of tap water fluoridation in South Kalimantan in 1997 was discontinued in 2002 due to funding limitations.
• Implementation trial of application of fluoride tablets on elementary school students in West Kalimantan have been carried out in 2003, but it was this terminated.

Table 1. Oral Health Status in Indonesia

<table>
<thead>
<tr>
<th>No.</th>
<th>Ages Group (year)</th>
<th>Indicator</th>
<th>Condition</th>
<th>TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1995</td>
<td>2001</td>
<td>2007</td>
</tr>
<tr>
<td>1</td>
<td>5-6</td>
<td>% free caries child</td>
<td>14 %</td>
<td>81 %</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>PTI</td>
<td>4,52 %</td>
<td>(4-5) %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DMF-T</td>
<td>2,2</td>
<td>1,1</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
<td>% child with complete tooth curve</td>
<td>No data</td>
<td>99,8 %</td>
</tr>
<tr>
<td>4</td>
<td>35-44</td>
<td>% people with minimum 20 tooth functioning</td>
<td>85,1 %</td>
<td>91 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Edentulous</td>
<td>0,5 %</td>
<td>0,4 %</td>
</tr>
<tr>
<td>5</td>
<td>Above 65</td>
<td>% people with minimum 20 tooth functioning</td>
<td>29 %</td>
<td>30 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Edentulous</td>
<td>23,6 %</td>
<td>24 %</td>
</tr>
</tbody>
</table>
90% of population brushing their teeth twice a day with a toothpaste containing fluoride. (Basic Health Research, 2007).

2. Oral Health Status

Oral diseases suffered by various age groups and characterized as progressive as well as accumulative.

The most oral health diseases suffered by people in Indonesia is caries and periodontal disease. Based on WHO indicators of Oral Health Global Goal 2010 the conditions of oral health of the people in Indonesia in 1995, 2001 and 2007 are as follows:

B. Some of studies of the public used of fluoride

1. Water Fluoridation

There are various factors causing the difference which among other is the difference level of fluoride contained in the drinking water. If the level of fluoride contained in the drinking water is 1.0 ppm, it will result on the low prevalence of tooth caries.

Herandi and Suwelo (1988) at Cipatat Bandung found quite high level of fluoride (0.75) ppm with a low prevalence of caries (56.46%) and DMF-T 1.34. Drinking water data (water well, river, water treatment company, etc) compiled by Suwelo (1991) in Java and outside Java shows low level of fluoride (less than 0.03 ppm).

Research results for water traded in market place as mineral water (more than 12 brands) shows that the level of fluoride in average is 0.07 ppm.

Several facts above mentioned among others are one of the factors of high prevalence of caries in Indonesia.

The pilot project of water fluoridation was underwent for 5 years from 1997 until 2002 at South Kalimantan. Prior to the pilot project the base line data was executed and resulting on prevalence caries for children of 12 years of age at Banjarmasin amounting at 91.26%, DMF-T=3.02 (Ministry of Health, 1997), whereas level of fluoride in drinking water originated from various sources of drinking/treated water company i.e. water treatment company, river, water well of the people of Banjarmasin is undetected.

The monitoring and evaluation results conducted after fluoriditation of drinking water in second year, 1st evaluation of 2nd year is 0.00, whereas 2nd evaluation of 2nd year, the results is ranging from 0.50-0.40. The level of 0.00 in 1st evaluation is caused by the constraints
such as difficulties in adding the Sodium Fluoride and mixturing it but in 2nd evaluation, improvement were found.

During third year evaluation, the level of fluoride in drinking/treated water is ranging from 0.25-0.58 ppm. No evaluation executed on fourth year and on fifth year, it was found that level of fluoride in drinking/treated water is ranging from 0.3-0.5 ppm. Based on the latest survey on oral health for categories of 12 years of age group, the DMF-T = 2.84 and based on baseline data it was 3.02 (done by Directorate of Oral Health). Thus, there was a decrease of DMF-T by 0.18, free of caries of 6.98% and no fluorosis detected during 5 years fluoridation of drinking/treated water. (Sinthawati, 2003)

Evaluation of water fluoridation

Based on interview with subscriber/customers of drinking/treated water company, it was found that 90% of the people agree to add fluoride in drinking/treated water as +/- 50% of water is used for cooking and drinking.

The main issues is that there is no consistencies of fluoride contained in drinking/treated water distributed to community which ranging from 0.25 - 0.58.

The device is very expensive.

Monitoring was difficult as policy changes overtime due to changes of policy makers from time to time.

Many people drink bottled mineral water, therefore treated/drinking water produced by public treated water company is used for washing and shower only.

Pilot project water fluoridation at Banjarmasin (South Kalimantan) is not effective because of a lot of constraints, therefore this study was not successful.

Workshops of fluoriditation policy in Indonesia has socializes companies to add fluoride regiments to its products/bottled mineral water but most companies has an objection to add fluoride in its products. Because they have the international standard of drinking/mineral water.

2. Fluoride Tablets

Prevalence of caries is still quite high as several studies ranked it first among diseases found for kindergarten and primary school, and ranked first among five provinces as nominated by people of West Kalimantan with a prevalence of 99% and DMF-T = 6.1, and trivial intervention has not showing any significant decrease. Tablets F 1 mg/day is among one of the method to prevent caries/protect the tooth for 1st grade primary school students. This results is the first year evaluation after distributing the F 1 mg/day tablet during the academic year and as the result of the three years controlled pre post experimental study.

The first year evaluation shows that there is an increase/higher prevalence of caries for student categorized in 15.6% control group compared to those receiving F 1 mg/day (8.9%). Incidences of student suffering caries in control group is 1.6 times of that in intervention group. Besides, DMF-T index of control group is increased by 0.8, whereas those receiving tablets F 1 mg/day, there is no different result between pre and post. The consumption of tablet F 1 mg/day is various. The distribution of F 1 mg/day tablet during one academic year will protect the tooth against the risk of caries eventhough the impact is marginal. (Magdarina, 1992)

Evaluation of fluoride tablet

Using 200 tablets/year from 1st grade until 3rd grade of elemantary school students.

Consistent uses of fluoride tablets in the areas of low level fluoride and high caries prevalence.

3. The Glass Ionomer used contain fluoride

The study was implemented in the districts of Cianjur, Karawang and Serang in West Java for two years. The study plan was a time series design,
comprising intervention and control groups. The respondents were 1200 pupils aged 8,9,10 years. At the start of the survey the dental health status was higher in the intervention group (DMF-T = 1.74±1.37) as well as the control group (DMF-T = 2.45 ±1.54) its better than control group (DMF-T = 4.45±1.51). Increase in the control group is twice as high as in the intervention group (125%) were very stricking compared to Fluoride increase in the control group (3%) (p = 0.0000). Increase in the Fluoride component on the intervention group (125%) were very striking compared in the control group. Fluoride content (in ppm) in saliva in the intervention group is always higher in day 1,2,7,15 and 28 after filling has been performed. GIC fillings through the ART method is cost effective. The dental health status of the intervention group is better than in the control group. Slowdown in the increase of new caries development was found. GIC fillings through the ART method is both preventive and curative in nature. The achievement of the Ministry of Health PTI target of 50% seems to be possible. GIC fillings through the ART method is cost effective. (Magdarina, 2002)

Benefit of GIC fillings is their fluoride content, ability to release fluoride and ability to act as a fluoride reservoir, making fluoride constantly available in the saliva. This, in turn, will have a positive influence towards the enamel structure of the tooth.

Evaluation of GIC

GIC filling with ART method do not require dental chairs or units and dental bur which are very expensive: nor do they need special electrical or water installations. Filings can be made by using only easily transportable hand instruments.

GIC fillings through the ART method are both effective and efficient to improve community dental health. On the other hand, it is also effective for children who are afraid of dental treatment.

C. Lesson Learned and Future Steps

1. Strengths and weakness of these preventive interventions
a. Water Fluoridation: the weakness i.e. the device is expensive, weak commitment of regent of the districts, and insufficient budget of the districts. The strengths i.e. the people support water fluoridation and the impact is preventing caries suffered by people.
b. Tablet Fluoridation: the weakness among others are the need of supervision, only applicable at areas of high caries endemis and low fluoride concentrated drinking water which could reduce caries by 50% - 60%.
c. GIC: the weakness among others are the need of operator for application, difficult for coverage, and expensive. The strength are to prevent caries and to cure.
d. Salt fluoridation: we cannot do this method because we have policy to add salt with yodium.
e. Tooth paste contained fluoride: the weakness among others are depends of the method of brushing, difficult to monitoring, while the strength are easy to distribute, affordable, and the people can afford it by themselves.

2. Recommendations resulting from the implementation of these fluoride regimens
a. For the individual consumers: tooth brushing with fluoridated toothpaste
b. Professionally applied: GIC
3. Future Country Plan
   a. Workshop of effectiveness used of fluoride
   b. Strengthening what is already existing
   c. Innovation : Need a research of food supplemetation in Community Integrated Health Services.
   d. Used Fluoride for communities at selected area which have low concentrate of fluoride and endemic of caries.

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Fluoride Use in Japan

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WHOCC for Translation of Oral Health Sciences ogahpre@dent.niigata-u.ac.jp

A brief country profile

Caries levels have decreased in Japan as trends in prevalence of decayed and filled permanent teeth among persons aged ≥5 years, by age group, 1957-2005 were shown (Table 1). According to the National Oral Health Survey in Japan (2005), mean DMFT for age 10-14 years was 1.9. Among adults (35-39 years) and older people (65-69 years), mean DMFT were 14.2 and 20.8 respectively (Table 2). Caries experiences of primary teeth have also declined, however, more than 60% of children aged ≥5 years have still suffered (Table 3). 96.2% reported to have brushed daily, 70.4% of them brushed twice a daily (Table 4).

Table 1: Trends in prevalence of decayed and filled permanent teeth among persons aged ≥5 years, by age group, 1957-2005

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>5 ~ 9</td>
<td>47.8</td>
<td>55.1</td>
<td>56.7</td>
<td>50.7</td>
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<td>43.3</td>
<td>36.3</td>
<td>24.3</td>
<td>14.6</td>
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<td>10 ~ 14</td>
<td>77.4</td>
<td>87.8</td>
<td>91.2</td>
<td>93.6</td>
<td>94.3</td>
<td>90.4</td>
<td>86.4</td>
<td>69.7</td>
<td>57.7</td>
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<tr>
<td>15 ~ 19</td>
<td>80.3</td>
<td>89.9</td>
<td>93.6</td>
<td>97.2</td>
<td>98.3</td>
<td>97.5</td>
<td>94.9</td>
<td>88.9</td>
<td>73.9</td>
</tr>
<tr>
<td>20 ~ 24</td>
<td>87.5</td>
<td>90.7</td>
<td>95.6</td>
<td>97.7</td>
<td>99.3</td>
<td>97.7</td>
<td>97.7</td>
<td>96.0</td>
<td>90.5</td>
</tr>
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<td>96.8</td>
<td>98.4</td>
<td>99.5</td>
<td>99.3</td>
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<td>78.9</td>
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<td>87.8</td>
<td>91.9</td>
<td>94.8</td>
<td>97.4</td>
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<td>68.1</td>
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<td>46.9</td>
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<td>65.2</td>
<td>68.7</td>
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<td>85 ~</td>
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<td>41.8</td>
<td>58.3</td>
<td>43.3</td>
<td>69.7</td>
<td>88.9</td>
<td>100.0</td>
<td>98.7</td>
<td>99.3</td>
</tr>
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</table>

Table 2. Trends in mean number of DMFT among persons aged ≥5 years, by age group, 1957-2005

<table>
<thead>
<tr>
<th>Age group</th>
<th>DMFT Year</th>
</tr>
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<tbody>
<tr>
<td>10 ~ 14</td>
<td>10.5</td>
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<td>20 ~ 24</td>
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<td>19.10</td>
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<tr>
<td>65 ~ 74</td>
<td>22.29</td>
</tr>
<tr>
<td>75 ~ 84</td>
<td>24.28</td>
</tr>
</tbody>
</table>


Table 3. Trends in prevalence of dental caries and untreated tooth decay in primary teeth among persons aged 1-14 years, by age, 1957-2005

<table>
<thead>
<tr>
<th>Age</th>
<th>Year</th>
<th>Prevalence of dental caries (%)</th>
<th>Prevalence of untreated tooth decay (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16.9</td>
<td>14.0</td>
<td>12.3</td>
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<td>2</td>
<td>57.8</td>
<td>62.3</td>
<td>47.4</td>
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<td>3</td>
<td>81.8</td>
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<td>4</td>
<td>92.1</td>
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<tr>
<td>14</td>
<td>2.7</td>
<td>3.9</td>
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Table 4. Status of toothbrushing habit among persons aged ≥1 year, by age group

<table>
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<tr>
<th>Age group</th>
<th>(%) Percentage</th>
<th>Brushing daily</th>
<th>Brushing sometimes</th>
<th>No brushing</th>
<th>(Repetition) Brushing twice a day and more</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Total</td>
<td>Once</td>
<td>Twice</td>
<td>3 Times and more</td>
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<tr>
<td></td>
<td>100.0</td>
<td>96.2</td>
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<tr>
<td>1 ~ 4</td>
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<td>45 ~ 49</td>
<td>100.0</td>
<td>98.8</td>
<td>23.3</td>
<td>53.5</td>
<td>22.1</td>
</tr>
<tr>
<td>50 ~ 54</td>
<td>100.0</td>
<td>99.0</td>
<td>26.0</td>
<td>54.4</td>
<td>18.6</td>
</tr>
<tr>
<td>55 ~ 59</td>
<td>100.0</td>
<td>97.2</td>
<td>23.3</td>
<td>52.4</td>
<td>21.6</td>
</tr>
<tr>
<td>60 ~ 64</td>
<td>100.0</td>
<td>96.5</td>
<td>28.4</td>
<td>46.0</td>
<td>22.1</td>
</tr>
<tr>
<td>65 ~ 69</td>
<td>100.0</td>
<td>95.1</td>
<td>28.6</td>
<td>44.3</td>
<td>22.2</td>
</tr>
<tr>
<td>70 ~ 74</td>
<td>100.0</td>
<td>95.4</td>
<td>30.8</td>
<td>41.2</td>
<td>23.5</td>
</tr>
<tr>
<td>75 ~ 79</td>
<td>100.0</td>
<td>93.8</td>
<td>35.7</td>
<td>36.0</td>
<td>22.1</td>
</tr>
<tr>
<td>80 ~ 84</td>
<td>100.0</td>
<td>89.7</td>
<td>35.2</td>
<td>38.8</td>
<td>15.8</td>
</tr>
<tr>
<td>85 ~</td>
<td>100.0</td>
<td>93.0</td>
<td>46.5</td>
<td>22.5</td>
<td>23.9</td>
</tr>
</tbody>
</table>


Table 5. Percentage of persons aged 1-14 years with experience of topical fluoride application, by age

<table>
<thead>
<tr>
<th>Age</th>
<th>(%) Percentage</th>
<th>Persons with experience of topical fluoride application</th>
<th>Persons without experience</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Total</td>
<td>At health centers</td>
<td>At other facilities</td>
</tr>
<tr>
<td></td>
<td>100.0</td>
<td>59.2</td>
<td>19.2</td>
<td>40.0</td>
</tr>
<tr>
<td>1</td>
<td>100.0</td>
<td>18.8</td>
<td>6.3</td>
<td>12.5</td>
</tr>
<tr>
<td>2</td>
<td>100.0</td>
<td>42.2</td>
<td>26.7</td>
<td>15.6</td>
</tr>
<tr>
<td>3</td>
<td>100.0</td>
<td>48.9</td>
<td>24.4</td>
<td>24.4</td>
</tr>
<tr>
<td>4</td>
<td>100.0</td>
<td>67.4</td>
<td>16.3</td>
<td>51.2</td>
</tr>
<tr>
<td>5</td>
<td>100.0</td>
<td>72.1</td>
<td>20.9</td>
<td>51.2</td>
</tr>
<tr>
<td>6</td>
<td>100.0</td>
<td>85.4</td>
<td>29.3</td>
<td>56.1</td>
</tr>
<tr>
<td>7</td>
<td>100.0</td>
<td>65.5</td>
<td>14.5</td>
<td>50.9</td>
</tr>
<tr>
<td>8</td>
<td>100.0</td>
<td>78.7</td>
<td>19.1</td>
<td>59.6</td>
</tr>
<tr>
<td>9</td>
<td>100.0</td>
<td>63.9</td>
<td>24.6</td>
<td>39.3</td>
</tr>
<tr>
<td>10</td>
<td>100.0</td>
<td>54.2</td>
<td>10.4</td>
<td>43.8</td>
</tr>
<tr>
<td>11</td>
<td>100.0</td>
<td>46.8</td>
<td>14.9</td>
<td>31.9</td>
</tr>
<tr>
<td>12</td>
<td>100.0</td>
<td>58.5</td>
<td>24.4</td>
<td>34.1</td>
</tr>
<tr>
<td>13</td>
<td>100.0</td>
<td>53.7</td>
<td>22.0</td>
<td>31.7</td>
</tr>
<tr>
<td>14</td>
<td>100.0</td>
<td>61.3</td>
<td>9.7</td>
<td>51.6</td>
</tr>
</tbody>
</table>

Though Japan is highly industrialized, neither community water fluoridation nor dietary fluoride supplements in the form of drops or tablets are currently available. While fluoridated dentifrice is widely available, majority of the population have benefited to prevent dental caries.

A school-based fluoride mouth rinse (FMR) programmes have become wide-spread since the 1970s, and at present, more than 650,000 nursery school children and primary and junior high school students participate.

Topical fluoride application (using 9000 ppm APF gel) is common for babies and infants, almost 60% of young children have been benefited (Table 5). Silver (diamine) fluoride solution has been used for over 30 years and has been shown to be effective in preventing and arresting caries.

**Fluoride use for oral health in Japan**

As the below indicated, historically, water fluoridation (0.6 ppm) was performed and tested in 1952 in Kyoto Yamashina, Japan. Though caries decline was noticed, first and common community-based programme has not been recognize as an artificial adjustment of fluoride concentration of drinking water. Toothpastes containing fluoride, mouth rinses and gels have dominated and shown significant effectiveness to reduce for caries increment.

**History of policy and guideline of Fluoride use:**

1949  Topical Fluoride Application (Ministries of Health and Education)
1952  Water Fluoridation (0.6 ppm) in Kyoto (until 1965)
1968  Fluoride Mouth Rinsing (Ministry of Health)
1971  Statement of Fluoride use (Japan Dental Association)
1999  Statement of Fluoride use and operational research to for oral health promotion (Japanese Association for Dental Science)
2000  Fluoride use and adequate intake for children (Ministry of Health and Social Welfare)
2002  Statement to encourage Fluoride use, included Water Fluoridation (Japanese Society for Oral Health)
2003  Fluoride Mouth Rinsing (Ministry of Health and Social Welfare)
2005  Statement to encourage Fluoride use in school (Japanese Society of School Dental Health)
2007  Adequate (0.05 mg/kg) and tolerable upper limited (0.1 mg/kg) level of Fluoride intake

**Use of Fluoridated dentifrice:**

The use of toothpaste containing fluoride (less than 1000 ppm) has been rising sharply, particularly in the last two decades. Majority of brands contain fluoride (MFP, NaF, SnF2) constituting about 90% of market shares (Fig 1). Numerous studies have been published with significant reduction of caries levels.

![Fig 1. Fluoride dentifrice market share in Japan](Source: Japan Dentifrice Manufactures Association (2006))
Use of Fluoride Mouth Rinse (FMR):

More than 650,000 nursery school children and primary and secondary (junior) high school students have participated in such programmes. Japanese society for Oral Health recommends the use of a weekly fluoride mouth rinse (0.2% NaF) for primary and secondary school children, and a daily regimen (0.05% NaF) for pre-school children (aged 4-5 years).

Several studies have confirmed the safety of weekly method with 0.2% NaF for nursery school children after training practices in non-fluoridated areas or for those who do not use dietary fluoride supplements.

Long-term FMR programmes in groups have been confirmed to markedly reduce caries prevalence (Fig 2). The effects of these programmes have been shown to continue even after their completion (Fig 3).
Fluoride application programme in health promotion plan at sub-national levels:

According to the investigation of current status of health policy for fluoride use in Japan (Ando et al 2006), eighty-three percent of prefectures and 55% of other municipalities had target values for fluoride use. Seventy percent of prefectures and 77% of other municipal cities had implemented health programs involving fluoride use. Sixty-one percent of prefectures and 25% of other municipalities had some form of guidelines regarding fluoride use. Fifty-seven percent of prefectures and 40% of other municipalities published educational materials regarding fluoride use (Table 6). National fluoride use policies contributed to promoting fluoride use at the level of local government in Japan.

### Table 6. Availability fluoride application programme in health promotion plan in Japan (2010)

<table>
<thead>
<tr>
<th></th>
<th>Available fluoride application programme in health promotion plan</th>
<th>Fluoride gel</th>
<th>Fluoride dentifrice</th>
<th>Fluoride mouth rinse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prefecture (47)</td>
<td>85.1 (40)</td>
<td>76.6 (36)</td>
<td>61.7 (29)</td>
<td>55.3 (26)</td>
</tr>
<tr>
<td>Ordinance-designated city (18)</td>
<td>88.9 (16)</td>
<td>83.3 (15)</td>
<td>66.7 (12)</td>
<td>33.3 (6)</td>
</tr>
<tr>
<td>Municipality (41)</td>
<td>68.3 (28)</td>
<td>43.9 (18)</td>
<td>48.8 (20)</td>
<td>24.4 (10)</td>
</tr>
<tr>
<td>Ordinance-designated city (Health Center) (7)</td>
<td>57.1 (4)</td>
<td>28.6 (2)</td>
<td>14.3 (1)</td>
<td>14.3 (1)</td>
</tr>
<tr>
<td>Tokyo Metropolitan (23)</td>
<td>73.9 (17)</td>
<td>43.5 (10)</td>
<td>52.2 (12)</td>
<td>8.7 (2)</td>
</tr>
<tr>
<td>Total (136)</td>
<td>77.2 (105)</td>
<td>59.6 (81)</td>
<td>53.7 (73)</td>
<td>33.1 (45)</td>
</tr>
</tbody>
</table>

Source: WHOCC Niigata et al, 2010

Future steps

Many epidemiological studies have shown that prevention of dental caries by fluoride is a basic and indispensable method to maintain and improve oral health. However, the countermeasures for maintenance of oral health and implementation of preventive programmes for caries may still not be satisfactory in Japan. Topical application of fluorides, especially mouth rinsing, has an extremely important role in Japan as compared with various other countries, because systematic application of fluorides such as water fluoridation and use of fluoride tablets are not yet available. Nevertheless, fluoride mouth rinsing has not become prevalent on a nationwide scale.

Therefore, it is hoped that population-wide strategies will be more appropriate than high-risk strategies in tackling public health issues, promoting “Health for All”, while a multi-tier policy making strategy at national, ‘sub-national’ and provincial levels can be functioned.

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The Workshop on “Effective Use of Fluoride in Asia”

Fluoride Utilization in Lao PDR.

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Phommavongsa K,
Hobdell MH,
Decroix B,
Courtel F.

University of Health Science Faculty of Dentistry,
Mahosot Hospital Vientiane capital,
AOI (Aide Odontologique Internationale)

Background

The People’s Democratic Republic of Lao is classified as one of the low-income counties in Southeast Asian. Lao PDR is land-locked inland sharing borders with China, Myanmar, Vietnam, Cambodia and Thailand. It lies along the Mekong River and is a member of the Mekong River commission composed of: Vietnam, Cambodia, Thailand, Myanmar and Lao PDR. Lao PDR has a population of 6.8 million people (early 2009), with a GDP per capital, per annum of just US 984 (World Economic, 2011), which is dispersed very unevenly across the country. Most people live in the lowland areas close to Mekong River. However, about 35% of the population lives in the uplands, in remote areas where access to roads and communication are difficult. The remote areas tend to be poorer and have fewer services (International Labor Organization 2006).

Dental services are offered by private dentists in the urban areas, but for the huge majority dental services are lacking particularly in rural area. Yet the oral health care needs of the population are left un-met as the population cannot afford the private dentist’s fees. There are in total 320 dentists university trained dentists in the country. On average, one dentist is responsible for oral health 18,000 population (Ministry of Health 2008). There are some government services provided through the Ministry of Health (MOH), which for the majority remains the essentially provider of oral health care. Although the MOH is strongly administered oral health is not seen as a priority. This view of the MOH is partly based on the limited use made by the rural population of rural oral health care services.

Untreated dental caries is a major problem in Lao PDR, particularly in the child population, with the resultant oral pain regularly, affecting the ability of children to eat, sleep and study at school (Alberts & Hobdell, 2006). Dental caries has major affects on physical and psychological health and other effects such as: an increase in absenteeism in school classes, growth delays. It also harms the quality of life, the experience pain, discomfort, disfigurement, acute and chronic infections disruption as well as higher risk hospitalization, high treatment cost.

The Decayed, Missing, and Filling Teeth (DMFT) Index among 6 and 12-year-olds school children in Lao PDR increased from 2.0 in 1991 to 4.6 in 2001(WHO Oral Health Country/Area Profile Programme, 2009). The proportion of caries in 5-year-old children was 96.1% for the primary teeth and 80.9% for the permanent teeth of children aged 12 years (Sjobbe Besseling 2010). An increase the prevalence of dental caries could be linked to increasing levels of sugar consumption. This is an evidenced by data from world per capita of sugar indicated an increase in sugars consumption for the country from 1.6 kg/yr/person in 1986 to 8.5 kg/person/yr in 2009 in Laos for the past twenty years.
The school preventive oral health program is very limited: the programs include several components: health education (lessons about oral health specifically written in primary school curriculum and routinely taught by the trained primary school teachers, some dental students and the local dental staff, including teachers in the Dental Faculty in Vientiane), brushing with fluoride toothpaste, fluoride mouth rinsing, sealant, ART restorations in a few of the primary schools.

Effective public health measures are also limited. Primary oral health care have not yet been implemented throughout the country. Improvements to the public dental health program such as improved standards of oral hygiene and the effective use of fluorides are urgently needed.

Health professionals need to advocate for a greater priority to the promotion of oral health within the framework of the government’s health program. One specific measure that needs to be examined is the implementation and promotion of the planned salt fluoridation program throughout the country.

Lao PDR needs to further strengthen its public health surveillance and response system and capacity to be preparing for the early detection and rapid response to oral and general communicable diseases including those that involve personal hygiene.

Fluoride assessment in Laos

Some studies have recently been undertaken by the University of Health Sciences Faulty of Dentistry, the Ministry of Health and in partnership with AOI (Aide Odontologique Internationale)

Fluoride concentration in drinking water study:

The concentration of fluoride in the drinking water of a country is one of the factors strongly related to dental caries prevention globally (CDC, 2001). Water fluoridation has been a proposed public health measure for Laos since 1999, but little has happened until recently.

Fluoride concentration in drinking water

Figure 1: Fluoride concentration in drinking water

In Laos there are several sources of water that are used: bottled water, treated tap water, water drawn from deep wells using hand pumps, shallow wells using hand dug, spring water, streams, lake water and river water.

The results of a study, by New Center (National Center for Water Quality Control) with the support of AOI and WHO in 2009, which used 617 samples collected from 9 provinces throughout Laos (see map in annex) showed that the levels of fluoride in all drinking waters were very low. The average fluoride concentration ranged between 0.0 to 0.5 ppm.

In Laos the climate is hot. People therefore drink more water than do those in moderate climates. The relatively few people in the population using treated piped tap water and the difficulties in extending the water grid to the whole population means that community water fluoridation programs are not possible. A different approach is therefore necessary for a truly national fluoridating program (annex, figure 1).
Annex

Table 1: Fluoride ingestion result

<table>
<thead>
<tr>
<th>Children age group</th>
<th>Laos 2009 Urine ug/hr</th>
<th>WHO 1999 Urine ug/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age 3-5</td>
<td>Low</td>
<td>3(2) Vientiane 5(4) Pakse</td>
</tr>
<tr>
<td>Low normal (optimum)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age 6-7</td>
<td>Low</td>
<td>6(4) Vientiane 10(5) Pakse</td>
</tr>
<tr>
<td>Low normal (optimum)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fluoride ingestion study

In a study carried out by personnel from Seoul National University, Thammasat University, Tokyo Dental College and Mahosot hospital (2009), children aged 3-5 and 6-9 years were examined to determine the prevalence and severity of dental caries and dental fluorosis. Also included in the study were the giving a second morning urination sample and the taking of fingernail clippings, from each child for fluoride analysis in the drinking water, the diet. Separately vegetable samples were also collected.

This study was undertaken as a baseline study for a proposed salt fluoridation programme. The results from this baseline study indicated that
- Caries in the primary teeth is much higher than in the permanent teeth, especially in Vientiane Province, where fluoride levels in the water is very low (<0.1 ppm)
- In Champasak Province the caries level is lower, but the prevalence of fluorosis is higher than elsewhere in the country (0.3-0.4 ppm)
- In Pakse (Champasak Province) the urinary fluoride excretion range from a low-normal level to low. While in Vientiane urinary fluoride excretion is even lower still.
- Possible conclusion that fluoride ingestion is generally low in Laos (annex table 1).

Fluoride toothpaste utilization in Laos

Toothbrushing with fluoride toothpaste is effective in preventing dental caries in children (and adults). Good quality of fluoride toothpaste should contain between 1,000 ppm to 1,500 ppm fluoride for children aged 3-6 year-olds. For very young children the fluoride content should be from 0.76 mg to 2.32 mg (Guha-Chowdhury N, 1999).

In Vientiane capital City (5 districts, 27 villages) showed that more than 95% of the population in utilized a toothbrush with fluoride toothpaste as the most common method to clean their teeth. And more than 80% cleaned their teeth several times per day. This information shows that the oral hygiene behavior of the population living in Vientiane City is good. Unfortunately there is a lack of data which for the whole country. The results of Justines survey (2008) are unlikely to be a representative of the Lao population as a whole. People who live in Vientiane City have a relatively high socio-economic status compared to those who live in other Provinces.

For many, particularly those in remote rural areas the cost of fluoride toothpaste and a toothbrush are a problem. There is also no toothpaste factory in Laos, so all toothpaste is imported from neighbors such: Thailand, Vietnam and Cambodia.
Table 2: Topical fluoride use in dental hospital and private dental clinic in Vientiane capital

<table>
<thead>
<tr>
<th>Topical fluoride</th>
<th>Dental practitioners</th>
<th>percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>F tablet</td>
<td>11</td>
<td>11.6%</td>
</tr>
<tr>
<td>F gel</td>
<td>19</td>
<td>20%</td>
</tr>
<tr>
<td>F mouthrinse</td>
<td>1</td>
<td>1.1%</td>
</tr>
<tr>
<td>F vanish</td>
<td>1</td>
<td>1.1%</td>
</tr>
</tbody>
</table>

Topical Fluoride Application

A preliminary random telephone survey about topical fluoride applications, of a convenience sample of dental practitioners from the 4 Central Dental Hospitals, and 91 Private Dental Clinics was carried out in 2011. In a short structured interview practitioners were asked about their use of: Fluoride tablets, mouth-rinses, gels and varnishes. Their use of all these materials was found to be low (annex table 2).

Salt Fluoridation:

The principle public health approaches for the enhancement of a fluoridated oral environment are water fluoridation, salt fluoridation, and fluoride toothpaste. Other sources of fluoride, such as mouth-rinses, gels and varnishes are also effective, but they are costly and are therefore accessible to a smaller population group, and depend on access to oral health care services (Marinho et al., 2004). All these things make these latter approaches inappropriate as public health measures for the population of a poor rural nation, such as that of Lao PDR.

Salt fluoridation is more suitable for countries with large rural populations or regions with poor centralized water systems (Horowitz, 2000). Salt fluoridation has therefore been the first priority considered as a strategy in Lao PDR for improving oral health and reducing the burden of dental caries. In principle salt fluoridation could be taken advantage of by the entire in nation.

Salt fluoridation in Lao PDR

Background

As reported above the content of most drinking water, the use of topical fluorides and dietary fluoride ingestion were found to be low in Lao PDR.

In 1996, with the support of the UNICEF (United Nations International Children’s Fund - originally United Nations Children’s Emergency Fund), Lao PDR began a national iodized salt programme, which reaches 90% of the Lao population.

Following the First National Oral Health Workshop activities were initiated to examine the feasibility of a salt fluoridation programme. Three Lao institutions: the Lao Dental Association, Mahosot Hospital Dental Service and University of Health Sciences-Faculty of Dentistry have led the process.
Table 3: Salt fluoridation Activities planned

<table>
<thead>
<tr>
<th>year</th>
<th>Working plan</th>
<th>partnership</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006-2009</td>
<td>Training about salt fluoridation</td>
<td>Robert Yee, AOI, Thammasat University</td>
</tr>
<tr>
<td>June, 2006</td>
<td>Visit salt factory, fluoride production in Vietnam</td>
<td>Salt factory in Hanoi</td>
</tr>
<tr>
<td>2006-2009</td>
<td>Technical feasibility of salt fluoridation Identification of mixing method</td>
<td>Group Salins, AOI, Thammasat University</td>
</tr>
<tr>
<td></td>
<td>(wet method selected) and finalization of the process and equipment required</td>
<td></td>
</tr>
<tr>
<td></td>
<td>for mixing</td>
<td></td>
</tr>
<tr>
<td>2006/2008/2009</td>
<td>Analysis of fluoride in the water</td>
<td>Thammasat University, WHO, NEW center, AOI</td>
</tr>
<tr>
<td>Jan, 2009</td>
<td>Fluoride ingestion examination, finger nail, Urine examination</td>
<td>Tokyo University, Seoul University, AOI</td>
</tr>
<tr>
<td>2008-2009</td>
<td>Protocole for the pilot project at Khoksaath: production, commercialization</td>
<td>AOI, Thammasat University, Group Salins</td>
</tr>
<tr>
<td></td>
<td>and quality control</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>Mixing test at Khoksaath between KF and KIO₃</td>
<td>Khoksaath factory, AOI, Grou Salins, Thammasat University</td>
</tr>
<tr>
<td>2010</td>
<td>Start salt production mixing fluoride and iodine, distribution in 3 districts</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>Salt distribution, evaluation of the pilot project, workshop and discussions</td>
<td>Khoksaath, Ministry of Health, AOI, UNICEF, WHO</td>
</tr>
</tbody>
</table>

Technical help and support have been provided through a partnership with the French NGO: Aide Odontologique Internationale (AOI) and Groupe Salins (group producing salt in France), Thammasat University, Thailand, Seoul National University and Tokyo Dental College.

Implementation

After initial trials with different mixes and methods in October 2009 salt fluoridation in Laos began along with the continuation of the iodization program.

To date at the initial pilot salt factory at Khoksaath in Vientiane city, potassium fluoride (KF) and potassium iodide (KIO₃) are mixed with locally produced salt (using the solar evaporation method) with 250 mg/1 kg salt by wet mixing (spray). After the mixing process every sample is examined and the fluoride concentration determined using a fluoride electrode.

Permission was received to distribute the fluoridated salt to three Districts. This then rapidly spread to most of the Northern Provinces in the country (see Map). Unfortunately so far as dental caries is concerned we do not yet have any results of the salt fluoridation project as it is necessary to wait for at least 5 years for this to become apparent (annex table 3).
The advantages of salt fluoridation

This program is the best to concentrate on the potential benefits of specifically in Laos-caries prevention, potential to produce salt fluoridation requirement inexpensive cost in the industrialized nation, this cheaply because of local production and public/private partnership (ie marketing and manufacturing done by industry not government), population based programme with potential to reach over 90% of the population and local acceptability.

Limitation

- The implementation of salt fluoridation needs initial financial and technical support (e.g. mixing machine, and potassium fluoride chemical) before the salt factory becomes self-sustainable. But this is a small process for the government and donor agencies to cover.
- Surveillance and quality control
- Hard to convince all people to use fluoridated
- Need to constantly and independently monitor the fluoride concentration after intake by fingernail, urine
- Benefits (outcome) of salt fluoridation might appear after 5 years.

Future plans

If the salt fluoridation programme is seen to be suitable for Lao PDR, it will be extended to the remaining 6 salt factories in Laos. Continued surveillance and quality control and social marketing of fluoridated salt.

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Effective Use of Fluorides in Malaysia

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Part 1 : A brief country profile

The Malaysian Healthcare System

Malaysia has a dual healthcare system with a large government-led public sector that provides personal healthcare and public health services, while the private sector caters mainly for personal care. There are different funders and providers of healthcare for various sub-groups, but the Ministry of Health (MOH) remains the main provider and funder of healthcare.

Oral healthcare in Malaysia

Oral healthcare in the public sector is heavily subsidised by government. In the public sector, preschool children, school children up to age 17 years, antenatal mothers, civil servants and their spouses and school-going dependents below the age of 21 years, are entitled to free basic oral healthcare at public sector facilities. Other groups who are also entitled to free basic care are the physically-, mentally- and economically-disadvantaged groups. A small charge is levied on certain procedures like dentures, orthodontics and other prostheses. All members of the public, regardless of income/economic means, may also access public sector facilities. Patients pay very minimal co-payments based on a Fee Schedule for the MOH and the system supports the majority of care for these targeted groups. Oral healthcare in the private sector is largely on a fee-for-service basis.

Oral Healthcare Delivery

In the Ministry of Health, the oral healthcare programme is divided into three components, namely primary, specialist and community oral healthcare. Primary oral healthcare consist of oral healthcare for toddlers, preschool children, schoolchildren, antenatal mothers, the ‘special groups’, and the elderly. Specialist oral healthcare are provided by periodontist, orthodontist and restorative specialist at primary care setting; whilst oral surgeons, paediatric dental specialists, oral medicine/pathology specialists and ‘special care’ dental specialists provide care in hospitals. Community oral healthcare includes public water fluoridation, integrated school-based fissure sealant programme, fluoride mouth rinsing programme, screening and early detection of oral pre-cancer and cancer.

Oral Health Status

In 2010, the total population of Malaysia is estimated at 28.9 million, which comprised 14.7 million males and 14.2 million females. Forty percent of the population are aged 20 and below, 52% aged 21-59, 7% aged 60 and above.

In the past 30-40 years, survey data have shown incremental improvement in oral health status of Malaysian, both children and adults. Schoolchildren in Malaysia have among of the best oral health status among Asia countries. In the 2007 National Oral Health Survey for School Children, the mean DMFT for 12-year-old schoolchildren was 1.1, in the very low caries
level category based on World Health Organisation classification. A detail description of oral health status of Malaysian is given in part 2 of this manuscript.

Part 2: Public uses of Fluoride in Malaysia

In Malaysia, various fluoride modalities have been used as caries preventive measures since 1950s, these includes water fluoridation, fluoride toothpastes, fluoride mouth rinses and professionally applied topical fluoride using fluoride gels and fluoride varnishes.

Water Fluoridation

Water fluoridation is a primary prevention initiative for dental caries in Malaysia. Although water supply is the purview of individual states, water fluoridation is monitored by the MOH nationally. Water fluoridation was first introduced in Malaysia in 1957 in the State of Johor, followed by Penang in 1959 and Sarawak in 1962.

In June 1969, the Honorable Minister of Health appointed a Committee on Fluoridation of Public Water Supplies in West Malaysia to study and report upon the feasibility of introducing fluoridation of public water supplies as a public health measure in all states of West Malaysia. The members of the committee comprised of the Director of Dental services, Director of Medical Services (Health), Director of Water Works, Senior Nutrition Officer, Director of the Institute of Medical Research, Deputy Director of Department of Chemistry, Public Health Engineer, Dental Public Health Officer. The committee had “Strongly recommends that fluoridation of public water supplies be instituted in West Malaysia as soon as possible and further recommends that an optimum level of 0.7 ppm fluoride be maintained in the reticulation system” This was following the findings by the committee that:

1. The dental caries burdens were high in West Malaysia (Table 1);
2. The fluoride content in drinking water was low (ranging from <0.05 to 0.25 ppm), below the recommended optimum level for caries prevention, and
3. The effectiveness of water fluoridation had been demonstrated in the State of Johor which had been implementing water fluoridation

Table 1: Caries experience of military and civilian males and females, 1962

<table>
<thead>
<tr>
<th>Age</th>
<th>Military Males</th>
<th>Civilian Males</th>
<th>All Males</th>
<th>Military Females</th>
<th>Civilian Females</th>
<th>All Males and Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Years</td>
<td>No. Mean DMF</td>
<td>No. Mean DMF</td>
<td>No. Mean DMF</td>
<td>No. Mean DMF</td>
<td>No. Mean DMF</td>
</tr>
<tr>
<td>5-9</td>
<td></td>
<td>- -</td>
<td>380 1.1</td>
<td>409 1.04</td>
<td>376 1.4</td>
<td>822 1.17</td>
</tr>
<tr>
<td>10-14</td>
<td></td>
<td>- -</td>
<td>368 3.1</td>
<td>307 3.11</td>
<td>261 3.69</td>
<td>634 3.35</td>
</tr>
<tr>
<td>15-19</td>
<td>46</td>
<td>3.89</td>
<td>123 5.79</td>
<td>169 5.27</td>
<td>88 6.17</td>
<td>293 5.71</td>
</tr>
<tr>
<td>20-14</td>
<td>221</td>
<td>4.25</td>
<td>78 4.43</td>
<td>299 4.30</td>
<td>53 5.92</td>
<td>483 5.13</td>
</tr>
<tr>
<td>25-29</td>
<td>104</td>
<td>5.57</td>
<td>53 5.96</td>
<td>157 5.70</td>
<td>64 7.14</td>
<td>273 6.48</td>
</tr>
<tr>
<td>30-34</td>
<td>65</td>
<td>6.1</td>
<td>43 5.32</td>
<td>108 5.79</td>
<td>66 10.33</td>
<td>194 7.77</td>
</tr>
<tr>
<td>35-39</td>
<td>23</td>
<td>5.95</td>
<td>36 5.8</td>
<td>59 5.86</td>
<td>46 10.60</td>
<td>109 7.92</td>
</tr>
<tr>
<td>40-44</td>
<td>1</td>
<td>9</td>
<td>44 7.86</td>
<td>45 7.88</td>
<td>58 10.62</td>
<td>104 9.49</td>
</tr>
<tr>
<td>45-49</td>
<td>-</td>
<td>-</td>
<td>32 11.78</td>
<td>32 11.78</td>
<td>43 11.46</td>
<td>75 11.6</td>
</tr>
<tr>
<td>50 +</td>
<td>-</td>
<td>-</td>
<td>134 19.35</td>
<td>134 19.35</td>
<td>137 16.23</td>
<td>271 17.77</td>
</tr>
</tbody>
</table>
since 1957. A study showed there was 60% reduction of dental caries in fluoridated communities compared to non-fluoridated communities (Figure 1).

This public health measure for prevention of dental caries was accepted as government policy in 1972\(^6\). Since 1974, the nationwide water fluoridation programme was implemented incrementally\(^4\). In 1972, the recommended optimum level of fluoride in public drinking water in Malaysia was 0.7 parts per million (ppm) based on the volume of water intake in local climate. However, the optimum fluoride level was revised to 0.5 ppm in 2005\(^5\) following studies done on fluoride enamel opacities among 16 year-old schoolchildren\(^6\) and fluoride exposure and fluorosis among school children in Malaysia\(^7\). It is mainly due to availability of alternatives sources of fluoride in the country.

### Multi-sectoral collaboration

Implementation of water fluoridation in Malaysia involves four (4) main agencies:

<table>
<thead>
<tr>
<th>Agencies</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral Health Division, MOH</td>
<td>Policy, standards, safety and effectiveness</td>
</tr>
<tr>
<td>Engineering Division, MOH</td>
<td>Surveillance of standards, inclusion of standards in National Guideline of drinking water quality, Safe Drinking Water Act (Regulation)</td>
</tr>
<tr>
<td>Water Treatment Plant Authority</td>
<td>Implementation of water fluoridation and maintaining the optimum level</td>
</tr>
<tr>
<td>National Water Services Commission</td>
<td>Ensuring fluoridated water supplies at optimum level</td>
</tr>
</tbody>
</table>

### Population coverage

The percentage of population which received fluoridated public water supplies have increased gradually from 62.4% in 2003 to 75.5% in 2009\(^10\). However, the extent of fluoridation in individual states varied considerably. In most of the states, more than 70% of their population received fluoridated water except Sabah (4.5%), Kelantan (16.1%), Terengganu (58.1%), and Sarawak (64.8%)\(^10\) (Figure 2).
Hurdles to implementation of water fluoridation

There have been many hurdles in the implementation of the water fluoridation programme in a few states, namely Terengganu, Kelantan and Sabah. The implementation of the programmes has been subjected to changes in state governments.

The water fluoridation programmes in Kelantan and Terengganu were discontinued in 1995 and 1999 respectively. With the efforts of Oral Health Division and State Oral Health Department, the programmes were reinstated in year 2006 and 2008 in Kelantan and Terengganu respectively.

In Sabah, the programme was stopped in 1988 due to anti-fluoridationist views in the state. With a change in state government in 1995, the Sabah State Health Department secured approval from the State Cabinet to re-instate the water fluoridation programme in 1996, water fluoridation was re-established at 0.7 ppm at nine water treatment plants. However, subsequent changes in state governments have not allowed for expansion in the number of water treatment plants supplying fluoridated water, only 4.5% of the population received fluoridated water in 2009. In October, 2010, the Sabah State Cabinet approved a proposal paper submitted by the Oral Health Division, Ministry of Health Malaysia for reinstitution and expansion of water fluoridation programme in Sabah. Following this, steps have been taken to expand the water fluoridation programmes. An amount of RM 2.5 million has been secured for this purpose under the 10th Malaysia Plan of the Ministry of Health Malaysia.

Outcome on the Reduction of Dental Caries

In Malaysia, the first series of fluoridation studies in Johore State\(^1\) showed that there was a 60% reduction of severity in dental caries in the permanent dentition and a 29% reduction in the deciduous dentition. Overall, fluoridation has brought about 44% reductions in dental caries (Figure 3).

Dental Caries in Adults

In the past 30-40 years, survey data have showed incremental improvement in oral health status of Malaysian schoolchildren\(^4,12,13,14,15,16\) (Figure 4).

This has been mainly attributed to the combined effect of water fluoridation, approved by the Malaysian Cabinet Committee in 1972\(^6\), and the comprehensive Incremental Dental Care Programme of the Ministry of Health started in the 1980s\(^17\) in collaboration with the Ministry of Education, Malaysia.

However, in spite of the improvement in the national data on dental caries for younger Malaysians, inequalities persist by age groups, by location, and across states. The disparity between age groups...
demonstrates higher caries experience among younger children\textsuperscript{18} than in older children of school-going age\textsuperscript{3,15,16} (Table 2). The caries problem is illustrated in the mean dft and mean DMFT figures for the various age groups. Over 10 years, there has been very slight improvement in the 5-year-old group\textsuperscript{18,19} (Table 2).

All survey findings showed disparity in caries severity by location, with figures being higher for rural areas than for urban areas. For instance, the National Oral Health Survey of Preschool Children 2005 (NOHPS 2005)\textsuperscript{18} showed significantly higher caries prevalence among rural children (85.6\%) than urban (69.3\%). The 2007 National Oral Health Survey for Schoolchildren\textsuperscript{3} reported 48.4\% caries prevalence among 12-year-olds in the rural areas compared to 36.0\% in the urban with mean DMFT was 1.3 in rural areas compared to 1.0 in the urban.

Again, although overall mean DMFT for 12-year-old schoolchildren was 1.1 in the year 2007, differences in caries experience persists, with Kelantan, Terengganu, and Sabah lagging behind the national average. Kelantan and Sabah were unable to achieve the National Oral Health Goal for 2010\textsuperscript{20} for dental caries of DMFT <1.5 for the 12-year-old group.

There seems to be association between caries experience and status of water fluoridation programmes\textsuperscript{10,21}. For 12-year-olds, states with problematic water fluoridation programmes such as Sabah, Kelantan and Terengganu showed the highest caries experiences compared to states with comparatively stable water fluoridation programmes such as the Federal Territory of Kuala Lumpur, Selangor, Johor and Negeri Sembilan (Figure 5). In Sarawak, different problems exist in terms of difficult terrain and economy-of-scale issues of fluoridating water for small scattered populations.

A study by Norlida et al.\textsuperscript{22} reported that following water fluoridation cessation in Kelantan

### Table 2: Caries Prevalence and Caries Severity in Children <18 Years from Several Surveys in Malaysia

<table>
<thead>
<tr>
<th>Age</th>
<th>Year</th>
<th>Pen. M’lia</th>
<th>Sarawak</th>
<th>Sabah</th>
<th>Malaysia</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 years</td>
<td>2005\textsuperscript{8}</td>
<td>73.5</td>
<td>88.8</td>
<td>81.1</td>
<td>76.2</td>
</tr>
<tr>
<td>6 years</td>
<td>2007\textsuperscript{4,5,9}</td>
<td>72.5</td>
<td>82.2</td>
<td>85.5</td>
<td>74.5</td>
</tr>
<tr>
<td>12 years</td>
<td>2007\textsuperscript{5}</td>
<td>37.2</td>
<td>47.1</td>
<td>73.3</td>
<td>41.5</td>
</tr>
<tr>
<td>16 years</td>
<td>2007\textsuperscript{5}</td>
<td>56.2</td>
<td>71.8</td>
<td>79.3</td>
<td>59.6</td>
</tr>
<tr>
<td>Mean dft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 years</td>
<td>1995\textsuperscript{10}</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>5.8</td>
</tr>
<tr>
<td>5 years</td>
<td>2005\textsuperscript{8}</td>
<td>5.0</td>
<td>6.2</td>
<td>8.0</td>
<td>5.5</td>
</tr>
<tr>
<td>6 years</td>
<td>2007\textsuperscript{7}</td>
<td>3.4</td>
<td>4.9</td>
<td>3.8</td>
<td>3.6</td>
</tr>
<tr>
<td>Mean DMFT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 years</td>
<td>1997\textsuperscript{3}</td>
<td>1.6</td>
<td>2.5</td>
<td>3.3</td>
<td>1.9</td>
</tr>
<tr>
<td>12 years</td>
<td>2007\textsuperscript{4}</td>
<td>0.9</td>
<td>1.4</td>
<td>2.9</td>
<td>1.1</td>
</tr>
<tr>
<td>16 years</td>
<td>1997\textsuperscript{2}</td>
<td>2.8</td>
<td>3.7</td>
<td>6.7</td>
<td>3.3</td>
</tr>
<tr>
<td>16 years</td>
<td>2007\textsuperscript{5}</td>
<td>1.8</td>
<td>3.0</td>
<td>4.1</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Source: Oral Health Division, Ministry of Health Malaysia

na = not available
(1995) and Terengganu (1999), both states in 2005 have caries levels that are two to three-folds higher than for the fluoridated state of Johor among 11-12-year-olds. Noting that the use of fluoride toothpaste is widespread in Malaysia, this study also serves to indicate that water fluoridation imparts additional cumulative benefit for caries control as seen in Johor.

Two large surveys on 16-year-old schoolchildren also assessed dental caries experience among children in schools and homes by their fluoridation status. The findings showed a more favourable DMFT scores among the children from fluoridated compared to non-fluoridated areas8,14 (Figure 6, Figure 7).

Dental Caries in Adults

From the National Oral Health Survey of Adults 200023, the scenario for dental caries showed increasing caries prevalence and caries experience with age (Figure 8 and Figure 9). But with declining caries rates among children, there is a follow-through impact as these children mature into adulthood, with increasingly lower caries prevalence among younger adults, the greatest increases seen in the groups below the age of 4523,24,25 (Figure 8). Caries severity continues to be of concern among adults. In year 2000, among younger adults of 35-44 years more than one-third of the dentition was affected with mean DMFT of 12.1 rising to 22.8 among the elderly of 65+ years23 (Figure 9).

Impact on Prevalence of Enamel Opacities

Past local studies utilising the Developmental Defects of Enamel (DDE) Index have reported prevalence of enamel opacities in fluoridated areas ranging from 72.5-90.7% among 11-12 year-olds26,27,28, 76.4% among 12-15 year-olds29 and 67.1% among 16-year-olds30. However, the nation-wide survey undertaken in 1999 indicated an overall prevalence of 56.0% among the 16-year-old school children14.

The first oral health survey on school children utilised Dean’s Index of Fluorosis in 197111 and reported that fluorosis was absent among 6 to 18-year-olds. However, a 1999 study on 16-year-olds8 with continuous residence history found fluorosis prevalence of 74.7% in fluoridated areas and 14.2% in non-fluoridated areas.
Other Fluoride Modalities

Fluoride toothpastes

It has been reported that 74% of the toothpaste available in the Malaysian market contained fluoride\(^3\). A recent study\(^3\) showed 58% of the adult toothpaste contained fluoride. Two local studies have reported on the utilisation of fluoride toothpaste; a study\(^3\) reported 100% of schoolchildren using fluoride toothpaste while another study\(^4\) reported about 91% of preschool children used fluoride toothpaste.

Fluoride levels in the toothpaste sold locally were reported to range from 20-197 ppm and 13-214 ppm in two studies respectively. Labelling of fluoride level in toothpaste was found unreliable as there were toothpaste labelled fluoridated but contained no fluoride and vice versa\(^5\).

Fluoride varnishes

Over the last two decades, there has been very slight improvement in the 5-year-old group. In order to improve the oral health status of the preschool children, fluoride varnish (FV) application at community level has been advocated. A manual on fluoride varnish application for toddlers has been developed in 2010. This is to establish a standardised, comprehensive and systematic fluoride varnish programme as an integral part of Early Childhood Oral Healthcare programme. For best use of resources in the public health sector, the FV programme will focus on high-risk populations/communities. At this initial stage, the programme will be piloted in four states, namely Sabah, Sarawak, Kelantan and Terengganu.

Fluoride varnish application is more costly as its application requires the services of trained personnel and relatively expensive, periodic re-applications are necessary to be effective.

Fluoride mouth rinses

School based fluoride mouth rinsing (FMR) programme have been implemented at a number of communities with no fluoridated public water supplies. In these communities, weekly FMR programme have been carried out throughout the school year, ceasing temporarily only during school holidays. FMR programme in Sarawak was started in year 2003; five schools were involved in the programme. The programme has expanded gradually, 21 schools were involved in 2009. In Kelantan, FMR programme were started in 2009 and seven schools are involved currently.

A three-year field study on the effectiveness of a school-based fluoride mouth rinsing programme in Sibu, Sarawak\(^6\) reported that the risk of developing caries decreased 0.52 times among the children exposed to the fluoride mouth rinsing programme compared to children in the unexposed group over a period of how three years.

In year 2010, a manual on FMR programme has been developed by Oral Health Division to establish a standardised, comprehensive and systematic school based fluoride mouth rinsing programme as an integral part of Oral Health Care for School Children residing in areas without fluoridated water supply.
Part 3: Lesson Learn and Futures Steps

As more than 95% of the population received public water supply, fluoridation remains the most appropriate public health measure to prevent dental caries in Malaysia. The enabling factors for water fluoridation in Malaysia include strong political will; good infrastructure of piped water to more than 95% of the population; good multiagency collaboration (including state government, public and private water authorities) and the effective monitoring of fluoride levels of 0.4-0.6 ppm under the National Drinking Water Quality Standards.

On the other hand, FMR programmes have been successfully implemented in communities without water fluoridation with good monitoring and cooperation from school authorities. The oral health status of preschool children and toddlers in Malaysia will continue to be the main priority of the Oral Health Division, MOH. This manual will facilitate the standardisation and systematic implementation of a FV application programme.

Recommendations

The Ministry of Health (MOH) strongly supports water fluoridation at 0.5 ppm as the front line strategy in the prevention and control of dental caries. In high risk communities/communities with no fluoridated public water supplies, other fluoride modalities, such as fluoride varnish and fluoride mouth rinse are advocated. The use of fluoride toothpaste of not less than 1000 ppm is also advocated.

In 2009, the Malaysian Dental Council published a position document on use of fluoride in Malaysia. The position statement emphasises that the dental profession, having the health and safety of the public as the prime concern
- strongly supports fluoridation of public water supplies at the optimum level of 0.5 ppm as the first-line preferred strategy for the prevention and control of dental caries
- recommends fluoride toothpaste use as an additional source of fluoride for further impact on reduction and control of dental caries incidence but with emphasis on supervised use of fluoride toothpaste in very young children
- that fluoride mouth rinses and the use of concentrated topical fluoride varnish, gels or foams be supervised/ be limited to applications by dental professionals to limit the occurrence of greater-than-optimal exposure to fluorides
- does not recommend the use of fluoride supplements, salt fluoridation or milk fluoridation given that there should only be one form of artificially-adjusted systemic source of fluorides, and that this is already existent in the form of the water fluoridation program of the Ministry of Health Malaysia with about 75% of Malaysians in 2008 having access to fluoridated public water supplies at the recommended optimum level of 0.5 ppm.

Future Country Plan

Continuous efforts have been directed towards strengthening the fluoridation programme and improving population coverage, especially in Kelantan, Terengganu and Sabah. The Ministry of Health objectives are to expand water fluoridation programme to cover all water treatment plants of 0.5 mgd; to calibrate all fluoride level tests at treatment plants and reticulation points and to monitor fluoride levels at reticulation at 0.4-0.6 ppm.
In communities where water fluoridation is not feasible, other fluoride modalities, for examples, fluoride varnish programmes, fluoride mouth rinsing programme and fluoride toothpaste programme will be continued.

The Oral Health Division will continue to monitor the use of fluoride modalities and appropriate exposure to fluoride to obtain maximum benefit of caries prevention and minimise the risk of dental fluorosis. In order to provide evidence based recommendations oral health policy, Oral Health Division will conduct researches on the effectiveness and safety of use of various fluoride modalities.

References
Use of Fluoride in Mongolia

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Part 1: A brief country profile

Oral health affects general health by causing considerable pain and suffering and by changing their diet, speech and their quality of life and well being. Poor oral health also has effect on other chronic diseases. Furthermore, children who suffer from poor oral health are 12 times more likely to have restricted-activity days than those who do not.

Oral diseases such as dental caries and periodontal disease are the most common chronic infectious diseases affecting humans, and the major public health problem worldwide because of their prevalence, impact on the individuals and society and the expense of their treatment.

A notable increase in the dental caries prevalence has been observed recently in Mongolian population. Numerous studies were carried out to investigate caries incidence of Mongolians in relationship with the age and sex of subjects, their lifestyles, dietary factors, in particular frequency of consumption of fermentable carbohydrates, occlusion, salivary buffer capacity, distribution and cariogenicity of mutans streptococci. Also, several Mongolian plants were investigated for their anticariogenic effects, and some of them are now used as therapeutic agents for the prevention and treatment of dental caries and other oral diseases. The caries prevalence of urban children was covered by 93.2 % of all works, the caries prevalence of countryside children by only 6.8% of all papers.

These studies revealed continuous increase of caries prevalence among Mongolian population, especially among children. Moreover, it has been shown that the percentage of children with untreated tooth decay had increased. Low income, lifestyle change, frequent consumption of fermentable carbohydrates and lack of oral education among Mongolian population are clearly risk factors for increased decay.

In 1993, the caries prevalence and dmft scores of 3-5 years old children living in the capital city were 78.5% and 4.9, respectively, and all of them had untreated tooth decay, while in 6-10 years old children, the caries prevalence was 86%, dmft scores were 5.1 and DMFT scores were 1.1. The caries prevalence of 11-15 years olds was 84%, the caries incidence 3.2 DMFT with 2.6 DT and 0.2 FT, while those of 16-17 years olds were 90% and 4.7 DMFT with prevailing untreated teeth (DT was 3.7, and FT was 0.7).

In the study conducted in 1997 and 2000 among children of Ulaanbaatar city, the caries prevalence of 8-13 years olds were studied in relation with the pit and fissure depth, individual oral hygiene, consumption of fermentable carbohydrates and chemical composition of tooth hard tissues. It has been shown that the caries incidence of 8-13 years old children with mixed dentition increased from 2.71±0.03 DMFT+dmft in 1997 to 3.65±0.01 DMFT+dmft in 2000, thus the caries increment was 0.94 DMFT+dmft. While in 12 years olds, the DMFT scores increased by 1.43 from 2.24 in 1997 to 3.67 in 2000. Moreover, the DMFT+dmft of
children living in downtown were significantly higher than those of children living in suburb 0.99 (t<0.001) which was related to high sucrose consumption.

In 2002, the caries prevalence of preschool children aged 4-6 years had become 96.1%, and the mean±SE for def-teeth and decayed teeth (dt) were 8.1±30.19 (SE) and 7.21±0.18, respectively. The mean value for extracted teeth (et) and filled teeth (ft) were 0.26±0.03 and 0.62±0.05, correspondingly. A statistically significant correlation has been found between buffering capacity, caries activity and decayed teeth (p<0.001). Moreover, a significant difference was found between buffering capacity of saliva and deft scores. As assessed by a caries activity test (CAT 21), the mean dt and deft of caries low-risk children were 5.30±0.27 and 6.02±0.31, respectively, while those of high-risk children were 8.29±0.21 and 9.31±0.22, correspondingly. There were statistically significant differences between these two groups (ANOVA p<0.001).

In 2002-2007, the incidence in relationship with the presence of cariogenic bacteria has been studied in preschool and school children living in Ulaanbaatar city. In preschool children, 63.4% were positive for S. mutans alone and 36.6% were positive for both S. mutans and S. sobrinus. In school children, 75% carried were positive for S. mutans alone and 25% had both S. mutans and S. sobrinus. The percentage of children positive for both S. mutans and S. sobrinus in the high caries risk group were significantly higher than those in the low risk group of either preschool (42% vs. 10%, p<0.01) or school children (46.6% vs. 12%, p<0.01). The mean dmft of preschool children with S. mutans alone was 5.29±0.98 (SE), while that of preschool children with both S. mutans and S. sobrinus was 11.79±1.15 (SE). The mean of DMFT of school children with S. mutans alone was 2.26±0.27, and that of school children with both S. mutans and S. sobrinus was 6.1±0.66 (SE) (Table 1.). The caries status of children positive for both S. mutans and S. sobrinus were significantly higher than those positive for S. mutans alone (p<0.01 for preschool children, and p<0.05 for school children).

In 2007-2008, the presence S. mutans and S. sobrinus in plaque samples of Mongolian mother-child pairs was studied in relationship with the caries status, and the mean age of initial colonization of mutans streptococci was determined. The study population consisted of 320 mother-child pairs living in Ulaanbaatar. The ages of the children ranged from 6- to 30 months. The caries prevalence of 6-18-month-olds were 29% and 1.3±0.2 while those of the 19-30-month-olds were 59% and 3.4±0.4 correspondingly. In mothers, the prevalence of S. mutans and S. sobrinus was 79% and 33%, respectively; 54% harbored S. mutans alone, 8% harbored S. sobrinus alone, 25% harbored both strains. In children, 45% were positive for S. mutans alone, 9% were positive for S. sobrinus alone, 18%

<table>
<thead>
<tr>
<th>Age</th>
<th>Bacteria detected</th>
<th>Caries incidence</th>
<th>Caries prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-5 years</td>
<td>S. mutans</td>
<td>5.29±0.98</td>
<td>81.48%</td>
</tr>
<tr>
<td></td>
<td>S. mutans, S. sobrinus</td>
<td>11.71±1.15</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>All children</td>
<td>7.49±0.89</td>
<td>87.8%</td>
</tr>
<tr>
<td>12-15 years</td>
<td>S. mutans</td>
<td>2.26±0.26</td>
<td>84%</td>
</tr>
<tr>
<td></td>
<td>S. mutans, S. sobrinus</td>
<td>6.1±0.66</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>All children</td>
<td>3.23±0.37</td>
<td>90%</td>
</tr>
</tbody>
</table>
were positive for both strains. Either or both strains were detected in 67.3% of 6-18-months old children and 76.5% of 19-30-months old children. A significant positive correlation was found between the presence of mutans streptococci in mothers and band detection in children. The children of mothers harbouring S. mutans and/or S. sobrinus had a tendency to be colonized with the same strain. Moreover, children harboring both S. mutans and S. sobrinus had a higher caries incidence and caries risk than those with either strain alone. It has been concluded that S. mutans and/or S. sobrinus first colonized infants’ teeth from 6-18 months, and the colonization increased with increasing age, so that by 30 months of age, 76.5% of children harbored the bacteria.

According a survey conducted among 500 preschool children residing in Ulaanbaatar in January 2011, the prevalence and the mean dmft value were 50% and 2.08±0.39 (SE) in 2-years-olds, 75.32% and 4.57±0.34 in 3-years-olds, 88.81% and 5.95±0.33 in 4-years-olds, and 91.44% and 6.32±0.36 in 5-years-olds. The caries prevalence and incidence has been increasing with the age of children. There is a tendency of developing carious lesions in the children as they become older. This was probably, due to successive eruption of primary teeth, dietary and feeding habits.

Early research and development was concerned with waterborne fluoride, both naturally occurring and added, and their effect on the prevalence and incidence of dental caries and dental fluorosis. Fluoride is a key agent in reducing the prevalence of dental caries. Fluoride is also associated with an increase in the risk of unaesthetic dental fluorosis.

In 2002, natural occurring concentration of fluoride in water was determined in 298 sums of twenty-one aimags of Mongolia, and its relationship to caries prevalence and dental fluorosis was investigated (See Fig. 1 and Table. 2). 7,628 people were enrolled in that study. There was a strong positive correlation between fluoride concentration in water and the prevalence of dental fluorosis (Rxy=0.89). A strong negative relationship have been found between fluoride concentration and caries prevalence (Rxy=0.905). Most Mongolian population had been receiving drinking water with very low amount of fluoride, and it had been significantly related with the high caries prevalence among Mongolians. The high caries prevalence and incidence had been observed in capital Ulaanbaatar city which may be due to the profound changes in lifestyle and diet, in particular high, frequent sugar intake, insufficient amount of fluoride in drinking water from public water supplies.

In 2005, the caries prevalence and distribution of fluorosis among Mongolian children aged 8-12 years in relation to waterborne fluoride content was performed. Thus, along with the results of above mentioned study, the findings of this study indicated that the prevalence and incidence of dental caries have been high in areas with low waterborne fluoride concentration such as Ulaanbaatar, and those in areas with high fluoride content and rural areas with limited intake of fermentable carbohydrates have been lower compared to Ulaanbaatar (Table 3).
Part 2: The public use of fluoride in Mongolia.

The WHO Oral health report 2003 noted that the prevalence and incidence of dental caries can be controlled by the joint action of community, professionals and individuals. In rural areas of Mongolia however, access to oral health services is very limited, while suburb area of Ulaanbaatar significant numbers of population groups are underserved. For these reasons, professionally applied fluorides cannot be considered to be relevant in caries prevention for entire Mongolian population.

Public health approaches includes water fluoridation, milk fluoridation, salt fluoridation and development of affordable fluoride toothpastes. In Mongolia, however, people don’t receive fluoridated water, milk or salt. Probably the most significant vehicle used for fluoride has been toothpastes. However, uptake and use is not uniform and is less likely in underprivileged groups and rural areas.

In 2005, the content of fluoride in 34 fluoride containing toothpastes sold at Mongolian market was evaluated. The toothpastes were imported from different countries. It has been found that the concentration of fluoride in these toothpastes were lower by 2-3% than claimed to be.

### Table 2. Prevalence of dental caries and fluorosis in relation to waterborne fluoride concentration (2002)

<table>
<thead>
<tr>
<th>No</th>
<th>City, province</th>
<th>Sample size</th>
<th>Number of participants</th>
<th>Fluoride concentration in water (mg/l)</th>
<th>Prevalence of dental fluorosis (%)</th>
<th>Caries prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ulaanbaatar</td>
<td>45</td>
<td>1,300</td>
<td>0.23±0.04</td>
<td>8</td>
<td>92.4</td>
</tr>
<tr>
<td>2.</td>
<td>Khangai-Khentii</td>
<td>323</td>
<td>3,135</td>
<td>0.27±0.025</td>
<td>6</td>
<td>61.2</td>
</tr>
<tr>
<td>3.</td>
<td>Altai</td>
<td>83</td>
<td>1,084</td>
<td>0.24±0.02</td>
<td>13.3</td>
<td>64.4</td>
</tr>
<tr>
<td>4.</td>
<td>Dornod</td>
<td>97</td>
<td>816</td>
<td>1.59±0.10</td>
<td>38.2</td>
<td>46.42</td>
</tr>
<tr>
<td>5.</td>
<td>Gobi</td>
<td>287</td>
<td>1,293</td>
<td>1.07±0.09</td>
<td>25.7</td>
<td>59.3</td>
</tr>
<tr>
<td>6.</td>
<td>Mongolia</td>
<td>790</td>
<td>7,628</td>
<td>0.82±0.09</td>
<td>13.7</td>
<td>60.0</td>
</tr>
</tbody>
</table>

### Table 3. Prevalence of dental caries and fluorosis in relation to waterborne fluoride concentration (2005)

<table>
<thead>
<tr>
<th>Areas</th>
<th>Number of participants</th>
<th>Prevalence of caries (%)</th>
<th>dmft</th>
<th>DMFT</th>
<th>Prevalence of fluorosis (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ulaanbaatar</td>
<td>1,800</td>
<td>88.1</td>
<td>2.19</td>
<td>2.54</td>
<td>3</td>
</tr>
<tr>
<td>Gobi-Altai</td>
<td>300</td>
<td>43.0</td>
<td>0.40</td>
<td>0.55</td>
<td>23.0</td>
</tr>
<tr>
<td>Dornogobi</td>
<td>300</td>
<td>67.7</td>
<td>0.20</td>
<td>0.34</td>
<td>14.3</td>
</tr>
<tr>
<td>Uvs</td>
<td>300</td>
<td>65.3</td>
<td>0.24</td>
<td>0.49</td>
<td>7.0</td>
</tr>
</tbody>
</table>
In 2005, school based intervention study, where the intervention group received 500 ml bottled water with fluoride content of 0.8 ppm and the control group received no intervention was conducted. Baseline examinations of 100 children aged 8-10 years were performed in 2004 and in March of 2005. The study was evaluated after 1 month in April 2005. Children receiving an intervention received daily 500 ml water containing 0.8 ppm fluoride. In control group, the dmft/DMFT increment in 1 month period was 0.26. In intervention group, new carious lesions and spots have not been observed. The study demonstrated that fluoridated bottled drinking water may be effective in controlling caries. However, the effects of fluoridated bottled water rely upon action by individuals and families, the issue of cost and the frequency and amount of intake.

We have been conducting an oral examination and applying topical fluorides in children residing in State orphanage twice a year in 2009-2010. Baseline examinations of 50 children aged 3-5 years were carried in March 2009. The caries prevalence and dmft of all children were 76% and 4.2±0.83, respectively. The increment after one year was 0.42. The findings of the study were significantly lower compared to the results of other studies. This was probably due to the lifestyle of children living in orphanage, taking regular meals, not eating snack while playing, not getting pre-chewing before meals, brushing their teeth 3 times daily under supervision of orphanage teachers and getting professional fluoride application.

Part 3: Lessons learned and future steps.

Decrease of dental caries and gum disease and improvement of oral health are dependent on implementation of public health strategies focusing on the underlying risk factors. Clinical prevention and oral health education along will not achieve sustainable improvements. Thus, a range of complementary actions delivered in partnership with relevant agencies and the community are needed. The Mongolian population is young, with 34 percent below the age of 15 and just 4 percent older than 65 (National statistical office, Statistical yearbook – 2009.).

Based on more than 50 years of research worldwide attesting its effectiveness and safety, fluoridated water might be the best method of delivering fluoride on a population basis. As a general consideration, both fluoridated water and fluoride toothpaste should be recommended to all individuals. Additional methods can be recommended for patients at a high risk for caries. These may include professional fluoride application and the use of fluoride releasing dental materials.
Effective Use of Fluoride in Myanmar

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Aye Aye Maw,
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(Nay Pyi Taw, Myanmar)

Myanmar, the Largest Mainland ASEAN Country of South East Asia (676,578) Square kilometers stretches 2,200 kilometers from North to South and 925 kilometers from north to south and 925 kilometers from east west at its widest point.

The country is divided into administratively into 14 States and Divisions. Myanmar falls into three wall marked natural divisions, the western hills, the central belt and Shan plateau on the east, with a continuation of the high land in the Tanintharyi.

General population of Myanmar is estimated at 58.38 millions. About 70 percent of the population resides in the rural area, whereas the remaining are urban dwellers.

In Myanmar, there is no water or salt fluoridation for communities yet. So, present of public use fluoride for the prevention of dental caries from tooth to brushing with fluoridated tooth paste. In some private clinic, supply fluoride varnish but very rare.

Most recent data of dental caries status and related data.

### Dental caries status

<table>
<thead>
<tr>
<th>12 yrs old</th>
<th>Mean</th>
<th>DMFT</th>
<th>0.83</th>
<th>37.7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 yr old (1999)</td>
<td>Mean</td>
<td>DMFT</td>
<td>0.65</td>
<td>Urban</td>
</tr>
<tr>
<td>6 yr old</td>
<td>Mean</td>
<td>DMFT</td>
<td>1.31</td>
<td>Rural</td>
</tr>
<tr>
<td>6 yr old</td>
<td>Mean</td>
<td>DMFT</td>
<td>4.17</td>
<td>84.5%</td>
</tr>
</tbody>
</table>

### Periodontal Status

Bleeding and Calculus scores are high (80%) in adolescent group.

- 35.44 yrs-old CPI 3 14.7%  CPI 4 2.64%
- 65-74 yrs-old CPI 3 20.4%  CPI 4 10.4%

Since 1992, after launching of POHC, MOH-DOH/WHO collaborative project, in Myanmar the effective use of fluoride was popularized by distributing IECS to the public and broadcasting from the national TV program by declaring “A tooth paste without fluoride is just for cosmetic benefit and fluoride is the only therapeutic ingredient for a toothpaste to prevent dental caries in both dentition”

Effected method of tooth brushing with fluoridated tooth paste was introduced to the general public and after-lunch tooth brushing teams were organized for primary school children of the projected townships to let school children exposed to the fluoride.

1995, A first batch of locally available toothpastes were sent to the biochemistry laboratory of the
Chulalongkorn University, Thailand for analysis of free and total fluoride content to assess the efficacy of the tooth paste.

2000, A study designed to assess the different levels of naturally occurring fluoride in drinking water (0-3.6 ppmF) and degree of dental fluorosis was conducted in a dental fluorosis endemic area of Myanmar.

Invitational Meeting on fluoride exposure and Oral Health care for Myanmar held in 2002. Decision makers, Dental and Medical profession, Manufactures, NGO’s and relevant sectors attended in that meeting major outcomes of the meeting arise permission to conduct fluoride tooth paste and dental fluorosis issues as an oral health project in Myanmar from the Health Ministry.

Production and marketing of fluoride tooth paste from the factor of the ministry of Industry in November 2002.

"Pepsodent with fluoride”
Free ionisable fluoride = 780 ppmF
Retail price = 313 ks/100 gm

In 2001, Analysis of fluoride in drinking water sources is made by taking 1,750 sources throughout Myanmar.

2006, Advocacy meeting with introduction fluoride consultants/DOH/Private manufacturer/MAMS conducted for labeling criteria and user-instruction for local made fluoride tooth paste:
Sources of fluoride in Myanmar drinking water, wells (dug, tube) lakes, ponds.
Tooth paste
Tea leaves
Various brands of tooth pastes are distributed in Myanmar market commonly used 17 tooth pastes (11 for adults & 6 for children) have up till now examined.

For children usual fluoride component should be 1000-2000 ppm

12 yrs old DMFT in Myanmar

<table>
<thead>
<tr>
<th>Source</th>
<th>Year</th>
<th>DMFT</th>
<th>Prevalence %</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHO</td>
<td>1977</td>
<td>0.8</td>
<td>35.0</td>
</tr>
<tr>
<td>Valentine</td>
<td>1982</td>
<td>1.3</td>
<td>44.8</td>
</tr>
<tr>
<td>WHO (POHC)</td>
<td>1993</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>Oral Health Unit</td>
<td>1996</td>
<td>0.83</td>
<td>39.7</td>
</tr>
</tbody>
</table>
Fluoride Exposure & Dentition status (12 years old)

<table>
<thead>
<tr>
<th>Place</th>
<th>Gender</th>
<th>Dentition Status (DMFT)</th>
<th>Prevalence</th>
<th>Fluoride Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taunggyi</td>
<td>Male</td>
<td>1.3 g (Low)</td>
<td>54.2</td>
<td>Tooth Paste Drinking water Tea leaf 1.33 ppm</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>1.66 (Low)</td>
<td>52.4</td>
<td></td>
</tr>
<tr>
<td>Mandalay</td>
<td>Male</td>
<td>1.55 (Low)</td>
<td>51.0</td>
<td>Tooth Paste Drinking water (&gt; 1-5 ppm)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>1.23 (Low)</td>
<td>48.9</td>
<td></td>
</tr>
<tr>
<td>Pyay</td>
<td>Male</td>
<td>0.69 (very low)</td>
<td>24.0</td>
<td>Tooth Paste Drinking water (&gt; 1.5 ppm)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>0.48 (very low)</td>
<td>24.4</td>
<td></td>
</tr>
<tr>
<td>Yangon</td>
<td>Male</td>
<td>0.58 (very low)</td>
<td>26.5</td>
<td>Tooth Paste Drinking water (&lt; 1.5 ppm)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>0.89 (very low)</td>
<td>36.9</td>
<td></td>
</tr>
</tbody>
</table>

We achieved

- Local mad fluoride toothpastes become efficacies
- More choices of efficacious fluoride toothpastes available
- Efficacious fluoride toothpaste with Myanmar language user instruction, shelf-life, appropriate labeling are cheaper.
- Local tooth paste Co’s received quality accreditation from WHOCC laboratory
- Local manufactures win more market share

In our country, allow <2% of total health expenditure for oral health. So very low if allow more expenditure for oral health. We plan to do professionally applied eg. Fluoride varnish, Silver Fluoride, school water fluoridation and community water fluoridation.
Effective Use of Fluoride in Nepal
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Executive member, Nepal Public Health Foundation.
Email of correspondence author: lprasai@yahoo.com

Nepal is a small and beautiful country situated between China and India with a total area of 147,181 sq km. Nepal has an estimated population of 29 million and GDP per capita of US$470. About 28% of the population is living below the national poverty line. Nepal is divided broadly into three ecological regions: The Terai (plains), the central hills and the rugged mountains (Himalayas) in the North. In terms of administrative division, Nepal is divided into five development regions; Central, Eastern, Western, Mid Western and Far Western Regions, 14 zones and 75 districts. The districts are divided into Village Development Committee (VDC) and urban municipalities.

The only major source of fluoride use by the public in Nepal is fluoridated toothpastes. Fluoride mouth rinses are available over the counters but are used by very few individuals in the urban areas. Fluoride varnish and gels are applied professionally in dental practices and hospitals in Nepal. Affordable fluoride programs such as tooth brushing in schools with fluoridated toothpaste is practiced in certain schools by different organizations and Institutes in Nepal covering pocket areas. However an organized community based fluoridation program is not available.

There are approximately 800 dental surgeons registered in Nepal Medical Council in 2010. Approximately one hundred plus dental surgeons are outside the country and remaining 85-90% of the dental surgeons work in the urban areas. There are 5 dental colleges in Nepal. One in the Eastern region, One in western and 3 in Central Nepal. There is a possibility of another Dental College opening in the Central region. Although there are many dental graduates graduating each year from within and outside the country, there is an inequitable distribution of dental workforce in Nepal. The dentist population ratio in Kathmandu is approximately 50,000 per dentist and outside the valley is 200,000 per dentist. About 70% of the dental surgeons are females. The dentist population ratio outside Kathmandu can be compared to Africa.

The most prevalent oral diseases in Nepal is Dental caries followed by periodontal disease and oral cancer. A non randomized pathfinder survey conducted in Western and Central Nepal in 1999 reported that the prevalence of dental caries in 5-6 years old was 67% and mean dmft score was 3.3. The caries prevalence of 12-13 year old was 41% and mean DMFT score was 1.1. A total of 2177 5 year old school children and 3323 12-13 year old school children from rural and urban areas were examined using the WHO Pathfinder methodology. The Nepal national pathfinder survey conducted in 2004 reported that dental caries in 5-6 year old children was above the WHO/FDI recommended target of less than 50% caries free in 5-6 year old age groups. Dental caries is one of the most prevalent non communicable childhood diseases in Nepal. The majority of the dmft score comprised of the decayed component. The study also reported untreated dental caries eventually lead to pain and loss of teeth. Untreated dental caries has an impact on the quality of life of the school children and also adult population. Amongst adolescent schoolchildren, the most frequent reported impact of pain and discomfort was the inability to eat, followed by the inability to speak.

The DMFT score of 12-13 year old children in Nepal is 0.5 as reported in 2004, with decayed teeth at 93%, 2% missing and 5% filled teeth.
Part 2

The history of fluoridation started with Dr. Fredrick McKay in Colorado Springs, USA in 1901 with the discovery of then called the “Colorado stains”. In 1942 Dean et al reported that 1 ppm of fluoride in drinking water lead to a 60% reduction of dental caries. In 1945 the first community water fluoridation program was started at Grand Rapids, Michigan, USA by addition of sodium fluoride. Toothpaste was used since the 19th century and in 1941 fluoride was first added to toothpaste.

Nepal has low level of fluoride in water due to climatic conditions such as high rainfall. 95% of 700 samples of drinking water collected between 1997 -2000 from all over Nepal by United Mission to Nepal Oral health Programme (UMN OHP) has determined that fluoride concentration in the water supplies throughout Nepal, are insufficient to prevent caries. In a sample of 632 samples of drinking water collected, only 5 samples of drinking water had therapeutic levels of fluoride above 0.7mg/l with highest level being 1.07mg/l to prevent caries.

The advocacy project of the UMN OHP (1997 - 2002) to increase the consumption and availability of fluoridated toothpaste and Market analysis of toothpaste in Nepal revealed that toothpaste manufactured in the country was virtually not fluoridated. The fluoridated toothpaste available had various concentrations of fluoride when tested and failed to meet the therapeutic concentration of fluoride. The market share of fluoridated toothpaste and volume of fluoridated toothpaste was negligible in 1997. However fluoridated toothpaste imported from neighboring countries were available but expensive compared to the local manufacturer. It was available and consumed by the more affluent communities. By March 2002 the total share market of fluoride toothpaste was approximately 90% which represents 900 tonnes of fluoride toothpaste sold annually as a result of the advocacy process. Nepal Lever and Colgate Palmolive started manufacturing fluoridated toothpaste in Nepal including other local manufacturers.

The project achieved health promotion outcomes including healthy corporate and public policies and organizational practices and increased availability of affordable fluoridated toothpastes in Nepal.

The net present value in 6 years was US$ 594466 for a 10% reduction in dental caries of 6-18 years population group. For every US$ 1 spent for advocacy, there is a savings of treating caries ranging from US$ 86-US$356. A decrease in dental caries prevalence by 26.6% was reported to be in 12-13 year old children from 1999 -2005. Approximately 65% to 75% of the 12-13 year old children brushed their teeth with fluoridated toothpaste in 1999 -2004. Report of pain decreased by 10%. This decrease in dental caries could be due to increased availability and consumption of fluoridated toothpastes in Nepal.

Extraction of permanent teeth is common in Nepal. A study was undertaken by the Department of Community Dentistry at Peoples Dental College and Hospital (PDCH) to determine the causes and pattern of missing permanent teeth among patients attending PDCH and to see if there is any association between variables like socio economic status, patient education level, dental visit and extraction of permanent teeth. In age groups ≤ 30 years, 90% it was reported that Dental caries was the most common reason for extraction of teeth. In age groups > 30 years, 55.6% periodontal disease was the most common reason for extraction of teeth. Distribution by type of teeth and dental disease was highly significant where Dental caries was the reason for extraction of first permanent molar. Distribution by education level and visit to dentist was highly significant. 93.1% of the people who were illiterate visited the dental surgeon while in pain and 76% of the university level graduates visited the dentist while in pain. Caries and its sequel remain the most important cause of tooth loss throughout adult life along with periodontal diseases at later stages. Prevention of dental caries and loss of teeth due to caries reasons needs to be addressed in Nepal with suitable mass fluoridation strategy (Paper submitted for publication).
The public health approaches for mass fluoridation is water, salt, milk and fluoride toothpastes. At present community and school based fluoridation program such as water, salt or milk fluoridation is not available in Nepal. The most common fluoride vehicle used in Nepal is Toothbrushing with fluoridated toothpaste. It is a common norm to brush teeth once a day for most Nepalese.

School based oral health programmes are been conducted at pocket areas in Nepal through different organizations and Institutes serving pocket areas. Dental sealants, mouth rinses program and topical fluoride application could be some interventions. However such type of program are expensive to conduct. One of the best economical method is awareness and use of fluoride toothpaste in school settings. This is created through school based Toothbrushing programs and conducting teachers training for increasing awareness among teachers and for facilitation of the implementation of the Toothbrushing program in schools. Glass ionomer cements are also used in school based oral health programs for restoration of decayed teeth. Schools and community based oral health education programs emphasizing the use of fluoride are also conducted during oral health camps in different places in Nepal. One of the examples of such school Toothbrushing program is the oral health project which covers about 4,142 schoolchildren from ethnic minority groups in 44 schools in seven Village Development Committee of Timal Besi, a remote area in Kavre District. (awaiting publication in the website of WHO oral health country/area profile Programme.)

The schools are initially supplied with toothbrush and toothpaste. Each toothpaste (40gm) costs about 10 NRs (1 US$ = App 71NRs). Teachers training was conducted with 44 focal teachers as most teachers were not aware about the benefits of fluoride and oral health in general. The school Toothbrushing program is conducted in supervision of the focal health teacher of the school after mid day meals. The child club in each school also takes active participation. Education materials are also developed such as poster and distributed in schools and child clubs about Toothbrushing in schools. The families and children residing in the area like most Nepalese living in rural areas have minimal accessibility and affordability to optimum healthcare including oral health. School based oral health project is an effective means of reaching children from socioeconomically marginalized communities. Integration of oral health component into the SHN program of NGOs under the WHO School Health and Nutrition Initiative would be very fruitful and effective in reaching the school age children in remote areas of Nepal.

Advocacy and awareness program in Nepal is an ongoing process. However it needs support nationally and Internationally. Nepal Dental Association used television to bring awareness on use of fluoridated toothpaste and publication in the national newsprint for awareness in oral health and use of fluoride. Topical fluorides in the form of varnishes and gels are applied professionally in dental practices and Institutes in Nepal.

The report of the Regional Consultation Meeting on Formulating Oral health strategy for South East Asia held in October 2008 highlights The priority national-level strategies to improve oral health in Nepal includes strengthening oral health education, prioritizing oral health promotion approaches (such as fluoridation), prevention of common oral diseases and conditions.

Part 3

Water fluoridation is not feasible in Nepal due to its rugged topography and the need for well established centralized piped water distribution systems. Milk fluoridation has proven successful in countries where a milk distribution system is established. At the present time this is not available in Nepal and it would not be a feasible measure in the near future as very little population consumes packaged milk. Fluoridated toothpaste is another feasible mode of fluoride delivery. Due to rugged topography and limited road accessibility, fluoride toothpaste may not be easily available.
There is also a need to reduce the price of locally manufactured toothpastes so it is reachable to socioeconomically marginalized communities. This could be achieved by reducing the tax of fluoridated toothpaste which is about 25-30% of the actual selling cost of the toothpaste. This needs strong advocacy, lobbying and intersectoral coordination. Salt fluoridation has been contemplated as a viable alternative. Salt fluoridation is a strategy for prevention of dental caries that can reach the entire population. For over 80 years salt has proved a reliable, safe, inexpensive and stable carrier to correct iodine deficiency on a large scale. Iodized salt is available to over 1 billion people and has paved the way for the introduction of fluoridated salt” (Hans Bürgi, 50th anniversary conference on salt fluoridation, October 2005). Iodized form of salt is available in Nepal. It has been estimated that the cost of salt fluoridation per person per year amounts to approximately $0.06 which is by far more affordable than the cost of restorative dental work.

Based on these considerations and information, salt fluoridation could be a good public health measure to reduce dental caries morbidity in Nepal and is consumed by virtually of population of all socioeconomic status. However, various forms of salt is consumed in Nepal through various sources. Other problems could be poor distribution of salt and quality control.

It is not surprising to see that oral health is not considered as high priority area in Nepal compared to other diseases. It is also a good sign that oral health has recently been added in to the Nepal Health Sector Plan 2. The challenge for effective fluoridation in Nepal is continuous advocacy, lobbying and intersectoral coordination and funding availability.

Research on further evaluation of the outcomes of advocacy programme for fluoride toothpastes in Nepal and sustainability could be a recommendation for Nepal. Advocacy and lobbying for reduction in taxes of fluoridated toothpaste would make it more available and accessible to socioeconomically marginalized communities.

References
Fluoride in Drinking Water and DMFT in Pakistan Future Strategy
Arif Alvi, BDS, MS, MSD

Introduction: Pakistan is the six most populous country in the world with a population of about 175 million people. The country covers an area of 800,000 square kilometers, approximately equaling the combined land areas of France and the United Kingdom and is the 36th largest nation by total area.

The geography of Pakistan is a blend of landscapes varying from plains to deserts, forests, hills, and plateaus. Pakistan’s climate varies from tropical to temperate with arid conditions existing in the coastal south, characterized by a monsoon season with adequate rainfall and a dry season with lesser rainfall which can vary radically from year to year, and successive patterns of flooding and drought are common.

Fluorine is an essential micronutrient, which is present in trace amount in human body. Its optimum concentration is critical for human health because its deficiency leads to dental caries while excess causes dental mottling. This paper would look at the available data with respect to studies done in Pakistan regarding the level of fluoride available in the drinking water as well as some studies which relate the same to the amount of caries present in the local population.

The country is divided into four provinces Khyber-Pakhtunkhwa, Punjab, Sindh and Balochistan. The provinces are administratively divided into districts each usually have 0.5 to 2 million people. Studies have been done in all districts of the country to establish the fluoride content of drinking water. Ali Khan et al in an extensive study have reported Fluoride content in all districts in the four provinces of Pakistan (Tables I to IV).

Table I - Province of Punjab

<table>
<thead>
<tr>
<th>Fluoride analysis of drinking water of Punjab by location, 1999-2000</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Punjab province; Division</strong></td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>Bahawalpur</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Dera Ghazi Khan</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Faisalabad</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Federal Area</td>
</tr>
</tbody>
</table>
## Fluoride analysis of drinking water of Punjab by location, 1999-2000

<table>
<thead>
<tr>
<th>Punjab province; Division</th>
<th>District</th>
<th>Population</th>
<th>Fluoride levels (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gujranawala</td>
<td>Gujranawala</td>
<td>3.37 m</td>
<td>0.06-0.26</td>
</tr>
<tr>
<td></td>
<td>Gujrat</td>
<td>1.84 m</td>
<td>0.06-0.31</td>
</tr>
<tr>
<td></td>
<td>Hafizabad</td>
<td>0.82 m</td>
<td>0.2-0.57</td>
</tr>
<tr>
<td></td>
<td>Mandi Bhahaudin</td>
<td>1.14 m</td>
<td>0.13-0.21</td>
</tr>
<tr>
<td></td>
<td>Narowal</td>
<td>1.25 m</td>
<td>0.04-0.18</td>
</tr>
<tr>
<td></td>
<td>Sialkot</td>
<td>2.68 m</td>
<td>0.1-0.65</td>
</tr>
<tr>
<td>Lahore</td>
<td>Kasur</td>
<td>2.34 m</td>
<td>0.24-13.2*</td>
</tr>
<tr>
<td></td>
<td>Lahore</td>
<td>6.21 m</td>
<td>0.08-1.42</td>
</tr>
<tr>
<td></td>
<td>Okara</td>
<td>2.19 m</td>
<td>0.11-5.8</td>
</tr>
<tr>
<td></td>
<td>Sheikhupura</td>
<td>3.22 m</td>
<td>0.04-0.77</td>
</tr>
<tr>
<td>Multan</td>
<td>Khanewal</td>
<td>2.04 m</td>
<td>0.15-0.79</td>
</tr>
<tr>
<td></td>
<td>Lodhran</td>
<td>1.16 m</td>
<td>0.12-0.19</td>
</tr>
<tr>
<td></td>
<td>Multan</td>
<td>3.08 m</td>
<td>0.07-0.35</td>
</tr>
<tr>
<td></td>
<td>Pakpattan</td>
<td>1.27 m</td>
<td>0.04-0.20</td>
</tr>
<tr>
<td></td>
<td>Sahiwal</td>
<td>1.82 m</td>
<td>0.12-1.82</td>
</tr>
<tr>
<td></td>
<td>Vehari</td>
<td>2.04 m</td>
<td>0.05-0.38</td>
</tr>
<tr>
<td>Rawalpindi</td>
<td>Attock</td>
<td>1.26 m</td>
<td>0.04-0.21</td>
</tr>
<tr>
<td></td>
<td>Chakwal</td>
<td>1.06 m</td>
<td>0.06-2.1</td>
</tr>
<tr>
<td></td>
<td>Jehlum</td>
<td>1.1 m</td>
<td>0.05-2.19</td>
</tr>
<tr>
<td></td>
<td>Rawalpindi</td>
<td>3.35 m</td>
<td>0.02-0.4</td>
</tr>
<tr>
<td>Sagodha</td>
<td>Bakhar</td>
<td>1.04 m</td>
<td>0.15-2.45</td>
</tr>
<tr>
<td></td>
<td>Khushab</td>
<td>0.89 m</td>
<td>0.39-1.28</td>
</tr>
<tr>
<td></td>
<td>Mainwali</td>
<td>1.03 m</td>
<td>0.13-3.1</td>
</tr>
<tr>
<td></td>
<td>Sagodha</td>
<td>2.65 m</td>
<td>0.05-0.91</td>
</tr>
</tbody>
</table>
Table II - Province of Sind

<table>
<thead>
<tr>
<th>Sind province; Division</th>
<th>District</th>
<th>Population</th>
<th>Fluoride levels (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyderabad</td>
<td>Badin</td>
<td>1.1 m</td>
<td>0.16-0.9</td>
</tr>
<tr>
<td></td>
<td>Dadu</td>
<td>1.63 m</td>
<td>0.04-0.46</td>
</tr>
<tr>
<td></td>
<td>Hyderabad</td>
<td>2.84 m</td>
<td>0.04-0.46</td>
</tr>
<tr>
<td></td>
<td>Thatta</td>
<td>1.1 m</td>
<td>0.04-0.37</td>
</tr>
<tr>
<td>Karachi</td>
<td>Karachi (Central)</td>
<td>2.24 m</td>
<td>0.6-1.46</td>
</tr>
<tr>
<td></td>
<td>Karachi (East)</td>
<td>2.71 m</td>
<td>0.1-0.15</td>
</tr>
<tr>
<td></td>
<td>Karachi (South)</td>
<td>1.72 m</td>
<td>0.1-0.14</td>
</tr>
<tr>
<td></td>
<td>Karachi (West)</td>
<td>2.08 m</td>
<td>0.1-0.15</td>
</tr>
<tr>
<td></td>
<td>Malir</td>
<td>1.04 m</td>
<td>0.27-0.36</td>
</tr>
<tr>
<td>Larkana</td>
<td>Jacobabad</td>
<td>1.4 m</td>
<td>0.19-0.57</td>
</tr>
<tr>
<td></td>
<td>Larkana</td>
<td>1.9 m</td>
<td>0.04-0.74</td>
</tr>
<tr>
<td></td>
<td>Shaikarpur</td>
<td>0.86 m</td>
<td>0.11-1.17</td>
</tr>
<tr>
<td>Mirpur Khas</td>
<td>Mirpur Khas</td>
<td>0.9 m</td>
<td>0.16-0.58</td>
</tr>
<tr>
<td></td>
<td>Shanghar</td>
<td>1.42 m</td>
<td>0.1-1.37*</td>
</tr>
<tr>
<td></td>
<td>Tharpaktar</td>
<td>0.9 m</td>
<td>1.05-6.3</td>
</tr>
<tr>
<td></td>
<td>Umer kot</td>
<td>0.66 m</td>
<td>0.04-0.87</td>
</tr>
<tr>
<td>Sukkar</td>
<td>Ghotiki</td>
<td>0.95 m</td>
<td>0.10-0.49</td>
</tr>
<tr>
<td></td>
<td>Khairpur</td>
<td>1.51 m</td>
<td>0.13-0.58</td>
</tr>
<tr>
<td></td>
<td>Naushahro Feroze</td>
<td>1.06 m</td>
<td>0.04-0.46</td>
</tr>
<tr>
<td></td>
<td>Nawab Shah</td>
<td>1.04 m</td>
<td>0.03-0.18</td>
</tr>
<tr>
<td></td>
<td>Sukkar</td>
<td>0.88 m</td>
<td>0.27-0.54</td>
</tr>
</tbody>
</table>
### Table III - Province of Balochistan

<table>
<thead>
<tr>
<th>Balochistan province; Division</th>
<th>District</th>
<th>Population</th>
<th>Fluoride levels (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kalat</td>
<td>Awaran</td>
<td>0.11 m</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>Kalat</td>
<td>0.23 m</td>
<td>0.19-0.26</td>
</tr>
<tr>
<td></td>
<td>Kharan</td>
<td>0.19 m</td>
<td>0.44-0.70</td>
</tr>
<tr>
<td></td>
<td>Khuzdar</td>
<td>0.41 m</td>
<td>0.5-0.52</td>
</tr>
<tr>
<td></td>
<td>Lasbela</td>
<td>0.31 m</td>
<td>0.12-0.81</td>
</tr>
<tr>
<td></td>
<td>Mastung</td>
<td>0.16 m</td>
<td>0.31-0.39</td>
</tr>
<tr>
<td>Mekran</td>
<td>Gwadar</td>
<td>0.18 m</td>
<td>0.05-0.12</td>
</tr>
<tr>
<td></td>
<td>Kech</td>
<td>0.41 m</td>
<td>0.17-0.79</td>
</tr>
<tr>
<td></td>
<td>Panjgur</td>
<td>0.23 m</td>
<td>0.13-0.25</td>
</tr>
<tr>
<td>Nasirabad</td>
<td>Bolan</td>
<td>0.29 m</td>
<td>0.75-1.67</td>
</tr>
<tr>
<td></td>
<td>Jafarabad</td>
<td>0.42 m</td>
<td>0.13-2.08</td>
</tr>
<tr>
<td></td>
<td>Jhal Magsi</td>
<td>0.1 m</td>
<td>0.85-1.8</td>
</tr>
<tr>
<td></td>
<td>Nasirabad</td>
<td>0.24 m</td>
<td>0.16-1.51</td>
</tr>
<tr>
<td>Quetta</td>
<td>Chagai</td>
<td>0.2 m</td>
<td>0.29-0.45</td>
</tr>
<tr>
<td></td>
<td>Pashin</td>
<td>0.36 m</td>
<td>0.1-1.11</td>
</tr>
<tr>
<td></td>
<td>Qila Abdulah</td>
<td>0.39 m</td>
<td>0.15-0.29</td>
</tr>
<tr>
<td></td>
<td>Quetta</td>
<td>0.76 m</td>
<td>0.86-1.11</td>
</tr>
<tr>
<td>Sibi</td>
<td>Dera Bugti</td>
<td>0.18 m</td>
<td>0.98-2.7</td>
</tr>
<tr>
<td></td>
<td>Kohlu</td>
<td>0.1 m</td>
<td>0.66-1.52</td>
</tr>
<tr>
<td></td>
<td>Sibi</td>
<td>0.18 m</td>
<td>1.17</td>
</tr>
<tr>
<td></td>
<td>Ziarat</td>
<td>0.03 m</td>
<td>0.65-0.81</td>
</tr>
<tr>
<td>Zhob</td>
<td>Bar Khan</td>
<td>0.1 m</td>
<td>1.35-1.56</td>
</tr>
<tr>
<td></td>
<td>Kila Saifullah</td>
<td>0.19 m</td>
<td>0.05-0.25</td>
</tr>
<tr>
<td></td>
<td>Loralai</td>
<td>0.3 m</td>
<td>0.23-1.08</td>
</tr>
<tr>
<td></td>
<td>Musa Khel</td>
<td>0.13 m</td>
<td>0.29-0.39</td>
</tr>
<tr>
<td></td>
<td>Zhob</td>
<td>0.27 m</td>
<td>0.16-0.34</td>
</tr>
</tbody>
</table>
### Table IV - Province of Khyber-Pakhtunkhwa (formerly NWFP)

<table>
<thead>
<tr>
<th>N.W.F.P. province; Division</th>
<th>District</th>
<th>Population</th>
<th>Fluoride levels (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bannu</td>
<td>Bannu 0.67 m</td>
<td>0.1-0.19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lakki Marwat 0.49 m</td>
<td>0.1-0.12</td>
<td></td>
</tr>
<tr>
<td>Dera Ismail Khan</td>
<td>Dera Ismail Khan 0.87 m</td>
<td>0.12-0.22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tank 0.23 m</td>
<td>0.07-0.14</td>
<td></td>
</tr>
<tr>
<td>FATA</td>
<td>South Waziristan 0.41 m</td>
<td>0.06-0.08</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kohat 0.09 m</td>
<td>0.2-0.31</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Orakzai 0.22 m</td>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bajaur 0.59 m</td>
<td>0.3-0.37</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Khyber 0.53 m</td>
<td>0.08-0.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mohmand 0.33 m</td>
<td>0.12-0.24</td>
<td></td>
</tr>
<tr>
<td>Hazara</td>
<td>Abbotabad 0.87 m</td>
<td>0.08-0.14</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Batagram 0.3 m</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Haripur 0.68 m</td>
<td>0.08-0.09</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kohistan 0.47 m</td>
<td>0.02-0.06</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mansehra 1.14 m</td>
<td>0.08-0.17</td>
<td></td>
</tr>
<tr>
<td>Kohat</td>
<td>Hango 0.31 m</td>
<td>0.06-0.08</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Karak 0.42 m</td>
<td>0.06-0.35</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kohat 0.56 m</td>
<td>0.2-0.32</td>
<td></td>
</tr>
<tr>
<td>Malakand</td>
<td>Buner 0.5 m</td>
<td>0.1-0.23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chitral 0.31 m</td>
<td>0.02-0.13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lower Dir 0.71 m</td>
<td>0.04-0.13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Malakand 0.43 m</td>
<td>0.12-0.28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sangla 0.43 m</td>
<td>0.05-0.16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swat 1.25 m</td>
<td>0.04-0.13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Upper Dir 0.57 m</td>
<td>0.07-0.11</td>
<td></td>
</tr>
<tr>
<td>Mardan</td>
<td>Mardan 1.45 m</td>
<td>0.57-0.85</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swabi 1.01 m</td>
<td>0.06-0.17</td>
<td></td>
</tr>
<tr>
<td>Peshawar</td>
<td>Charsadda 0.97 m</td>
<td>0.08-0.13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nowshera 0.87 m</td>
<td>0.08-0.18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Peshawar 2.04 m</td>
<td>0.11-0.15</td>
<td></td>
</tr>
</tbody>
</table>
Sugar Consumption:
Per Capita sugar consumption in Pakistan has increased from 21.2 Kg per year in 1991 to 26.6 Kg per year in 2006.

Relationship of Fluoride Content in Drinking water to Caries:
Khan, Whelton and O'Mullane conducted a study to observe a dose-response relationship between the prevalence of dental caries at different concentrations of fluoride in drinking water. Clinical dental examination of 1020 school children aged 12 years was carried out in 19 cities of Pakistan. Correlation between concentrations of water fluoride, caries and fluorosis was investigated by analyzing the data on fluoride concentrations in drinking water in the sampled population for which the caries and the fluorosis levels were also measured. It was found that the maximum reduction of caries in relation to fluoride levels in Pakistan was witnessed between the fluoride concentrations of 0.00–0.33 ppm. (Table V)

Table V- Relationship of Fluoride in Drinking water to Caries

<table>
<thead>
<tr>
<th>City</th>
<th>Fluoride Level</th>
<th>DMFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mirpurkhas</td>
<td>0.03</td>
<td>2.24</td>
</tr>
<tr>
<td>2. Islamabad</td>
<td>0.07</td>
<td>1.90</td>
</tr>
<tr>
<td>3. Jhelum</td>
<td>0.10</td>
<td>0.68</td>
</tr>
<tr>
<td>4. Sialkot</td>
<td>0.14</td>
<td>1.05</td>
</tr>
<tr>
<td>5. Karachi</td>
<td>0.15</td>
<td>1.09</td>
</tr>
<tr>
<td>6. Lahore</td>
<td>0.15</td>
<td>1.07</td>
</tr>
<tr>
<td>7. Peshawar</td>
<td>0.15</td>
<td>1.02</td>
</tr>
<tr>
<td>8. Hyderabad</td>
<td>0.16</td>
<td>0.99</td>
</tr>
<tr>
<td>9. Faisalabad</td>
<td>0.20</td>
<td>0.80</td>
</tr>
<tr>
<td>10. Rahimyar Khan</td>
<td>0.22</td>
<td>0.84</td>
</tr>
<tr>
<td>11. Gujranwala</td>
<td>0.29</td>
<td>0.54</td>
</tr>
<tr>
<td>12. Sukker</td>
<td>0.30</td>
<td>0.46</td>
</tr>
<tr>
<td>13. Sahiwal</td>
<td>0.33</td>
<td>0.43</td>
</tr>
<tr>
<td>14. Khanpur</td>
<td>0.40</td>
<td>0.50</td>
</tr>
<tr>
<td>15. Sammundari</td>
<td>0.53</td>
<td>0.60</td>
</tr>
<tr>
<td>16. Hasilpur</td>
<td>0.60</td>
<td>0.60</td>
</tr>
<tr>
<td>17. Khaipur</td>
<td>0.73</td>
<td>0.60</td>
</tr>
<tr>
<td>18. Quetta</td>
<td>0.91</td>
<td>0.60</td>
</tr>
<tr>
<td>19. Mianwali</td>
<td>1.4</td>
<td>0.96</td>
</tr>
<tr>
<td>20. Mean DMFT</td>
<td></td>
<td>0.9</td>
</tr>
</tbody>
</table>
The optimal level of fluoride in drinking water is universally calculated by applying the equation of Galagan and Vermillion, which permits the calculation of water intake as a function of temperature. The annual mean maximum temperatures (AMMT) recorded during the last 5 years were collected from the meteorological centres of the 28 divisional headquarter stations. The average AMMT of Pakistan is 29 degrees C at which the optimal fluoride in drinking water of Pakistan was calculated to be 0.7 ppm. As drinking habits differ in various parts of the world, determination of optimal concentration of fluoride for drinking water in Pakistan was performed using a modified Galagan and Vermillion equation, which applies a correction factor of 0.56 to the equation. They state that the optimal fluoride in drinking water in Pakistan using this modified equation was determined to be 0.39 ppm.

This tallies very well with their results where they found that a fluoride concentration of 0.35 ppm in drinking water was associated with maximum reduction in dental caries and a 10% prevalence of fluorosis.

They state that determining the most appropriate concentrations of fluoride in drinking water is crucial for communities. It is imperative that each country calculates its own optimal level of fluoride in drinking water based on the dose-response relationship of fluoride in drinking water with the levels of caries and fluorosis. Climatic conditions, dietary habits of the population and other possible fluoride exposures need to be considered in formulating these recommendations.

Conclusion: Pakistan at present has no fluoridation of community water. Because of a warm climate the population drinks a reasonable amount of water and they are also drink a few cups of tea daily. Because there is no water fluoridation the Pakistan Dental Association and the dental community believes that the best source of fluoride is dental tooth paste. In Pakistan 90 percent of tooth paste marketed contain fluoride. Advocacy of frequency of brushing with a fluoride tooth paste is the method of choice for the near future.

References

Public Use of Fluoride in the Prevention of Dental Caries in the Philippines

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The Philippines

The Philippines is an archipelago made up of 7,107 islands located in the western part of the Pacific Ocean off the coast of Southeast Asia. The country has a total land area of 300,000 square kilometers and is one of the largest island groups in the world.

The total population of the Philippines in 1980 was 48,316,503. This figure has increased to 76,504,077 in 2000, a 58 percent increase between 1980 and 2000. The population is projected to increase to 84,241,341 in 2005 and 94,013,400 in 2010 (NSO). This makes the Philippines one of the world’s most populous countries. Comparing the Philippines with other countries, it ranked twelfth among the countries of the world in terms of total population. The Philippines is also among the countries of the world with a high annual population growth rate (2.36 percent) and is ranked fifth among Southeast Asian countries.

The median age of the Philippine population is 21 years old, which means, half of the population is below 21 years old. This makes the Philippines a country of mostly young people. The age structure of the Philippine population is a typical broad base at the bottom consisting of large numbers of children (Ages 0-14 years old is 28,313,897) and a narrow top made up of fairly small numbers of older persons. Approximately 52 percent of the Philippine population lives in rural areas (NSO 2007).

Dental services in the Philippines are mostly offered by the private dentists who are predominantly located in urban areas. It is basically paid “out of pocket” or through direct payment to the provider. Unfortunately not all Filipinos can afford the services of these private dentists. A huge majority of the population has never been to a dentist in their life.

The government through the Department of Health (DOH), the Department of Education (DepEd) and the Local Government Units (LGUs) provide care for specific target groups such as the under five children, school children, mothers, indigents, adults and the elderly. Unfortunately, there are only less than 2,000 public health dentists and school dentists to cater the needs of these specific target groups with a dentist to population ratio of 1:76,360 or as high as 1:120,000 in some regions of the country. This means that despite planned and good oral health programs for the Filipinos, these programs are not effectively implemented due to lack of manpower. The problem is further aggravated by financial resources wherein some successful pilot programs are not being sustained due to program funding.

The national government is primarily tasked to develop policies and guideline for local government units. In 2007, the Department of Health formulated the Guidelines in the Implementation of Oral Health Program for Public Health Services (AO 2007-0007).
The program aims to reduce the prevalence rate of dental caries to 85% and periodontal disease by to 60% by the end of 2016. The program seeks to achieve these objectives by providing preventive, curative, and promotive dental health care to Filipinos through a lifecycle approach. This approach provides a continuum of quality care by establishing a package of essential basic oral health care (BOHC) for every lifecycle stage, starting from infancy to old age.

Under the same Administrative Order, the Department of Health seeks to build healthy public policy by integrating oral health preventive programs in the prevailing general health promotional activities and campaigns. The department recognizes that in order to adopt a more sustainable approach in the delivery of basic health care to Filipinos, health programs should be upgraded and integrated with each other. For example, oral health will be regarded as a basic health component in the family and will be linked with other family health programs, such as maternal and child health, reproductive health, nutrition programs, and other departmental initiatives formulated against the plight of communicable diseases. One such campaign is the Garantisadong Pambata (GP), an institutionalized and multi-sectoral campaign that delivers essential packages of health services and relevant health information to children 0-14. This approach promotes work efficiency and advances the prioritization of oral health together with other public health agenda.

The Department of Education has its own oral health program for public school children ranging from health promotion and education, preventive and curative care to include the use of fluoride to prevent dental caries such as supervised toothbrushing with fluoride toothpaste, sodium fluoride mouthrinsing and topical application of fluoride gel among others. However, the services offered are limited in scope and rarely comprehensive and mostly emergency type in nature. A major reason behind this is the lack of adequate resources to provide the necessary dental equipment and materials for comprehensive treatment.

To complement the efforts of the government in promoting oral health to all Filipinos, the Philippine Dental Association together with all its 118 chapters, affiliates nationwide and specialty organizations have conducted and are continually initiating programs and projects, both preventive and curative, to address the dental needs to unserved and underserved population groups in the country. To name a few of the programs/projects are:

a. Visit your Dentist Campaign (1984) - This is a project intended to increase dental health consciousness among the major segments of the population. The project works on the assumption that people has the intrinsic fear to submit for dental treatment unless prodded by necessity. In effect, the campaign with the help of tri-media will penetrate the grassroots and invite them to clinics of participating members for free dental check-up.

b. Dental Health Education Program “Go for Good Oral Health” (1992)- The aim of this project is to utilize mass media, school and home materials with objective of increasing the knowledge of school children and mothers on good oral health. Selected elementary schools in unserved areas are the focus of the project where the school health facilities and personnel are meager and inadequate.

c. Adopt a School/Adopt a Barangay Project (1995-1999) - The general objective of this program is to enable each chapter or affiliate to provide effective dental health care in the selected barangay or public schools. This project started in 1995 with the objective to create awareness on oral health consciousness among the public school and to reach out to different barangays to provide dental health care.

d. “Sang Milyong Sepilyo” Project (1999-2000) - The project aimed to raise one million new kiddie toothbrushes, in order to promote awareness on the importance of oral health and oral hygiene practices. It was launched in 1999 wherein toothbrushes were collected from donors and distributed to poor and disadvantaged children throughout the country. Oral
health awareness and education activities were provided to the recipients of the toothbrushes.

e. Bright Smiles, Bright Futures Program (BSBF) (2002-2006) - It is a global oral health education program with the objective of giving teachers, children and families the tools they need to make oral health a permanent part of their lives.

f. FDI-PDA Live. Learn. Laugh Program (2006-present) - increasing oral health education and promotion in countries around the world. The partnership enables participating National Dental Associations (NDAs) to implement oral health projects locally.

g. “Zero Dental Caries Program” (1996-2001) - In line with the Declaration of Filipino Children’s Right to Good Oral Health, the PDA embarked on “Zero Dental Caries Program” with the Department of Health. Subjects are Grade 1 pupils will undergo yearly comprehensive check-ups and treatment for the next six years with the same treatment planning until the pupils reaches Grade VI.

h. Oral Health Promotion through Billboard Campaign (1996-present) - This program is about putting-up of billboards in strategic locations in their respective towns and/or barrios to help increase awareness of the public about the proper oral health.


j. “Healthy Month for a Healthy Well-Being” (2010) - A joint project of the Philippine Dental Association and ACS Manufacturing Corporation, the manufacturer of Unique Toothpaste. It has a mission of promoting oral and overall health to the public through providing free dental check-ups, oral health education, Unique toothpaste samples and toothbrushes.

There are also some non-government organizations, local and international, that provide limited assistance for the health of the Filipinos. Some of these groups are the USIAD, JICA, Unicef, Plan Philippines, Fit for School, Inc, Save the Children, Global Child Dental Health Taskforce among others. So far, only a few have strong, direct and clear assistance to oral health.

Oral Health Status

The prevalence of dental caries on permanent teeth has generally remained above 90% throughout the years. Minimal reductions were depicted in the (1987, 1992 and 1998) National Monitoring and Epidemiological Dental Survey (NMEDS) (Table 1) which may be attributed to the global trend of decreasing dental caries prevalence. Experts believed that the wide availability of fluorides from various sources contributed to the reduction. Government programs and private dental practitioners also introduced various methods of using fluorides that could have affected positive change.

Unfortunately, oral disease continues to be a serious public health problem in the Philippines. The two main oral health problems in the Philippines are dental caries and periodontal diseases. About 92.4% of Filipinos have tooth decay (dental caries) and 78% have gum diseases (periodontal diseases) (DOH, NMEDS 1998). Although preventable, these diseases affect almost every Filipino at one point or another in his or her lifetime.
The oral health status of Filipino children is alarming. The 2006 National Oral Health Survey (Monse B. et al, NOHS 2006) investigated the oral health status of Philippine public elementary school students. It revealed that 97.1% of six-year-old children suffer from tooth decay. More than four out of every five children of this subgroup manifested symptoms of dentinogenic infection. In addition, 78.4% of twelve-year-old children suffer from dental caries and 49.7% of the same age group manifested symptoms of dentinogenic infections. The severity of dental caries, expressed as the average number of decayed teeth indicated for filling/extraction or filled permanent teeth (DMFT) or temporary teeth (dmft), was 8.4 dmft for the six-year-old age group and 2.9 DMFT for the twelve-year-old age group (NOHS 2006).

Table 1: Prevalence of the Two Most Common Oral Diseases by Year, Philippines

<table>
<thead>
<tr>
<th>Year</th>
<th>Dental Caries</th>
<th>Periodontal Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>93.9%</td>
<td>65.5%</td>
</tr>
<tr>
<td>1992</td>
<td>96.3%</td>
<td>48.1%</td>
</tr>
<tr>
<td>1998</td>
<td>92.4%</td>
<td>78.3%</td>
</tr>
</tbody>
</table>

Filipinos bear the burden of gum diseases early in their childhood. According to NOHS, 74% of twelve-year-old children suffer from gingivitis. If not treated early, these children become susceptible to irreversible periodontal disease as they enter adolescence and approach adulthood.

In general, tooth decay and gum diseases do not directly cause disability or death. However, these conditions can weaken bodily defenses and serve as portals of entry to other more serious and potentially dangerous systemic diseases and infections. Serious conditions include arthritis, heart disease, endocarditis, gastro-intestinal diseases, and ocular-skin-renal diseases. Aside from physical deformity, these two oral diseases may also cause disturbance of speech significant enough to affect work performance, nutrition, social interactions, income, and self-esteem. Poor oral health poses detrimental effects on school performance and mars success in later life. In fact, children who suffer from poor oral health are 12 times more likely to have restricted-activity days (USGAO 2000). In the Philippines, toothache is a
common ailment among schoolchildren, and is the primary cause of absenteeism from school (Araojo 2003, 103-110). Indeed, dental and oral diseases create a silent epidemic, placing a heavy burden on Filipino schoolchildren.

Fluoride Utilization in the Country

The Enactment of Fluoridation Law in the Philippines

The optimum level of fluoride in drinking water recommended by WHO is 0.5-0.7 parts per million (ppm). The Philippine National Standards for Drinking Water specified the maximum limit of fluoride in drinking water which is 1mg/liter or 1 ppm. Data from the DOH Fluoride Analysis (1977-1999) and the NOHS, 2006 from various sampling points in the country showed that the level of fluoride naturally present in communal drinking water systems in the country is very nil to low which is 0.04-0.3 (NOHS, 2006) except in isolated communities in the country which have optimal levels of fluoride (0.4-0.6ppm) and some areas in Cavite Province which exceeded the optimum level for up to 2.80 ppm. Generally, the absence of the fluorine ion in the drinking water in the largest part of the country deprives young Filipinos of its anticariogenic benefit.

Cognizant that fluoridation is an effective public health preventive measure to reduce the incidence of dental caries, the then President of the Republic of the Philippines, Ferdinand Marcos authorized the release of funds for the purchase and installation of equipment and apparatus for the fluoridation program in the most populous area of the country which is Metro Manila. However it was only in 1983 that the installation of fluoridation system is completed and became operational. The system used sodium silico fluoride (Na2SiF6) for the program. The fluoridation of water supply in Metro Manila lasted only for 3 years hence the supply of Sodium Silico Fluoride was exhausted and never been replenished due to lack of government budget.

School Water Fluoridation

In the 70’s, almost one third (60 to 70%) of rural communities in the country have no communal water supply system which shows that majority of the population particularly in rural areas depend on rain water, deep well, river, spring, artesian well and etc. for the source of drinking water supplies. It is that these geographically areas without the water supply system that the innovative approach to the utilization of fluoride e.g. school water fluoridation have their greatest appeal and the answer to the community constrained on fluoridation among developing countries.

In 1976, the feasibility of School Water Fluoridation as a public health measure in the country was studied targeting 6 to 12 years old school children in a community with nil fluoride content in the sources of drinking water. The method uses innovative approach to the utilization of fluoride systematically that make use of simple container made of polyethylene and no fluoridation machine will be used. Chemicals used was hydrofluosilisic acid (H2SIF6), a clear colorless liquid with a commercial strength of 30% and fluoride content of 23.7%. at acceptable dose in millilitre H2SIF6 is...
mixed to a gallon of water with level of fluoride at 2.25 ppm. Each child must have to consume 2 to 3 glasses of water every day in a swish and swallow procedure to attain the maximum reduction of 40% to 60% in caries incidence after years of implementation.

After one year of implementation there was an increase of 0.9646 in the Mean DMFS/child for the treatment group compared to the control group which has an increase of 1.4138 Mean DMFS/child. It was anticipated that after 5 years of the study, there will be a significant reduction in the incidence of dental caries for the treatment group after drinking fluoridated water.

Following the success of the School Water Fluoridation, the approach was duplicated in several schools all over the country. Other schools used the indigenous clay pot “Banga” instead of the polyethylene container.

**Controlled Water Fluoridation Projects**

To determine the effectiveness, safety and applicability of controlled water fluoridation as a preventive measure against dental caries in local conditions, the water Fluoridation Project in Limay, Bataan was conducted in 1980, with two pumphouse serving approximately 809 households. However, the fluoride water treatment was stopped intermittently due to various technical problems which shortened its actual implementation from 5 years to two years and two months for pump No. 1 and one year and four months for pump 2. Subjects utilized for evaluation of the study were public schoolchildren aged 7-14 years. They were classified into Groups A and B based on which pump is serving them. School children aged 7-14 years from adjoining town of Mariveles, where there was no water fluoridation served as the control group.

Group A and B showed lower percentage of caries prevalence than the control group. No dental fluorosis was observed among the subjects involved. Using t-test, a significant difference was observed in the mean DMFT between groups A and B. The results suggest that water fluoridation is effective in controlling dental caries even if implemented for a short period of time, for children 7-14 years old.

The result of evaluation also identified various technical and organizational problems peculiar to our locals which cropped up and contributed to the decrease effectiveness of the system. These technical problems are as follows:

1. The frequent breakdown of fluoride chemical feeder and spectrophotometer which forced the stoppage of fluoridation.
2. Corrosion of pipes and fittings installed along feeder line which required replacements that took a great deal of time, causing disruption in the operation of the project.
3. The personnel assigned were not hired exclusively for this fluoridation project. The task assigned to them in connection to fluoridation i.e. water sampling and fluoride analysis, were just additional responsibilities, thus, water sampling and fluoride analysis were not done regularly.

In the light of these findings, the control of dental caries can be successful to a great extent and the prevalence of the disease will be reduce more significantly if fluoridation is implemented continuously for a longer period of time. This can be accomplished if the following are considered, should the fluoridation project is reactivated:

1. A spare fluoride chemical feeder and spectrophotometer should be provided to serve as an alternative in case the one in use broke down to insure the continuous operation of the project.
2. PVC pipes and fittings should be used in the fluoridation system to prevent corrosion of pipes and fittings due to acid.
3. Personnel should be assigned exclusively for the fluoridation project alone.
4. The most important is a regular budget allocation should be provided for its day to day operation and maintenance.
0.2 % Sodium Fluoride Solution as Mouthrinse

The effect of 0.2% sodium fluoride mouthrinse in the prevention of dental caries on school children was first studied in San Jose City, Nueva Ecija, a non-fluoridated community, in 1967-1968. After one year of program implementation 27.82% reduction in dental caries increment on permanent teeth already erupted for some time in the oral cavity was observed. Although the reduction was not significant on the first year, the decrease was quite significant on the second year (33.33% with a t-value of 2.3092). In view of this encouraging result the same studies were conducted also in various areas all over the country (Sto. Tomas, Pampanga, Bamban, Tarlac, Sta. Barbara, Iloilo Agusan del Sur, Davao, Rizal and etc) to verify observations obtained in San Jose City.

The Sta. Barbara, Iloilo study gives us the following facts:

1. The 3-minute mouthrinsing of 0.2% sodium fluoride every two weeks by children in schools produces some reduction on the progress of dental decay although not significant, after the first year of program implementation;
2. After the second year of program exposure, the anticariogenic effect on permanent tooth already erupted for sometime is quite significant (38.70% reduction);
3. For newly erupted teeth the procedure causes a highly significant reduction of dental caries (71.84%);
4. The preventive measure can be made outside a dental clinic since the patients can institute self application;
5. That the measure can render caries protection en masse supervised by a dental auxiliary;
6. The measure is safe, practical, cheap and does not require too much of Dentist’s time.

Because of its feasibility and effectiveness in the prevention of dental caries by as much as 35%, Weekly Mouthrinsing with Fluoride Solution (0.2% Sodium Fluoride) was implemented in schools for children 7-12 years old or children in Grades 1-VI in public schools nationwide. The following guidelines in its implementation in schools were developed:

a. In a one-liter plastic bottle/pitcher, place first 2 grams of sodium fluoride powder. Add plain water up to 1,000 cc. Stir the solution with plastic rod or wooden stick. Avoid using glass container and rod because chemical reaction will take place between the glass and fluoride powder.
b. School children are assembled outside the classroom either by class/section or en masse. All children must have plastic cup or tumbler.
c. Right after the supervised toothbrushing drill, the teacher will dispense or distribute 10 cc of the prepared 0.2% sodium fluoride solution in each child’s plastic tumbler/cup.
d. School children will swish and rinse their mouth with 10 cc of 0.2% sodium fluoride solution holding it in the mouth for one minute. The fluoride solution should not be swallowed by the children.
e. After one minute of vigorous rinsing, let the children throw out or spit out the solution.
f. This exercise shall be done once a week.

Topical Application of Fluoride Solution

In 1973 topical application of 8% stannous fluoride solution was introduced in the country in the Unicef Assisted MCH-Dental Integrated Projects (Demonstration Clinic). However, with the positive cariogenic effect of the use of 0.2% Sodium Fluoride Solution as mouthrinse in schools, the Department of Health (DOH) through the Bureau of Dental Health Services (BDHS) in 1975 instructed that the Unicef
assisted MCH-Dental Integrated Projects will adopt the use of 0.2 Sodium Fluoride Solution as Mouthrinse instead of the topical application of stannous fluoride solution which method is too costly in manpower and materials for the prevention and control of dental caries.

In private dental clinics nationwide, the topical application of Fluoride, in the form of gel, varnish or rinse is a routine procedure for children receiving dental care. Application interval varies from 3 to 6 months depending on the caries risk assessment of the child. In cases where caries risk is high an adjunct home care program is also advised using CPP-ACP mousse.

Use of Wild Tea “Tsaang Gubat” (Ehretiamicrophylla Lam.)

In 1995, the Department of Health, Department of Education, Department of Agriculture and the Philippine Dental Association piloted the use of a locally herbal plant known as “Tsaang Gubat” as source of fluoride to reduce the occurrence of tooth decay among children. This herbal plant is used as a tea drink for children 1-12 years old at home or in school. To attain its optimum efficacy by as much as fifty percent caries incidence reduction, children have to consume one glass of tsaang gubat tea every day in a swiss and shallow method (Age one year - ¼ cup daily, ages 2-3 years old - ½ cup daily and ages 4-12 years old - 1 cup daily). To enhance its taste, a little amount of sugar and milk/calamansi (lemon) can be added to the tea.

The use of this indigenous source of fluoride was not completely implemented in schools or even at home for the reason that schools cannot generate sufficient amount of tsaang gubat plants for the school children daily use. It became also a concern by parents and stakeholders of the negative health effects of over ingestion of tsaang gubat tea to children which might lead to constipation. However, until now Tsaang gubat is one among the ten herbal plants being endorsed in the Philippines for its medicinal use and as source of fluoride to prevent dental caries.

Fluoride in Toothpaste

The use of fluoride toothpaste in brushing the teeth is an effective way of reducing dental caries by as much as 20%-30% reduction.

Toothpaste is widely use in the country. There are varieties of toothpastes available in the Philippines containing fluoride as high as 1.450 ppm as recommended by the World Health Organization. The availability of fluoride toothpastes all over the country explains the rationale behind most child health programs in the country are promoting regular brushing of teeth with fluoride toothpaste especially for children and advocating supervised toothbrushing drills with fluoride toothpaste in schools and day care centers. However, not all communities/families/individuals can afford to buy fluoride toothpaste and even have their own toothbrush in cleaning their teeth at home which is not a basic need.

Toothpastes companies have also contributing a lot in the activities of the dental profession by providing limited number of fluoride toothpastes and toothbrushes and Informative and educational materials for school based programs/projects (Bright Child, Bright Future and SMILE). However, these are not enough to provide the child with adequate exposure to fluoride toothpaste for the whole year and throughout the child’s stay in the public school. In effect, the program is deemed not effective because of inadequate exposure to fluoride in toothpaste.

Aside from these, the Philippine Pediatric Dental Society, Inc. (PPDSI) is continually conducting policy review and researches on fluorides as basis in formulating policies, standards and guidelines on the use of fluoride for the prevention of dental caries to children in the country. Recommendations from professional organizations such as the PDA and PPDSI will serve as basis for the government (DOH) to formulate national policy on fluoride use.
Recommendations:

Fluoridation of community water supplies, as shown by studies is the least expensive and most effective way to provide fluoride to large group of people. Thousand of studies of prominent researchers throughout the world have shown that children who consume optimally fluoridated water from birth have 50 to 65 percent less dental decay than they would experience without fluoridation. Following these findings, the per capita cost of dental treatments like fillings is also greatly reduced. The entire community benefits from the procedure regardless of socio-economic level, educational achievement, individual motivation or the availability of the dentist. No cooperative effort or direct action need be taken by those who will benefit. Moreover, the improvement for dental health continuous for life if consumption of fluoridated water continues.

Muhler and co-worker suggested that use of multiple fluoride treatments might more or less nearly achieve a goal of complete caries protection so that in spite of the wide use of toothpaste with fluoride, topical application of fluoride gel done by private practitioners throughout the country and the use of sodium fluoride mouthrinsing for children in schools, fluoridation of communal water supply is still a must in our public health program.

However, if the above methods are not possible for some reasons, the use of fluoride toothpaste in brushing the teeth as early as the first tooth erupts is the best source of fluoride to prevent dental caries.

The Child Health Global Task Force which has been created in the Philippines recommended the following strategies to promote the use of fluorides in the country.

1. Formulation of national policies on fluoride and ensure funding and support to previous studies on the use of fluoride in the country.
2. Strengthen the advocacy for use of affordable fluoride toothpaste and the importance of toothbrushing with fluoride toothpaste in the prevention of dental caries
3. Strengthen public-private partnership such as;
   a. involvement of toothpaste companies in the development and repacking of affordable fluoride toothpastes to enable government to purchase adequate supplies for community health programs and ensure the effective and efficient implementation of daily toothbrushing in schools and day care centers
   b. Involvement of private dental practitioners through the Philippine Dental Association in school based, community based fluoride utilization programs.
   c. Involvement of specialty groups specially those in pediatric dentistry in coming up of policy recommendations on the use of fluorides for children and the training of dentists on the use of fluorides in the prevention of dental caries.
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Public Use of Fluoride for the Prevention of Dental Caries in Korea

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²Korean Dental Association, Korea

Part 1. Overview of the South Korea.

The population of South Korea recorded 48,215 thousand persons in November 1st 2010. Among them, 24,045 thousand persons were male and 24,174 thousand persons were female.

In South Korea, there are seven metropolitan cities and nine provinces, the population of Seoul Metropolitan Area was 23,616 thousand persons, which accounted for 49.0 percent of the total population. The population in Gyeonggi marked 11,270 thousand persons, occupying the largest share (23.4 percent) of the total population. Seoul marked 9,708 thousand persons, occupying 20.1 percent. Busan marked 3,403 thousand persons, occupying 7.1 percent. Gyeongnam marked 3,154 thousand persons, occupying 6.5 percent. By comparison with the number of the age groups, 0-6 year olds were 3,596 thousand persons, 12 year olds were 698 thousand, 15 year olds were 632 thousand, 35-44 year olds were 8,226 thousand, and over 65 year olds were 5,215 thousand. The number of the elderly people was increased rapidly, from 7.2% in 2000 to 10.7% in 2010. In 2009, the life expectancy at birth for both genders recorded 80.5 years. The life expectancy at birth for males and females marked 77.0 years and 83.8 years, respectively. The difference in the life expectancy between the two genders was 6.8 years.

Table 1. Total population

<table>
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<th>2005</th>
<th>2010</th>
<th>change</th>
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<td>Females</td>
<td>23,655</td>
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Table 2. Population by metropolitan city and province

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<tr>
<th></th>
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<th>2005(B)</th>
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<td>Seoul Metropolitan Area</td>
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<td>1,014</td>
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<td>1,049</td>
<td>2.2</td>
</tr>
<tr>
<td>Provinces</td>
<td>23,887</td>
<td>51.8</td>
<td>25,030</td>
<td>52.9</td>
</tr>
<tr>
<td>Gyeonggi</td>
<td>8,984</td>
<td>19.5</td>
<td>10,415</td>
<td>22.0</td>
</tr>
<tr>
<td>Gangwon</td>
<td>1,487</td>
<td>3.2</td>
<td>1,465</td>
<td>3.1</td>
</tr>
<tr>
<td>Chungbuk</td>
<td>1,467</td>
<td>3.2</td>
<td>1,460</td>
<td>3.1</td>
</tr>
<tr>
<td>Chungnam</td>
<td>1,845</td>
<td>4.0</td>
<td>1,889</td>
<td>4.0</td>
</tr>
<tr>
<td>Jeonbuk</td>
<td>1,891</td>
<td>4.1</td>
<td>1,784</td>
<td>3.8</td>
</tr>
<tr>
<td>Jeonnam</td>
<td>1,996</td>
<td>4.3</td>
<td>1,820</td>
<td>3.8</td>
</tr>
<tr>
<td>Gyeongbuk</td>
<td>2,725</td>
<td>5.9</td>
<td>2,608</td>
<td>5.5</td>
</tr>
<tr>
<td>Gyeongnam</td>
<td>2,979</td>
<td>6.5</td>
<td>3,056</td>
<td>6.5</td>
</tr>
<tr>
<td>Jeju</td>
<td>513</td>
<td>1.1</td>
<td>532</td>
<td>1.1</td>
</tr>
</tbody>
</table>
According to the Korean National Oral Health Survey from 2000 to 2010, the caries (D) prevalence rate of the 12-year old was decreased rapidly from 42% to 20%. The tendency of the reduction was the similar in metropolis to rural areas, but the rural area shows a somewhat high rate of caries (Table 3). The caries experience (DMFT) rate among 12-year olds was also decreased by year, but still high (Table 4).

The mean DMFT was 3.3 in 2000 while 2.08 in 2010. Depending on the time pass by, the number of the untreated caries was the decrease dramatically, 1.10 to 0.43 (Table 5). The rate of calculus formation showed to somewhat decline among 35-44 year olds, but the number of the teeth with shallow pocket was slightly increased (Table 6).

Table 3. Prevalence of caries by regions from 2000 to 2010 (12-yr old)%

<table>
<thead>
<tr>
<th>Region</th>
<th>2000</th>
<th>2003</th>
<th>2006</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>42.0</td>
<td>49.7</td>
<td>23.7</td>
<td>19.8</td>
</tr>
<tr>
<td>Metropolis</td>
<td>35.9</td>
<td>50.7</td>
<td>19.0</td>
<td>19.1</td>
</tr>
<tr>
<td>Cities</td>
<td>45.7</td>
<td>51.0</td>
<td>22.5</td>
<td>19.2</td>
</tr>
<tr>
<td>Rural area</td>
<td>57.2</td>
<td>43.3</td>
<td>41.6</td>
<td>25.6</td>
</tr>
</tbody>
</table>

Table 4. Prevalence of dental caries experience of 12-yr old from 2000 to 2010

<table>
<thead>
<tr>
<th>Region</th>
<th>2000</th>
<th>2003</th>
<th>2006</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>77.1</td>
<td>75.8</td>
<td>61.1</td>
<td>60.5</td>
</tr>
<tr>
<td>Metropolis</td>
<td>73.7</td>
<td>78.1</td>
<td>59.4</td>
<td>60.1</td>
</tr>
<tr>
<td>Cities</td>
<td>79.7</td>
<td>75.5</td>
<td>60.2</td>
<td>59.7</td>
</tr>
<tr>
<td>Rural area</td>
<td>83.2</td>
<td>70.0</td>
<td>68.7</td>
<td>65.3</td>
</tr>
</tbody>
</table>

Table 5. Mean caries indices of 12-yr old from 2000 to 2010

<table>
<thead>
<tr>
<th>Yr</th>
<th>DT</th>
<th>MT</th>
<th>FT</th>
<th>DMFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>1.01</td>
<td>0.03</td>
<td>2.26</td>
<td>3.30</td>
</tr>
<tr>
<td>2003</td>
<td>1.50</td>
<td>0.02</td>
<td>1.72</td>
<td>3.25</td>
</tr>
<tr>
<td>2006</td>
<td>0.58</td>
<td>0.01</td>
<td>1.58</td>
<td>2.17</td>
</tr>
<tr>
<td>2010</td>
<td>0.43</td>
<td>0.01</td>
<td>1.64</td>
<td>2.08</td>
</tr>
</tbody>
</table>
Table 6. Conditions of the gingival health among 35-44 year olds by CPI

<table>
<thead>
<tr>
<th>yr</th>
<th>H</th>
<th>B</th>
<th>C</th>
<th>P1</th>
<th>P2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Both sex</td>
<td>9.67</td>
<td>8.78</td>
<td>58.83</td>
<td>18.48</td>
</tr>
<tr>
<td>2000</td>
<td>Males</td>
<td>7.71</td>
<td>7.12</td>
<td>57.84</td>
<td>21.71</td>
</tr>
<tr>
<td></td>
<td>Females</td>
<td>11.73</td>
<td>10.51</td>
<td>59.87</td>
<td>15.09</td>
</tr>
<tr>
<td></td>
<td>Both sex</td>
<td>13.53</td>
<td>11.60</td>
<td>52.72</td>
<td>19.68</td>
</tr>
<tr>
<td>2003</td>
<td>Males</td>
<td>8.80</td>
<td>11.27</td>
<td>54.58</td>
<td>22.18</td>
</tr>
<tr>
<td></td>
<td>Females</td>
<td>18.25</td>
<td>11.93</td>
<td>50.88</td>
<td>17.19</td>
</tr>
<tr>
<td></td>
<td>Both sex</td>
<td>28.20</td>
<td>15.1</td>
<td>47.30</td>
<td>7.00</td>
</tr>
<tr>
<td>2006</td>
<td>Males</td>
<td>19.40</td>
<td>13.60</td>
<td>54.90</td>
<td>8.90</td>
</tr>
<tr>
<td></td>
<td>Females</td>
<td>36.80</td>
<td>16.50</td>
<td>39.80</td>
<td>5.20</td>
</tr>
<tr>
<td></td>
<td>Both sex</td>
<td>21.80</td>
<td>4.70</td>
<td>43.70</td>
<td>23.70</td>
</tr>
<tr>
<td>2010</td>
<td>Males</td>
<td>17.00</td>
<td>3.13</td>
<td>41.90</td>
<td>29.60</td>
</tr>
<tr>
<td></td>
<td>Females</td>
<td>26.80</td>
<td>6.30</td>
<td>45.60</td>
<td>17.60</td>
</tr>
</tbody>
</table>

*H : No signs for disease, B : Bleeding, C : Calculus, P1 : Pocket depth 4 or 5 mm, P2 : Pocket depth over 6 mm*
Part 2. Fluoride uses in South Korea

1. Water fluoridation

Korean water fluoridation has started since 1978 by Oral Health Team consisting of government officials, professors, and dentists. At that time, the Ministry of Health and Society investigated localized actual conditions, analyzed the feasibility of the project, and established rules about water fluoridation. Pilot water fluoridation started in Jinhae 1981, Chungju 1982. World Health Organization sent foreign technical consultants and oral health prosecutors, and examined pilot water fluoridation. In 1988, the department of preventive dentistry, college of school, Seoul National University evaluated the projects, held seminar about water fluoridation, and discussed branching out methods of water fluoridation.

Korean Dental Association and Dental Association of Health Society urged expansion of water fluoridation because of the excellent cost benefit effect. Dental Association of Health Society began a campaign to urge the extension of water fluoridation and held research exhibitions, symposiums, and national meetings to push water fluoridation. Moreover, in a national scale, a union comprised of non-governmental organizations which are interested in water fluoridation urged to spread it all over the nation. However, only 3.5% of Korean people were supplied fluoridated water in 1997. But, as the efforts of the government and associated organization, the number of the population who use fluoridated water increased slowly up to 11% of the entire population in 2000.

However, these efforts confronted difficulties. Moreover, just merely few water fluoridation areas were chosen as a sample area of Korean oral health examination, and the number of the community health centers which carried out water fluoridation decreased from 2000 to 2009. In 2009, about 2,820 thousand people which is almost 5.8% of the entire populations from 21 cities use fluoridated water (Fig.1)

---

*Figure 1. The Number of the cities and areas with water fluoridation service*
The reason of discontinue water fluoridation is an argument about harmful effect of fluoride especially interested by environmentalists. Chungju city investigated a survey about water fluoridation in 2003, and the result showed that disagreements (49%) are more than agreements (45.2%). Consequently, water fluoridation discontinued in 2004.

Now, it is difficult to extend water fluoridation all over the nation because of false claims by some environmentalists. So, the oral health team in the ministry of health and welfare reorganized the related organization, and established new managing system (Fig. 2) and support new approached, such as an advertisement and oral health education to the public. The annual budget of the education for the public is almost one hundred thousand USD since 2007. From 2010, some cities were considered about the implementation of water fluoridation service, so many seminars and public hearings were held.

Especially, year 2011 is the 30th anniversary of the water fluoridation service in Korea, so we plan to hold a symposium, campaign and exhibitions.

### 2. Individual use of Fluoride

According to the research, most tooth pastes (92.5%) made in Korea contains fluorides. Also, other research reported that tooth pastes containing fluorides showed a market share of 99 percentages. So, the percentage of people who use fluoride toothpaste was reported from 97.4% (2000) to 99.3% (2004).

A project of tooth brushing with fluoride rinsing was accepted by elementary schools due to the policy of the Ministry of Health and Well-fare in 1974. That project had a basic instruction to brush teeth with mouth

<table>
<thead>
<tr>
<th>Year</th>
<th>Main events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980. 11</td>
<td>Establishment of provision (Rule 412) on water fluoridation</td>
</tr>
<tr>
<td>1981. 04</td>
<td>Started pilot water fluoridation service in Jinhae city in Gyeongnam province</td>
</tr>
<tr>
<td>1982. 02</td>
<td>Started the water fluoridation service in Chungju city in Chungbuk province</td>
</tr>
<tr>
<td>1985-1987</td>
<td>Evaluated the effect water fluoridation service (Jinhae, Chungju)</td>
</tr>
<tr>
<td>1992-1995</td>
<td>Evaluated the effect water fluoridation service (Chungju)</td>
</tr>
<tr>
<td>1994</td>
<td>Expanded to national wide starting in Gwacheon</td>
</tr>
<tr>
<td>1995. 01</td>
<td>Established the National Health Service: regulating water fluoridation</td>
</tr>
<tr>
<td></td>
<td>Started the water fluoridation in Pohang</td>
</tr>
<tr>
<td>1998</td>
<td>Started the water fluoridation in Jinju</td>
</tr>
<tr>
<td>1999</td>
<td>Started the water fluoridation in Wolsan, Kimhae</td>
</tr>
<tr>
<td>2000</td>
<td>Established the oral health measure: regulating water fluoridation service</td>
</tr>
<tr>
<td></td>
<td>Revision of the law of the oral health: water fluoridation</td>
</tr>
<tr>
<td></td>
<td>Established of ‘water fluoridation technical supporting committee’</td>
</tr>
<tr>
<td>2006. 02</td>
<td>Reorganized of ‘oral health promotion supporting committee’</td>
</tr>
<tr>
<td>2008. 11</td>
<td>Started the water fluoridation in Keoje</td>
</tr>
</tbody>
</table>
rinsing of 0.05% NaF solution. But, most of the schools modified that program and implemented it with 0.2% NaF mouth rinsing programs. Only a small number of the schools adopted 0.05% NaF mouth rinsing with tooth-brushing program.

According to the National oral health survey data (2006), the number of the people who use fluoride mouth rinse solution every day was 12% of the total population. Most of them are metropolitan and city inhabitants, and only 5.6% were rural area residents.

One research (2008) showed 26.1% preventive effect of dental caries on permanent teeth when the program of tooth brushing with 0.2% NaF mouth rinsing was established during 3 years in elementary schools.

3. Professional use of fluoride
Fluoride topical applications are used widely especially in pediatric dental clinics. Although there is no research about fluoride topical application of private dental clinics, many parents used to go to pediatric dental clinic with their children and recently children (6 ages older) have lower prevalence rate than past time (Table 4, 5). In 1992, the Korean first private pediatric dental clinic (Children Dental Clinic) was established and now there are many pediatric dental clinics more than 100 only registered in Korean Academy of Pediatric Dentistry. The increasing number of pediatric dental clinics and interests on pediatric dentistry may reduce the prevalence rate of dental caries.

4. Evaluations and outcomes
In the toothpaste market, most tooth pastes (99%) contain fluorides and these prices are not expensive and supplies also enough. Hence, most Korean people can get fluorides tooth pastes easily. However, water fluoridation is not supplied widely at most only 5.8% in 2009 due to arguments about harmful effects of fluorides. Moreover, fluoride topical applications are considered as expensive treatments by Korean people and mostly used at private dental clinic. Therefore, fluoride topical applications are primarily used on children whose patients having dental interests and not financial difficulties.

To be sure, Korean government also took actions related other fluorides. Korean community health centers took a project that instructed TBI with mouth rinsing of fluorides gargle solution in 2000(3,096,618), 2003 (5,361,477), 2006 (2,480,383) (Ministry of...
Health & Welfare, 2008). Although this project has a decreasing tendency, it widely used especially till 2003 and most Korean people use fluoride toothpastes. Thus it may have a considerable effect on reducing dental caries. Especially DMFT index decreased from 3.3 (2003) to 2.2 (2006). These results are meaningful in that oral health trends can be changed. Oral health projects, which have been taken by Korean government such as sealants, TBI with fluorides rinsing, water fluoridation, are effective and improve oral health condition. However, it is still inferior to OECD (DMFT index: 1.6) and necessary to extend widely water fluoridation and other public method to use fluoride for prevention of dental caries.

Part 3. Our future plan

From early 1970’s, Korean Ministry of Health and Welfare foster the people to use fluoride as a main methods of dental caries prevention, through local public health centers. They only develop new policy, which was not fully supported by the public, and implemented by the local administration organization. Also community-based oral health education was not accomplished successfully. Lack of the need assessment of people, it was a very difficult problem to get a support of the public.

Now, we change our strategy to the public, although it is hard to drive a new public health program, we exchange our thought and plan with the people and seek the right solution together. And include concerning people as many as possible.

Also, we consider other preventive methods, such as milk fluoridation or salt fluoridation, and include the fluoride topical application to an item of insurance coverage.

Moreover, we try to emphasize the importance of the prevention than treatment by all means to the people. The Health plan 2020 of Korea belaboured the whole life health as one of the important goals to be accomplished, therefore every efforts should be applied to improve oral health properly.
Part 1: Brief country profile

Singapore is a small and compact island nation measuring 710.2 km² lying off the southern tip of Peninsular Malaysia. Its total population stands at 5.08 m comprising 74.4% (3.77 m) residents and 25.6% (1.30 m) of an expatriate workforce.

With no natural resources of its own, Singapore relies primarily on its strategic location and manpower for economic growth. Its major industries are finance, trade, and tourism and more recently information technology and biomedical research and development.

Today the nation is ranked among the top 10 global cities in the world alongside New York, London, Tokyo, Hong Kong, and Sydney in terms of economic, political, cultural, and infrastructural development. WHO has also ranked Singapore’s healthcare system the 6th in the world based on overall health system performance.

Singapore’s current per capita GDP is US$36,537 and has a healthcare budget of 4.0% of the GDP. Dental Healthcare however comprises only 2.5% of the overall healthcare budget.

In 1958, Singapore was the first country in Asia to implement a community water fluoridation program covering 100% of its population. With universal coverage via a municipal water supply (there is only one water utility in Singapore, the Public Utilities Board), Singapore does not have to depend on other communal forms of fluoride delivery.

Professionally applied fluoride vehicles are available for patients with high risk of dental caries and include fluoride varnishes and gels. However, silver fluorides/silver diamine fluorides are not available locally.

Fissure sealants are also routinely placed for high risk children in the School Dental clinics which provide ‘free’ dental services to all (100%) school going children of age 6-18 years.

Fluoridated toothpastes and mouthrinses are available for self-use in Singapore and empirical observation suggests that majority of dentifrices are fluoridated. However, some manufacturers have increasingly marketed non-fluoridated toothpastes containing other “substitute” proprietary ingredients such as chlorhexidine, triclosan, and even green tea.
Some South Asian migrants still use traditional cleaning powders or pastes instead of fluoridated toothpastes. This number could possibly increase with the increasing number of immigrants from the Indian subcontinent.

The latest survey undertaken by the Health Promotion Board in 2003 on the dental caries prevalence of school children in Singapore found the DMFT for 12 year olds to be 0.54. A more recent examination of 1,782 preschoolers aged 3-6 years undertaken in 2005 found that about 40% of the study group had dental caries.

The mean deft (SD) of 3-4, 4-5, and 5-6 year olds were 0.70 (1.78), 1.40 (2.68), and 2.03 (3.07) respectively. This study also found that 16% of the children carried 78% of the burden of disease and that 16.5% of children suffered from rampant caries (defined in the study as caries affecting smooth surfaces of 2 or more maxillary incisors). It was also reported that the caries experience and levels of unmet treatment needs were much higher among children of lower socioeconomic status and the indigenous population.

Part 2: Public uses of fluoride in Singapore

Loh reported that the prevalence of dental caries in school children was as high as 95% in the 1940s and early 1950s. The School Dental Service was established in 1949, in response to the high unmet dental needs of school children. There were few dentists in Singapore in the early 1950s and dental auxiliaries (similar to the New Zealand type school dental nurse) were employed in the School Dental Service to provide cost-effective primary dental care. The School Dental Service currently provides heavily subsidized dental treatment to all school going children 6 to 18 years of age.

The authorities at that time realized that the enormity of the scope presented by the prevalence of dental caries could not be managed by a purely curative approach. Discussions to fluoridate the water supply were undertaken in the mid 1950s and the decision to implement water fluoridation was approved by the government in 1954. Fluoridation was first implemented on an experimental basis in May 1956 and by January 1958, the entire water supply of Singapore was fluoridated. There were no reports of anti-fluoridation activities or calls for referenda then.

Based on the formula derived by Galagan and Vermillion, Singapore’s water was initially fluoridated at 0.7 ppm using a dry feeder distribution system and sodium silicofluoride as the derivative fluoride compound. A 1989 study on the developmental defects of enamel (DDE) including fluorosis was conducted on 2,090 children aged 11 to 13 years. In this sample, it was reported that 83.3% of the children used fluoridated toothpaste before 6 years old and while 61.9% had no or questionable fluorosis, 26.6% had very mild fluorosis and 10.5% mild fluorosis. This was a huge increase from the earlier findings of 1970, when it was reported that less than 5% of children had a very mild form of fluorosis. The Community Fluorosis Index (CFI) based on the 1989 study was 0.56 which was deemed to be bordering onto a CFI of 0.60 (which may warrant consideration as a public health concern).

The results of this study on DDE and fluorosis together with reports from the downward adjustment of the levels of fluoride in Hong Kong’s drinking water from 1.0 ppm in 1967 to 0.7 ppm in 1978, and finally to 0.5 ppm in 1988 prompted the Ministry of Health to lower the fluoride levels from 0.7 to 0.6 ppm as of January 1992, and a further reduction to 0.5 ppm in January 2008 where it has since remained unchanged.

Since its implementation, water fluoridation has been the mainstay caries preventive measure in Singapore. Other vehicles of fluoride delivery are also available for use by the professional (fluoride varnishes and gels) or individual (fluoridated toothpastes and mouth rinses). These are shown in Table 1. Unfortunately, there are no local data on the availability, accessibility, affordability, acceptability or coverage of these other forms of fluoride.

Local guidelines concerning the use of professionally applied fluorides are however similar to international practices, which is the judicious and selective use of these fluoride vehicles for patients at high risk of dental caries.
The Health Science Authority (HSA) of Singapore has also set guidelines regarding the maximum concentration of fluoride that can be present in dentifrices that are imported into Singapore. Toothpastes available can be divided into those for children and those for adults based on the content of fluoride concentration.

Currently, the product with the highest concentration of fluoride available “over-the-counter” locally is Colgate’s Neutrafluor 220 Daily Fluoride Rinse (0.05% w/w neutral sodium fluoride). Toothpastes with much higher concentrations of fluoride (i.e. 5000 ppm) are not available but there are ongoing discussions with the relevant health authorities to introduce Neutroflor toothpaste (5000 ppm) into Singapore.

### Outcomes in Dental Caries Control

In 1957, a baseline study was undertaken before the implementation of water fluoridation. The study comprised annual surveys conducted over a ten year period to evaluate the reduction of dental caries. Children in the control group were selected from schools in unfluoridated Malacca, West Malaysia. Each year, a total of 2,200 Malay and Chinese children aged 7 to 9 were selected from Singapore and Malacca.

The results showed a decline in primary dentition caries experience by 30.8% of the Singapore children, whereas there was no corresponding decline among the Malacca (control) group. For the permanent dentition, the Malaccan Malays experienced an increase of 63.1% in caries experience compared with a decrease of 31.0% in Singaporean Malays. On the other hand, Malaccan Chinese children showed an increase of 21.6% in permanent caries experience compared to their Singaporean peers who experienced a reduction of 52.3%. The greater reduction in caries experience in the Chinese was reported to be due to the higher prevalence of dental caries over their Malay counterparts.

Subsequent surveys by various authors have reported steadily declining dental caries experience in school children aged 6 to 18. A composite of these various findings are shown in Table 2. For example, Lo and Bagramian reported that sequential school dental surveys carried out by the Ministry of Health showed an

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**Table 1. Public uses of fluoride in Singapore**

<table>
<thead>
<tr>
<th>Type of fluoride regime</th>
<th>Name of fluoride vehicle</th>
<th>Current status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community</td>
<td>Water fluoridation</td>
<td>100% coverage since 1958</td>
</tr>
<tr>
<td></td>
<td>Milk fluoridation</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Salt fluoridation</td>
<td>NA</td>
</tr>
<tr>
<td>Self-use by individuals</td>
<td>Fluoridated toothpastes</td>
<td>Available</td>
</tr>
<tr>
<td></td>
<td>Fluoride mouthrinses</td>
<td>Available</td>
</tr>
<tr>
<td></td>
<td>Fluoride supplements</td>
<td>NA</td>
</tr>
<tr>
<td>Professionally applied</td>
<td>Fluoride varnishes</td>
<td>Available</td>
</tr>
<tr>
<td></td>
<td>Fluoride gels</td>
<td>Available</td>
</tr>
<tr>
<td></td>
<td>Silver fluorides/silver diamine fluorides</td>
<td>Not available locally, individual professionals have to order from overseas</td>
</tr>
</tbody>
</table>

---
Table 2. Mean dmfta and DMFT scores for various age groups in Singapore

<table>
<thead>
<tr>
<th>Age</th>
<th>Year</th>
<th>Mean dmft/DMFT</th>
<th>Source†</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 (DMFT)</td>
<td>1970</td>
<td>0.41</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1979</td>
<td>0.39</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1984</td>
<td>0.15</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1989</td>
<td>0.13</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1994</td>
<td>0.09</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>2.03</td>
<td>6</td>
</tr>
<tr>
<td>6-11 (DMFT)</td>
<td>1970</td>
<td>2.6</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>1979</td>
<td>2.1</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>1984</td>
<td>1.9</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>1989</td>
<td>1.3</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>1994</td>
<td>1.1</td>
<td>10</td>
</tr>
<tr>
<td>12 (DMFT)</td>
<td>1970</td>
<td>2.97</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1979</td>
<td>2.84</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1984</td>
<td>2.47</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1989</td>
<td>1.39</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1994</td>
<td>0.98</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>2003</td>
<td>0.54</td>
<td>5</td>
</tr>
<tr>
<td>12-18 (DMFT)</td>
<td>1970</td>
<td>4.6</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>1979</td>
<td>3.8</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>1984</td>
<td>3.2</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>1989</td>
<td>2.5</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>1994</td>
<td>1.6</td>
<td>10</td>
</tr>
</tbody>
</table>

† Numbers refer to reference listings. For example, 4 refers to Loh (1996).
increase in the proportion of children free of caries in
the permanent dentition from 30.0% in 1970 to 58.7%
in 1994. There was also a decline in mean dft from 2.60
to 1.08 for school children aged 6-11 years and the mean
DMFT had decreased from 2.98 in 1970, 2.61 in 1979,
1.97 in 1984, 1.61 in 1989 to 1.05 in 1994. In each
of these surveys, approximately 5,000 school children
aged 6 to 18 years were examined and this sample size
represented 1.2% of the school going population.

However, the success in caries control among
Singaporean school children is not seen in pre-schoolers
as suggested by the 2005 study undertaken by Gao
et al. (aforementioned in Part 1). The authors of that
study attributed their findings to the “plateau effect of
water fluoridation and insufficient organized dental
services and oral health promotion for the pre-schooling
population.” The authors therefore suggested extending
the School Dental Service to pre-schoolers, particularly
those at high-risk of dental caries.

Gao et al. also reported that higher caries
experience and unmet treatment needs were found
among children of lower socioeconomic status (Social
Economic Status proxies used were parental education
level and children living in public housing units, HDB
apartments) and the indigenous population (Malays).
They attributed the racial and socioeconomic difference
in caries severity to differences in: (i) poor oral health
practices/behaviours (such as prolonged breastfeeding,
night time bottle feeding, cariogenic diet); (ii) dental
awareness and knowledge of parents and caregivers;
(iii) cultural, ethnic and religious norms and beliefs
(i.e. how people of different ethnicities prioritize their
resources, how attentive and receptive they are to
health education messages, and how they synthesize
and comprehend these information); and (iv) barriers
to assessing oral healthcare services faced particularly
by the disadvantaged.

Some suggestions that have been advocated by
Gao et al. to overcome the racial and socioeconomic
inequality in oral health are: (i) professionals should
provide specific tailor-made advice rather than generic
ones with respect to oral health behaviors and seeking
dental services; (ii) public literacy programs to
advocate increased dental attendance; (iii) addressing
barriers to assessing dental services that are faced by
disadvantaged communities; and (iv) understanding the
health-related values and lifestyles of the different target
population in a multi-ethnic society (i.e. the frequent
intake of sweet deserts in the Malay community).

Part 3: Lessons learned and future steps

Singapore is fortunate that water fluoridation
has been in place for over half a century and there have
been only sporadic reports of opposition to this public
health measure at the onset of its implementation. In
recent years however, opposition to water fluoridation
has increased probably due to a better educated and
well-travelled populace that has found its political voice
and the myriad of anti-fluoridation material that is readily
accessible off the internet (water fluoridation hardly gets
any media attention in Singapore). It is hoped that the
lukewarm or mild opposition to fluoridation would remain
this way in time to come because the overall political
atmosphere of the populace is fairly muted.

In line with systematic review and audits of
all governmental policies, the Ministry of Health has
set up a fluoride review committee whose objective
is to monitor and conduct reviews on the fluoridation
of drinking water by: (i) determining the appropriate
and safe concentration levels of fluoride to maintain in
Singapore’s drinking water in order to achieve optimal
effectiveness against dental caries; (ii) determining the
estimated daily fluoride exposure per individual; and (iii)
debating the need for mandatory fluoridation of
the drinking water supply.

It is highly unlikely that water fluoridation
would be reversed and the role of the committee is more
to review the contemporary literature as is required of
good public health practices.

Generally, the levels of oral health in Singapore
are good and are comparable to other developed
countries. Singapore is fortunate to have enjoyed
universal coverage of water fluoridation for over fifty years. The population is also highly educated and health awareness is generally high. The School Dental Service provides ‘free’ dental care to school children up to 18 years of age. Furthermore, primary dental care is also readily accessible by the general public. 25% of the primary dental care is provided through public sector community clinics (polyclinics) which are heavily subsidized by the government, whereas the remaining 75% is provided by an extensive network of private general practice clinics found across the island. Moreover, public education to increase awareness and literacy of healthcare issues are also routinely carried out by the Health Promotion Board.

The challenges facing Singapore are to:

(i) address the inequality of dental caries - a burden that is mainly carried by members of lower socioeconomic groups and the indigenous population;

(ii) address the high dental caries experience among pre-schoolers;

(iii) with the government’s policy of attracting foreign talent and the resultant rapid influx of immigrants, it is expected that the prevalence of dental caries would increase and there is a need to look into the provision of accessible and affordable dental care and services;

(iv) fine tune the current healthcare delivery system to ensure that the less fortunate, elderly and those with Special Needs are not deprived of accessing oral healthcare services;

(iv) more effective inculcation of good dental homecare and dietary habits by the public in view of the popularity of fizzy and sports drinks consumed by many Singaporeans.

References

3. WHO ranking of countries by healthcare systems. Available at: http://www.photius.com/rankings/healthranks.html
Country Report-Sri Lanka

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1. General Introduction:

Sri Lanka is an island in the Indian ocean located in south of India. It is a nation with 65,610 sq km land area. The total population of Sri Lanka is approximately little over 20 million with 8.6% children under 5 years of age. The male to female ratio in Sri Lanka is 0.9 to 1 and the average house hold size is 4.7

The climate of Sri Lanka can be described as tropical. It lies between latitudes 5° and 10°N and longitudes 79° and 82°E. Its position between 5 and 10 north latitude endows the country with a warm climate moderated by ocean winds and considerable moisture. The mean temperature ranges from about 16 °C (60.8 °F) in the central highlands, where frost may occur for several days in the winter, to a maximum of approximately 33 °C (91.4 °F) in other low-altitude areas. The average yearly temperature ranges from 28 °C (82.4 °F) to nearly 31 °C (87.8 °F). Day and night temperatures may vary by 4 °C (7.20 °F) to 7 °C (12.60 °F).

It is comprised of several ethnic communities, Sinhalese make up a majority of 73.8%, Sri Lankan Tamils 18%, Moors 7.2% and others 0.5%, according to 2001 provisional data. Sri Lanka is a developing country with a per capita income of USD 818 per person per year at an average. However, 23% of the Sri Lankan population is below the poverty line. Sri Lanka has shown an average GDP of 4.5 % in the last 10 years.

As per the records of the Department of Registrar General (2003), the life expectancy at birth for an average Sri Lankan male is 71.7% while for female is 76.4% (2006). The maternal mortality rate has been reduced to 14.3 per 100,000 live births while infant mortality rate has been recorded as 11.17 per 1,000 live births and neo natal mortality rate as 8.4 per 1,000 live births.

Figure 1 Distribution of Fluoride Ions in Ground Waters of Sri Lanka
Sri Lankan citizens enjoy free health care and education, fully funded by the government. In addition, a large network of private health care providers delivers excellent facilities, which are available for those who can afford them. There are little over 2,000 dental surgeons currently working in Sri Lanka in both Government and Private sector and the availability of Dental Surgeons per 100,000 population comes to about 5.9.

It has been found that at the age of 35, an average Sri Lankan has 26.86 teeth but are reduced to 12.5 at the age of 65. Caries experience in Sri Lanka is shown in table 1.

2. Fluoride in Sri Lanka:
Sri Lanka is blessed with quality natural water resources in most parts of the country. The annual average rainfall of Sri Lanka is 1,200-1,800 mm. However, there is a vast regional variation of annual rainfall from the wet zone to the dry zone. The average annual rainfall is 2,540-5,080 mm in the South-West region of the island (wet zone) and less than 1,250 mm in the North-West and South Eastern regions of the Island (dry zone). Approximately, only 34% of the population enjoys pipe born water in Sri Lanka. The rest of the population (66%) who live in rural parts of the country do not have pipe born water and consume mainly water from large reservoirs of the irrigation systems. There is a unique irrigation system in Sri Lanka around which a majority of rural people dwell and they cultivate crops which are their main livelihood by using the water from these reservoirs. Furthermore, a substantial amount of people living in villages consume well water for both cooking and drinking purposes.

Drinking Water and Fluoride:
Drinking water is usually the largest contributor to Fluoride intake. Internationally the permissible upper limit for fluorides in drinking water has been set at 1.5 mg/l (WHO 1994). However, as Sri Lanka is a tropical Country where the water consumption is comparatively higher, the permissible upper limit has been proposed at 0.8mg/L (Warnakulasuriya 1992).

The fluoride content in waters of Sri Lanka varies from 0.3 mg to 6-8 mg per liter. Even though the dental fluorosis is not a very common health hazard with reference to the country as whole, it appears as an endemic problem and excessive fluorides in groundwater is a serious water quality problem in some parts of Sri Lanka. Figure 1 shows distribution of fluorides ions in ground water of Sri Lanka.

As there is no major central water supply system covering the majority of people in the counter, water fluoridation is not considered and practiced as a primary health care measure in Sri Lanka. Further, the water fluoridation would be effective in lowering the DMFT in communities where DMFT is considerably higher. Among Sri Lankan children the DMFT is lower compared to other communities of the country, particularly in the West. Hence the cost effectiveness of water fluoridation is questionable in Sri Lanka.

<table>
<thead>
<tr>
<th>Age group</th>
<th>% with D. C</th>
<th>% with treated C</th>
<th>Mean DMF</th>
</tr>
</thead>
<tbody>
<tr>
<td>05Yrs Deci</td>
<td>65.3</td>
<td>1.8</td>
<td>3.51</td>
</tr>
<tr>
<td>05Yrs Per</td>
<td>2.21</td>
<td>0.26</td>
<td>0.05</td>
</tr>
<tr>
<td>12Yrs</td>
<td>39.17</td>
<td>4.85</td>
<td>0.88</td>
</tr>
<tr>
<td>15Yrs</td>
<td>52.27</td>
<td>4.89</td>
<td>1.03</td>
</tr>
<tr>
<td>‘35-44</td>
<td>89.75</td>
<td>15.9</td>
<td>8.53</td>
</tr>
<tr>
<td>65-74</td>
<td>71</td>
<td>23.47</td>
<td>17.12</td>
</tr>
</tbody>
</table>
Although Sri Lanka has no water fluoridation programme, it has other alternative fluoride therapies that are also proven to be effective in prevention of tooth decay. These include fluoride toothpaste, mouth washes, gel application, and Fluoride Varnishes.

**Fluoride Toothpastes:**

Fluoride toothpaste is the most widely used and rigorously evaluated fluoride treatment. It is widely used in Sri Lanka, but less so among the poor. It is known that the per capita use of toothpaste is second highest in Sri Lanka among the countries of South East Asia. It has been estimated that 98% of Sri Lankan households purchase at least 1 tube of toothpaste per year and 80% of Sri Lankan households purchase at least 1 tube of toothpaste every 3 months.

Recent survey reveals that the habit of brushing teeth with fluoride tooth paste is shown by more than 75% of children. Table 2.

### School Based Florid Mouth Rinse (FMR) programme:

Faculty of Dental Sciences of the University of Peradeniya, Sri Lanka started a joint research project with the Niigata University, Japan to find out the effectiveness of fluoride mouthwashes in reducing the incident of caries in school children in Sri Lanka. This School Based Florid Mouth Rinse (FMR) programme was started in 2010 as a pilot study in the Kandy district of Sri Lanka. The objectives of this programme were to identify problems associated with School based FMR programme in Sri Lanka, evaluate the effectiveness of the program by comparing caries levels among the test group and the control group, assess the cost effectiveness and see the feasibility of introducing it as an island wide programme. Based on the success rate, the research group is planning to make recommendations to the government for a island wide, School based Florid Mouth Rinse (FMR) programme.

#### Table 2 Usage of Fluoride toothpaste in tooth brushing in different age groups

<table>
<thead>
<tr>
<th>Age group</th>
<th>% brushing with fluoride tooth paste</th>
</tr>
</thead>
<tbody>
<tr>
<td>05 Yrs</td>
<td>73.9</td>
</tr>
<tr>
<td>12 Yrs</td>
<td>76.6</td>
</tr>
<tr>
<td>15 Yrs</td>
<td>79.8</td>
</tr>
<tr>
<td>35-44</td>
<td>71.5</td>
</tr>
<tr>
<td>65-44</td>
<td>30.8</td>
</tr>
</tbody>
</table>

### Other methods of Fluoride Therapy:

Although not widely used, fluoride mouthwashes, gel application and application of fluoride varnish are practiced in the private sector, particularly in the urban part of the country. A pilot study is being carried out in MOH areas of Maharagama, Kaduwela, Homagama and Piliyandala by the Dental Public Health unit of the Institute of oral health, Maharagama to study the feasibility and effectiveness of using fluoride gel and fluoride varnish for high risk children under three years of age.

Even though the effectiveness of salt fluoridation is about the same as that of water fluoridation, fluoridated salts are not available in Sri Lanka.
**Problem of Excessive Fluoride in Drinking Water:**

**Dental Fluorosis:**

Dental fluorosis is not a major common national level health problem in Sri Lanka. However, it cannot be ignored of dental fluorosis appearing as an endemic problem in some parts of Sri Lanka. There are areas in some districts of the country where over 90% of people are affected with dental fluorosis. Majority of people in these endemic areas show moderate to severe degree of dental fluorosis. The North Central Province, some parts of Hanbantota and Kurunagala districts have been identified as the areas where dental fluorosis is prevalent.

**Prevention of Dental Fluorosis:**

**Water Fluoride Filters:**

Advocating water de-fluoridation filters to people who live in the fluoride endemic areas has been tried in Sri Lanka at the research level in the first instance and subsequently as a government sponsored project under the ministry of Science and technology. The aim of this project was to prevent the occurrence of dental fluorosis by avoiding ingestion of high fluoride water. This has been identified as a cost effective method suitable for a country like Sri Lanka compared to expensive and complicated methods like usage of de-fluoridator plants employed in developed countries.

The de-fluoridation filter project was carried out in some villages of the North Central province as a pilot study in 1994. As there was over a 90% acceptance, the project further extended for a number of other villages as well.

The filters had been designed as household equipment fabricated with freely available inexpensive material from the surrounding environments of the villages. One of the other salient features of this de-fluoridation system is the ability for the village community to use it and change the filter medium without a special training or skill.

Figure 2 below shows the cross-sectional diagram of the defluoridator introduced in 1994 as a preventive strategy.

The house hold defluoridator is fabricated using a 225 mm diameter, 1 meter PVC pipe length and an elbow bend. Broken pieces of freshly burnt bricks of sizes 8-16 mm was used as a filtering medium of the defluoridator. In order to get a longer retention time for fluoride rich water that passes through the broken pieces of freshly burnt bricks. The filter medium is to be changed every 3 months depending on the fluoride level of water. It has been experimentally shown that 50% removal has been achieved after 3 hours of filtration. Furthermore 75-80% fluoride removal could be obtained if the withdrawal of water is carried out after longer intervals. The frequency of water withdrawal could be adjusted according to the level of fluoride available in the water. However, it has been shown that approximately 8 to 10 liters of de-fluoridated water could be harvested at a time from the filter which is fairly sufficient for purposes of cooking and drinking for a household with 4 to 5 members.

The incidence of dental fluorosis shows a high correlation with the presence of groundwater in certain areas. Tube wells constructed in various rock types have shown different fluoride concentrations, possibly due to the different mineral constituents in...
these rocks and their relative capability of releasing fluoride ions into groundwater. It has been observed that the tube wells located in the dry zone have higher fluoride concentrations than those in the wet zone. The fluoride contents of groundwater show an inverse relationship with average yields of the tube wells, indicating the inverse relationship of aquifer permeability to the fluoride content in groundwater. There are approximately 15,000 tube wells in Sri Lanka. Most of them are fabricated in the dry zone or the North Central region of the country as a solution to the water insufficiency.

**Treatment of Dental Fluorosis:**

Moderate to severe dental fluorosis is aesthetically unacceptable. Hence it becomes necessary to treat in order to improve aesthetics. Several treatment modalities such as jacket crowns veneers, light cure composites, and vital bleaching methods have been tried. Some of these treatment modalities such as crowns and veneers are prohibitively expensive for people of low socio-economical category.

The Sri Lanka Dental Association, in collaboration with the Japanese Dental Association launched a project for improving aesthetics of those who have moderate to severe Dental Fluorosis. Two main treatment modalities provided under this project included:

1. Vital Bleaching
2. Composite veneering

This ongoing project is being carried out by the Sri Lanka Dental Association using voluntary manpower for the benefit of the under privileged in the high fluoride areas.

**3. Steps to be taken in the future**

**Use of Fluoride for prevention of Dental Caries:**

1. An oral health policy is being drafted in line with the national health policy of Sri Lanka. One of the broad aims of the National Health Policy is to reduce the disease burden by improving the preventive programme. Appropriate use of fluoride will be an important area of this policy. Already, guidelines have been prepared and disseminated among health authorities and health care workers on the use of fluoride for prevention of dental caries.

2. Based on the Beijing declaration, use of fluoride tooth paste use will be promoted in all areas irrespective of the level of fluoride ions in drinking water.

3. Fluoride varnish and fluoride gel to be included in the essential drug list of the ministry of health provide such material to Government Dental clinics and school dental therapists for the purpose of providing fluoride application free of charge.

**Handling the problem of excessively high fluorides in Drinking Water:**

1. Studies have shown that even in high fluoride areas, there are wells containing relatively lower levels of fluoride ions. For an example, out of 16,446 wells in Anuradhapura district in high fluoride zone, there are 7,107 wells with level of fluoride ions is less than 0.7 mg/l). It is the intention of the authorities to identify the well with safer levels of Fluoride ions and mark them as “safe to Drink” so that the public could take water from these wells at least for drinking and cooking purposes.

2. National water supplies department is planning to expand mass water schemes for distribution of surface water containing less fluoride.

3. There are also plans to provide user friendly domestic water defluoridators to households in the high fluorides areas of the country.
Fluoride Use in Thailand
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Thailand is one of the Southeast Asian countries, with a population of 67.4 million in 2010. (1) Oral health care is covered by one of three health insurance programs: universal coverage, social welfare and welfare for government officers. For more than half of the population, dental care is covered by universal coverage under the National Health Security Office. Their policy offers free-of-charge basic dental services. For oral health promotion and prevention, policies and projects are supervised by the Bureau of Dental Health, Ministry of Health. The oral health promotion policies have been extended to an autonomous state agency, outside the formal structure of the government; the Thai Health Promotion Foundation.

According to data from the Thai Dental Council, there were 11,243 dentists in January 2011. About half of these dentists work in the private sector. Distribution of dentists in rural areas is still one of dental service problems. According to data in 2009, the other dental personnel included 4,313 dental therapists, 1,800 dental assistants and 98 dental technicians. (2) Basically, the dental therapists work on prevention and promotion as well as simple treatments mainly for school children. In the future, dental therapist curriculum will be extended from two to four years and stress more on promotion and prevention. They will fill all Health Promoting Hospital Districts.

Table 1. Caries prevalence from National Dental Health Surveys in Thailand

<table>
<thead>
<tr>
<th>Year/age</th>
<th>Caries Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td>1977</td>
<td>-</td>
</tr>
<tr>
<td>1984</td>
<td>-</td>
</tr>
<tr>
<td>1989</td>
<td>66.5</td>
</tr>
<tr>
<td>1994</td>
<td>61.7</td>
</tr>
<tr>
<td>2001</td>
<td>63.3</td>
</tr>
<tr>
<td>2007</td>
<td>61.4</td>
</tr>
</tbody>
</table>
The first national oral health survey was reported in 1977. After that, the surveys were conducted about every five years. The prevalence and caries status are shown in Tables 1 and 2. The dental caries increases with age in both primary and permanent teeth. The overall dental health has not changed much since the initial survey. Although there have been many projects on prevention and promotion, it is difficult to decrease the caries. Dental caries is still a dental health problem in Thailand and needs to be reevaluated and planned. Fluoride has been shown to decrease caries experience, significantly. It is widely used in Thailand for community, individual and professional approaches.

### Community approach

#### Water fluoridation

Water fluoridation was a pilot project at Bangpakong, Chachoengsao Province in 1991 to evaluate feasibility and effectiveness. The fluoride level was adjusted to 0.7 ppm. Results showed that for children aged 6 to 14 years, dental caries decreased 33.2%. According to National Health Development Plan No. 7, a plan was made to set water fluoridation in Bangkok but it didn’t work due to local policy issues. In 1994, the project was set at Nakhonrayok and Prachuap Khiri Khan and was evaluated five years after that. The optimal fluoride level was adjusted to 0.5 ppm. Results showed that dental caries decreased 45.1% and 28.1% in primary teeth and 31.4% and 14.4% in permanent teeth of 12-year-olds respectively. The evaluated cost was 12 baht/person/year. However, water fluoridation in Thailand is no longer conducted.

#### Fluoridated milk

The fluoridated milk project was initiated in 2000. A pilot project was started in Bangkok. For the first five years, the project covered preschool and school-aged children. The project was evaluated for effectiveness and feasibility three years after. Currently, the project has been extended to six provinces and covers 691,680 children as shown in Table 3. Criteria selection followed WHO recommendations mainly in high risk groups at community level. Fluoride level was determined by considering optimal fluoride level (0.5 ppm). Milk consumed daily was 200 ml, thus the fluoride was added at 2 ppm. Fluoridated milk is still an ongoing project.

### Individual approach

#### Fluoride toothpaste

In Thailand, use of fluoride toothpaste can be considered as both a community and individual approach. The use of fluoride toothpaste has been widely promoted and accepted by the public.
The Workshop on “Effective Use of Fluoride in Asia”

Fluoride toothpaste is one of the most effective cariostatic products when used as a daily fluoride application. Fluoride toothpaste has been found to improve the prevented fraction for dental caries by 24% (8). The Bureau of Dental Health, Ministry of Health promotes the use of fluoride toothpaste after the eruption of primary teeth. The fluoride toothpaste is recommended at all ages and dental caries risks. Most fluoride toothpaste products for children in Thailand contain fluoride varying between 500 to 1,000 ppm. The use of fluoride toothpaste for very young children has been a concern among dentists. Overdose of fluoride ingestion can cause dental fluorosis. According to the survey, dental fluorosis of 12-year-old children was found in about 5% of cases and related to the high fluoride concentration of consumed water. Moderate to severe fluorosis was found in only 0.14% of Thais as shown in Table 4. The use of fluoride is recommended as soon as the primary teeth erupt as shown in Table 5. The reasons for that are high caries prevalence of primary teeth, accessibility of fluoride toothpaste and low level of dental fluorosis. Even though, fluoride effectiveness is dose dependent but high-dose fluoride products are not available on the counter. According to the Thai Food and Drug Administration, the maximum allowable fluoride level is 1,100 ppm. According to the survey from the Bureau of Dental Health in 2007, most of Thais use fluoride toothpaste as shown in Table 6. (3) At the school level; an after lunch tooth brushing project has been conducted since 1988. The Thai Ministry of education has accepted and continued this project which covers more than 80% of school children of the country.

Fluoride mouthrinse

Currently, the use of fluoride mouthrinse is for individual use. Indications include moderate to high caries risk, initial caries or white lesions. Fluoride products are 0.05% NaF, daily and 0.2% NaF, once weekly or biweekly. Mouthrinse is recommended for children over age 6. Mouthrinse containing alcohol is not suggested for children. The use of 0.2% sodium fluoride every two weeks had been one prevention project in schools since 1977. Since the use of fluoride toothpaste is more accessible, school-based programs are no longer used.

Table 3. Fluoridated milk project of Thailand in 2010 showing provinces, participants and percent coverage

<table>
<thead>
<tr>
<th>Area</th>
<th>Participants</th>
<th>Coverage (% of total students)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangkok</td>
<td>338,638</td>
<td>100*</td>
</tr>
<tr>
<td>Chum Phon</td>
<td>35,000</td>
<td>77.78**</td>
</tr>
<tr>
<td>Khon Kaen</td>
<td>190,400</td>
<td>84.9**</td>
</tr>
<tr>
<td>Surat Thani</td>
<td>8,000</td>
<td>8.54*</td>
</tr>
<tr>
<td>Sa Kaeo</td>
<td>42,332</td>
<td>87.22*</td>
</tr>
<tr>
<td>Chonburi</td>
<td>77,310</td>
<td>61.83**</td>
</tr>
<tr>
<td>Total</td>
<td>691,680</td>
<td></td>
</tr>
</tbody>
</table>

* Government schools ** Government and private schools
Table 4. Percent of Dental Fluorosis of 12-year-old Thai children

<table>
<thead>
<tr>
<th>Area</th>
<th>Fluorosis</th>
<th>Fci*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal</td>
<td>Suspicious</td>
</tr>
<tr>
<td>Whole country</td>
<td>94.21</td>
<td>3.19</td>
</tr>
<tr>
<td>City</td>
<td>92.90</td>
<td>3.85</td>
</tr>
<tr>
<td>Country side</td>
<td>94.45</td>
<td>3.14</td>
</tr>
<tr>
<td>Bangkok</td>
<td>94.9</td>
<td>2.6</td>
</tr>
</tbody>
</table>

*Fluorosis community index

Table 5. Fluoride toothpaste recommendation for children

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>F concentration (ppm)</th>
<th>Amount of toothpaste</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>First tooth erupt -&lt; 3</td>
<td>500</td>
<td>(Smear layer)</td>
<td>Parental assistance</td>
</tr>
<tr>
<td>3-6</td>
<td>500-1,000</td>
<td>(Pea-size)</td>
<td>Parental assistance or supervision</td>
</tr>
<tr>
<td>&gt;6</td>
<td>1,000 (+)</td>
<td>Toothpaste length 1-2 cm</td>
<td>Self-brushing</td>
</tr>
</tbody>
</table>

Table 6. Fluoride toothpaste use of Thai people at different ages in 2007

<table>
<thead>
<tr>
<th>Age</th>
<th>% uses of fluoride toothpaste</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>89.92</td>
</tr>
<tr>
<td>15</td>
<td>89.31</td>
</tr>
<tr>
<td>35-44</td>
<td>78.47</td>
</tr>
<tr>
<td>60-74</td>
<td>63.82</td>
</tr>
<tr>
<td>80</td>
<td>28.51</td>
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</tbody>
</table>
Fluoride supplement

Fluoride supplement is indicated for high risk groups. Their recommended use is shown in Table 7. The use of fluoride supplement is efficacious but not successful because of compliance problems. Prior to prescribing fluoride supplements, fluoride content of drinking water needs to be assessed. According to a survey in 2007, fluoride levels of drinking water in 16 provinces and Bangkok varied from 0.02 to 1.17 ppm. The Food and Drug Administration, Thailand, requires fluoride content of bottled water not to exceed 0.7 ppm. In addition, other sources of fluoride exposure need to be considered such as fluoridated milk and fluoride toothpaste ingestion. The cariostatic effects of fluoride supplement is mainly a topical effect. The fluoride tablet should be chewed or permitted to slowly dissolve in the mouth. Although, there has been strong evidence showing that it is a risk factor for mild fluorosis, considering the risks and benefits, pediatric dentists in Thailand still prescribe fluoride supplements for children with high caries risk. However, individual caries risk assessment needs to be evaluated.

Professional Approach

Fluoride varnish

Fluoride varnishes are widely used among pediatric dentists and in preventive programs for young children. Indications are moderate to high risk and white lesions. The uses of fluoride varnish have been shown to reduce enamel caries progression. A widely used product is 5% sodium fluoride or 2.26% fluoride. It is recommended for children under three year of age or one who can’t cooperate with fluoride gel application. Some advantages are easy application, reducing fluoride ingestion during application, applicable on specific target and no suction needed. In Thailand, there have been some projects for infants, toddlers and preschool children. Fluoride varnish is included in benefit package for 0-3-year-olds.

Fluoride gel

Fluoride gels were developed and made with high viscosity for easy application. The products include 1.23% acidulated phosphate fluoride and 2% sodium fluoride. In Thailand, recommendations for use are moderate to high caries risk. Mainly, it is used in dental clinic settings. Concerning fluoride ingestion during application, saliva suction should be used. There have been some private programs in some schools but not a governmental policy. Fluoride gel is also includes in benefit package for 3-5-year-olds.

Conclusions and future plan

Dental caries is still a dental health problem in Thailand. Fluoride uses, especially toothpaste, are a part of caries prevention for all ages. For school programs, after lunch tooth brushing has been an

Table 7. Fluoride supplement recommendation

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>Fluoride dosage (mgF/day)</th>
<th>Water fluoride concentration (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;0.3</td>
<td>0.3-0.5</td>
</tr>
<tr>
<td>First tooth erupt to &lt; 3</td>
<td>0.25</td>
<td>0</td>
</tr>
<tr>
<td>3-6</td>
<td>0.5</td>
<td>0.25</td>
</tr>
<tr>
<td>&gt;6</td>
<td>1.00</td>
<td>0.50</td>
</tr>
</tbody>
</table>
ongoing project. The fluoridated milk program needs to be closely followed-up. Preschool programs should pay more attention at early age. Parental assistance of tooth brushing with fluoride toothpaste for infants and toddlers need to be more actively promoted. Because dental caries is related to multifactors, not only tooth brushing, but also the dietary behavior should be focused on. To date, oral health prevention and promotion plan in this country need to be developed continuously in order to achieve the oral health goal for Thai citizens.

Acknowledgement

We would like to thank Dr. Piyada Prasertsom, Dr. Wigul visalseth, Dr. Srisuda Leelasithorn and Dr. Sunee Wongkongkathep from the Dental Health Division, Department of Health for providing national information.

References

The Public Use of Fluoride for Caries Prevention in Vietnam

Trinh Dinh Hai,  
Nguyen Thi Hong Minh,  
National Hospital of Odonto-Stomatology,  
Vietnam

Part 1:

a/ Country profile  
Using fluoride to prevent dental caries has been implemented in Vietnam for recent several decades which bring a considerable benefit to reduce caries prevalence and DMFT index.

Fluoride regimens used in Vietnam focus on target groups include:
- The community: water fluoridation  
- Individual consumers: tooth brushing with fluoridated toothpaste and fluoride mouth rinsing.

General population data with a focus on the target groups who uses fluoride regimens was shown in the following table:

Table 1. Approximately number of population uses fluoride regimens in Vietnam (2002)

<table>
<thead>
<tr>
<th>Fluoride Target regimens groups</th>
<th>Water fluoridation</th>
<th>Tooth brushing with fluoridated toothpaste</th>
<th>Fluoride mouth rinsing</th>
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</thead>
<tbody>
<tr>
<td>Community</td>
<td>3.5 millions people</td>
<td>56 million people</td>
<td>24 millions</td>
</tr>
<tr>
<td>Primary school student</td>
<td></td>
<td></td>
<td>05 millions students</td>
</tr>
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</table>

b/ Recent data of dental caries status and related data

1. Caries experience in children

Table 2. Caries experience in deciduous dentition in Vietnam (2002)

<table>
<thead>
<tr>
<th>Age</th>
<th>% caries</th>
<th>dmft</th>
<th>dmfs</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>dt</td>
<td>mt</td>
</tr>
<tr>
<td>6-8</td>
<td>84.9</td>
<td>5.07</td>
<td>0.31</td>
</tr>
<tr>
<td>9-11</td>
<td>56.3</td>
<td>1.85</td>
<td>0.01</td>
</tr>
</tbody>
</table>
Table 3. Caries experience in deciduous dentition in Hanoi and Laocai province (2008)

<table>
<thead>
<tr>
<th>Region</th>
<th>Tuổi</th>
<th>n</th>
<th>% caries</th>
<th>DMFT</th>
<th>DMFS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>DT</td>
<td>MT</td>
</tr>
<tr>
<td>Hanoi</td>
<td>6-8</td>
<td>116</td>
<td>92.2</td>
<td>5.4</td>
<td>0.15</td>
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<tr>
<td></td>
<td>9-11</td>
<td>123</td>
<td>67.5</td>
<td>2.9</td>
<td>0.1</td>
</tr>
<tr>
<td>Laocai province</td>
<td>6-8</td>
<td>110</td>
<td>90.9</td>
<td>6.05</td>
<td>0.03</td>
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<tr>
<td></td>
<td>9-11</td>
<td>146</td>
<td>61.0</td>
<td>2.36</td>
<td>0.01</td>
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</table>

Table 4. Caries experience in permanent dentition (2002)

<table>
<thead>
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<th>Age</th>
<th>% caries</th>
<th>DMFT</th>
<th>DMFS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DT</td>
<td>MT</td>
</tr>
<tr>
<td>6-8</td>
<td>25.4</td>
<td>0.47</td>
<td>0.00</td>
</tr>
<tr>
<td>9-11</td>
<td>54.6</td>
<td>1.15</td>
<td>0.02</td>
</tr>
<tr>
<td>12-14</td>
<td>64.1</td>
<td>1.96</td>
<td>0.05</td>
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<tr>
<td>15-17</td>
<td>68.6</td>
<td>2.12</td>
<td>0.15</td>
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Table 5. Caries experience in permanent dentition in Hanoi and Laocai province (2008)

<table>
<thead>
<tr>
<th>Region</th>
<th>Age</th>
<th>% caries</th>
<th>DMFT</th>
<th>DMFS</th>
</tr>
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<tr>
<td></td>
<td></td>
<td></td>
<td>DT</td>
<td>MT</td>
</tr>
<tr>
<td>Hanoi</td>
<td>6-8</td>
<td>18.2</td>
<td>0.30</td>
<td>0</td>
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<td></td>
<td>9-11</td>
<td>39.0</td>
<td>0.79</td>
<td>0</td>
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<td></td>
<td>12-14</td>
<td>43.1</td>
<td>1.08</td>
<td>0.02</td>
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<td></td>
<td>15-17</td>
<td>47.1</td>
<td>1.24</td>
<td>0.01</td>
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<tr>
<td>Laocai Province</td>
<td>6-8</td>
<td>18.2</td>
<td>0.30</td>
<td>0</td>
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<tr>
<td></td>
<td>9-11</td>
<td>39.0</td>
<td>0.79</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>12-14</td>
<td>39.0</td>
<td>0.79</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>15-17</td>
<td>47.1</td>
<td>1.24</td>
<td>0.01</td>
</tr>
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</table>
Table 6. Dental caries experience in key age group in Vietnam (2002)

<table>
<thead>
<tr>
<th>Age</th>
<th>% caries</th>
<th>DMFT</th>
<th>DMFS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DT</td>
<td>MT</td>
</tr>
<tr>
<td>6 years</td>
<td>83.7</td>
<td>5.88</td>
<td>0.24</td>
</tr>
<tr>
<td>12 years</td>
<td>56.6</td>
<td>1.83</td>
<td>0.01</td>
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<tr>
<td>15 years</td>
<td>67.6</td>
<td>2.03</td>
<td>0.12</td>
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2. Dental caries in adult

Table 7. Dental caries experience in adult by age (2002)

<table>
<thead>
<tr>
<th>Age</th>
<th>% caries</th>
<th>DMFT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DT</td>
</tr>
<tr>
<td>18 years</td>
<td>87.5</td>
<td>2.28</td>
</tr>
<tr>
<td>18-34 years</td>
<td>75.2</td>
<td>2.31</td>
</tr>
<tr>
<td>35-44 years</td>
<td>83.2</td>
<td>2.35</td>
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<tr>
<td>45 + years</td>
<td>89.7</td>
<td>2.14</td>
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</table>

3. Dental fluorosis among Vietnamese children

Table 8. Percentage of fluorosis among Vietnamese children by Dean’s criteria on tooth 1.1 (2002)

<table>
<thead>
<tr>
<th>DEAN’S FLUOROSIS SCORE (%)</th>
<th>0.0</th>
<th>0.5</th>
<th>1.0</th>
<th>2.0</th>
<th>3.0</th>
<th>4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
<td>Questionable</td>
<td>Very mild</td>
<td>Mild</td>
<td>Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>6-8 years</td>
<td>87.5</td>
<td>8.7</td>
<td>2.1</td>
<td>1.7</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>9-11 years</td>
<td>83.4</td>
<td>10.4</td>
<td>4.4</td>
<td>1.0</td>
<td>0.7</td>
<td>0.1</td>
</tr>
<tr>
<td>12-14 years</td>
<td>84.2</td>
<td>8.8</td>
<td>5.0</td>
<td>1.1</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>15-17 years</td>
<td>82.9</td>
<td>6.7</td>
<td>6.8</td>
<td>2.8</td>
<td>0.3</td>
<td>0.3</td>
</tr>
</tbody>
</table>

4. Fluoride concentration in drinking water sources in Vietnam
On National oral health survey 2002, 5,948 samples of drinking/cooking water were collected. The analysis data show that fluoride concentration in most of them was low, less than 0.4 ppm.

On Survey in Hanoi and Laocai supported by WHO Vietnam in 2008, 87 samples of drinking water were analyzed with fluoride concentration was less than 0.35 ppm.

Part 2. The public use of fluoride in Vietnam

1. Water fluoridation
   Water fluoridation is the unique systemic fluoride method that has been applied in Vietnam until now.

   Water fluoridation has been implemented in Ho Chi Minh City since 1989 with the concentration is 0.50 ppm and 0.07 ppm from 1993. Now, the water fluoridation network cover some district in Ho Chi Minh city and one district of Dong Nai province with about 3.5 millions citizens.

   After 10 years fluoride supplementation in tap water, caries prevalence of 12 years old children decreases from 87% to 65% and DMFT is 2 at this age group.

   Water fluoridation is one of effective method for caries prevention in Vietnam but it has covered only a small area where have had tap water network. More than 70% of Vietnamese people, especially in rural areas, do not have tap water that will not be able to approach this program.

2. Mouth rinsing with fluoride solution
   Mouth rinsing with fluoride solution of 0.2% weekly for children at primary schools was implemented in Ho Chi Minh city since 1980 and expanded to many other provinces in Vietnam quickly. Mouth rinsing with fluoride solution of 0.2% weekly has been one important content of school- based oral health promotion program and more than five millions school children have had benefit from this program since 2004.

   One study in Hai Duong province in 2000 showed that the school children group who have used mouth rinsing with Fluoride solution of 0.2% weekly (stared at 6 years old) for 5 years continuously had caries experience of 10.53%, while caries experience of the control group who have not rinsed Fluoride solution, had reached 35.79%.

   Nowadays, mouth rinsing with fluoride solution of 0.2% weekly have been implemented widely in Vietnam and proven to reduce dental caries in children effectively.

3. Tooth brushing with fluoridated tooth paste
   According to the result of National Oral health survey 2002, more than 90% of children and adult brush their teeth and use toothpaste when brushing in Vietnam. From that time, the awareness of community on tooth brushing to prevent caries considerable improved and almost Vietnamese people brush their teeth daily.

   Most of toothpastes in Vietnamese market are fluoridated toothpaste now.

4. Fluoridated salt
   According to the National Oral Health Survey (2002), 84.9% of 6-8 years old children in Vietnam are affected by tooth decay and in adults the average number of decayed teeth is over 8. The lack of fluoride in almost drinking water sources is a problem in the prevention of dental caries in Vietnam. The risk of dental caries is growing in the country due to rapidly growing consumption of sugars and using bottled drinking water which are very low in fluoride concentration (less than 0.03 ppm).

   In 2006, World health organization recommended that salt fluoridation should be implemented urgently to prevent caries for community in Vietnam.

   The recommended dosage is at the level of 250 ppm fluoride per kg salt.

   With the technical and financial support form World health organization Vietnam, the pilot phase of
The salt fluoridation program has been implementing with the following activities:

- Epidemiology surveillance on caries prevalence, DMFT, fluorosis in the region where distributing fluoridated salt. Salt consumption and dietary habits also are investigated.
- A map of fluoride concentration in drinking water in this area was developed.
- Set up procedure of fluoridated salt production and control the quality of salt under supervision of WHO’s experts.
- Producing 20 tones of fluoridated salt and transport to LaoCai province.
- Making plan for communication campaign to raise social acceptance.
- Making plan for delivery fluoridated salt to Lao Cai province that covers over 20 million people.
- Making plan to monitor the program.

Part 3. Lesson learned and future steps

*Strengths and weakness of preventive interventions in Vietnam*

- Raise the awareness of community on caries prevention.
- Responsible reduce caries experience in children and adult.
- Water fluoridation required modern equipment with complete network of tap water seems not to be suitable for Vietnam where 70% people do not use tap water.
- School based oral health promotion program (fluoride mouth rinsing and dental health education) shortly develop which cover only 5 million students out of a total school population of 25 million students.

*Recommendations resulting from the implementation of fluoride regimens and in Vietnam*

- Water fluoridation is an effective method to prevent dental caries for limited community only and seem not to be suitable for Vietnam.
- Fluoride mouth rinsing has been proven considerable effectively in caries prevention for school children. It is necessary to expand the school based oral health program to whole country.
- Tooth brush with fluoridated tooth paste should be encouraged as its availability, accessibility and acceptability.
- Although applying effective prevention programs, the burden of dental caries in Vietnam is a significant and growing public health problem. Traditional approach to control dental caries is not possible due to economic constraints and the lack of oral health manpower. Thus, the implementation of effective programs is needed in Vietnam.

*Future plan for caries prevention in Vietnam*

- Continuously raising the awareness of community on caries prevention.
- Convincing the health policy makers on the public uses of fluoride to prevent dental caries.
- Expanding the school based oral health program to whole country to prevent dental caries for children at school.
- Promoting communication campaigns for tooth brushing twice a day with fluoridated tooth paste, especially for children through media, school, and physicians.
- Implementing fluoridated salt as the priority strategy for caries prevention for community.
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## List of Participants

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5. Khov Sok  
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16. Armasastra Bahar  
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18. Yoshinobu Maki  
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20. Lee Soo-Ku  
    Korea
21. Bo-Hyoung Jin  
    Korea
22. Khamhoung Phommaovongsa  
    Lao PDR
23. Amphayvahn Jing  
    Lao PDR
24. Norain Abu Talib  
    Malaysia
25. How Kim Chuan  
    Malaysia
26. Ishak Abdul Razak  
    Malaysia
27. Bazar Amarsaikhan  
    Mongolia
28. Aye Aye Maw  
    Myanmar
29. Thein Tut  
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38. Prasad Armaratunga  
39. Upul B Dissanayake  
40. Sutha Jienmaneechotechai  
41. Siriruk Nakornchai  
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45. Troung Manh Dung  
46. Denis Bourgeois

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7. Kanyarat Korwanich  
8. Kasekarn Kasevayuth  
9. Kornkamol Niyomsilp  
10. Kwanchanok Yucharoen  
11. Narumanas Korwanich  
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13. Oranart Matangkasombut  
14. Panida Phawilai  
15. Panida Thanyarisung  
16. Patcharawan Srislapanan  
17. Patita Bhuridej  
18. Pattarawadee Leelawateeewud  
19. Piyada Prasertsom  
20. Pornpan Theerarungsikul  
21. Puangtong Bukrittyakamee  
22. Puangtong Lekfangfu  
23. Rujira Puaniyaka  
24. Supranee Dalodom  
25. Surat Mongkolnchaiarunya  
26. Thanya Sithisettapong  
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28. Waranuch Pitiphat  
29. Arunee Laiteerapong  
30. Yosskit Lochaiwatana  
31. Rodrigo Marino  
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33. Roger Ellwood  
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37. Tan Bee Siew  
38. Norfida Abdullah  
39. Ken Zhang  
40. Gabriel Chong  
41. Arathi Rao  
42. Nguyen Minh Thi Hong  
43. Nguyen Huyen Thanh
Group Sessions:

Group session I (March 23):
Group I (Community Approach)
- Cambodia
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- China SAR Hong Kong
  Michael Ho and Lee Kwing Hong
- Lao PDR
  Khamhoung Phommavongsa and Amphayvanh Jing
- Malaysia
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- Thailand
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- Vietnam
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  Nguyen Huyen Thanh
  Francois Courtel
  Puangtong Lekfuangfu
  Kornkamol Niyomsilp
  Supranee Dalodom
  Puangtong Bukrisyakamee
  Patita Bhuridej
  Surat Mongkolchaiaranya
  Waranuch Pitiphat

Group II (Professional Approach)
- Indonesia
  Dewi Kartini Sari, Zaura Rini Anggreinei and Amasastra Bahar
- Bhutan
  Sonum Ngedup
- Japan
  Yoshinobu Maki and Hirochi Ogawa
- Mongolia
  Basar Amarsaikhan
- Myanmar
  Aye Aye Maw & Thien Tut
- Sri Lanka
  Jayasundara Bundara, Prasad Armaratunga and Upul Disanayake
  Nguyen Minh Thi Hong
  Adirtia Putri
  Ellya Farida
  Chantana Ungchusak
  Piyada Prasertsom
  Kasekarn Kasevayuth
  Nuchnaree Akkarachaneeyakorn
Group III (Self-care Approach)

- Brunei
  - Mary Cheong and James Lee
- China
  - Wang Weizhen, Luan Wenmin and Shuguo Zheng
- India
  - Naseem Shah, Sharad Kokate & Shoba Tandon
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  - Lonim Prasai
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- Korea
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  - Rao Arathi
  - Roger Ellwood
  - Norlida Abdulla
  - Ken Zhang
  - Em-on Benjawongkulchaisak
  - Jaranya Hunrisaksak
  - Kanyarat Korwanich
  - Narumanas Kowvanich
  - Kwanchanok Yuchareon
  - Panida Thanyasrisun
  - Panida Phawilai

Group session II:

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  Ellya Farida
  Kwanchanok Yuchareon
  Araya Phonghanyuth
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- Thitinart Dhammaraks
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