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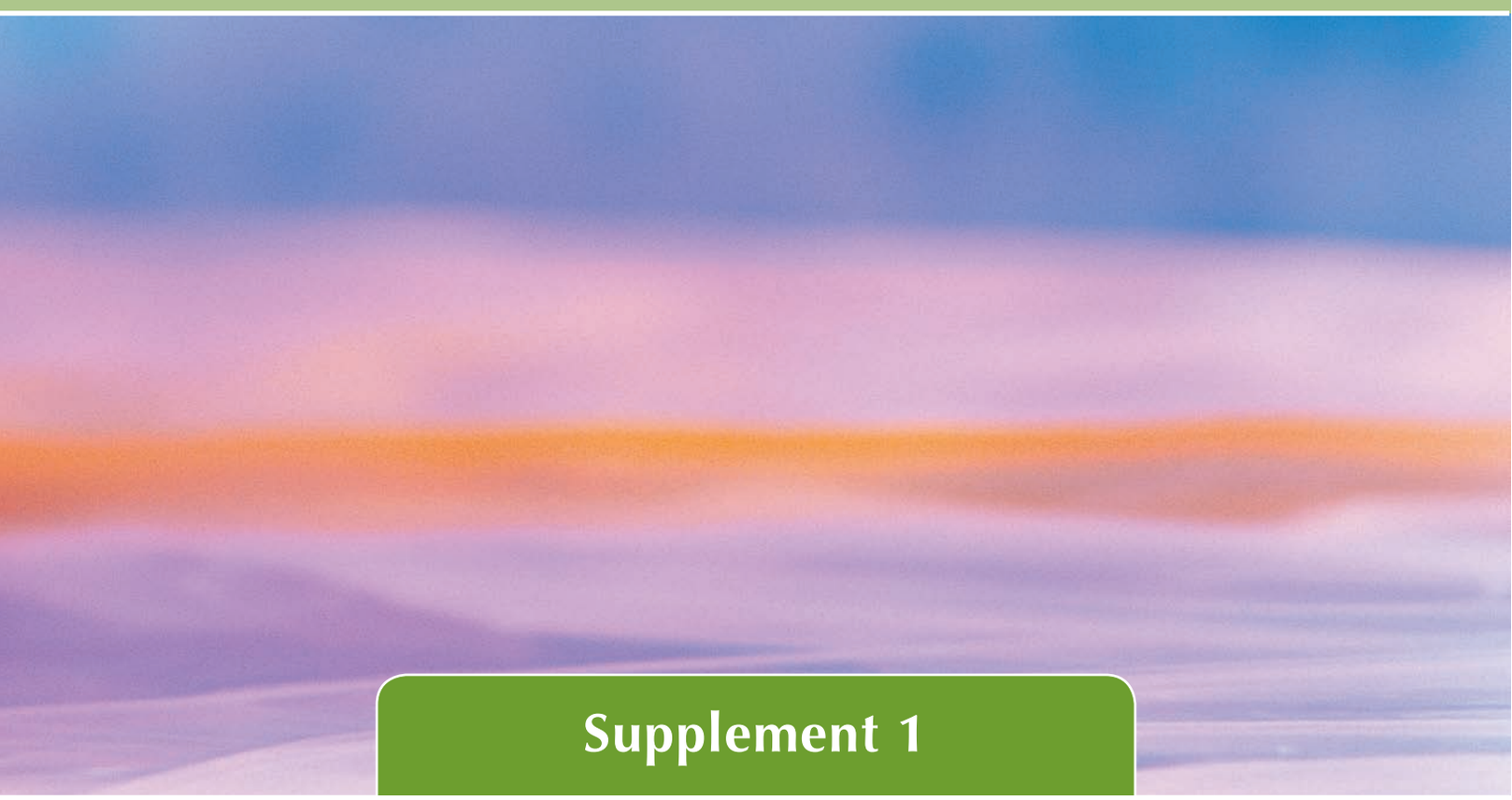

## Supplement 1

P.E. Petersen, S. Kwan, L. Zhu, B.X. Zhang and J.Y. Bian

Effective use of fluorides in the People's Republic of China - A model for WHO Mega Country initiatives

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# Effective use of fluorides in the People's Republic of China - A model for WHO Mega Country initiatives

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Poor dental health has been reported in the Chinese National Surveys of Oral Health. With the changing lifestyle and growing consumption of sugars, the incidence of dental caries may well continue to rise, compounded by limited access to professional care. The increasing oral disease burden could become a major public health problem in China, leading to considerable personal and health service costs. There is a desperate need for systematic implementation of preventive programmes. 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. In order to address this growing public health problem, the World Health Organization (WHO) Global Oral Health Programme advocates the effective use of fluoride as an essential approach to prevent dental caries in the 21st century - part of the WHO Global Oral Health Strategy. Population-wide automatic fluoridation measures are considered the most effective, complemented by appropriate use of toothpastes containing fluoride. There are wide variations of fluoride levels in drinking water in China and, in many areas, the levels of fluoride in drinking water are lower than the recommended levels. The use of toothpaste containing fluoride is still too low in some areas and decreases with age. Those who live in rural areas have limited access to affordable toothpastes containing fluoride. In March 2006, as part of the WHO Mega Country Health Promotion Network initiatives, the WHO Global Oral Health Programme organised a three-day symposium in Beijing, People's Republic of China. The aim of the symposium was to bring together international experience and Chinese expertise to facilitate policy development for effective use of fluoride in China, highlighting the benefits of, and barriers to, the implementation of different fluoridation programmes at the strategic levels as well as for operational planning. This article reports the proceedings of the meeting. In summary, China is a Mega country with much diversity and disparity. The situation in China is unique with endemic fluorosis due to other 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 obtain the benefits and avoid adverse effects of fluorides, controlling enamel fluorosis without jeopardising the prevention of dental caries. Various complementary fluoridation programmes can be considered for different population groups with varying needs, strategies that bring about additive effects. A multi-tier policy making approach at national, regional and provincial levels can be employed, based on sound evidence. The roles of WHO, Ministry of Health and the National Committee for Oral Health (NCOH) were emphasised. Lessons learned from the Chinese experience will prove invaluable to other countries with similar socio demographic characteristics that are in the same process of developing and implementing fluoridation policies and programmes.

*Key words: Appropriate administration of fluorides, benefits and adverse effects of fluoride, Mega countries, national fluoride policy, population-directed prevention of dental caries, socio-environmental diversity*

## Introduction

The World Health Organization (WHO) Mega Country Health Promotion Network was originated from the recognition that a grouping of the world's most populous countries would have tremendous potential to influence and improve the health of the whole world. Eleven countries which have populations of 100 million or more together constitute over 60% of the global population. They are Bangladesh, Brazil, China, India, Indonesia, Japan, Mexico, Nigeria, Pakistan, the Russian Federation and the United States of America.

These diverse countries stand at different levels of development and are experiencing different trends in the shifting patterns of disease and risks to health. Among the trends that have an impact on the global health are:

- Rapid changes in lifestyles and living conditions
- Population growth and demographic changes
- Increasing urbanization
- Increased mobility and migration
- Development and proliferation of communication channels
- Global trade and marketing

These changing circumstances have major health consequences that are too large to be satisfactorily addressed by individual countries acting alone. By working together, Mega countries can raise a powerful voice in support of the global health policy agenda and help to bring about positive outcomes.

According to the 2nd National Survey of Oral Health in China, 77% of 5-year-old children suffer from dental caries, with a mean dental caries experience index (dmft) value of 4.5 (Wang *et al*., 2002). Among adults (35-44 years) and older people (65- to 74-year-olds), the mean caries experience index (DMFT) scores are 2.1 and 12.4 respectively. Oral health is poorer among those living in rural areas. This poses a tremendous challenge to public health programmes and the continuous development of the oral health system.

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With the changing living conditions, lifestyles and the growing consumption of sugars, the incidence of dental caries may increase, compounded by poor access to professional care. Given that oral health has a profound impact on general health and quality of life, the increasing oral disease burden has become a major public health problem in China, leading to considerable personal and health service costs. There is an urgent need for systematic implementation of oral disease prevention programmes. 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.

In order to address this growing public health problem, 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 (Petersen and Lennon, 2004). Population-wide automatic fluoridation measures are considered the most effective (Petersen and Lennon, 2004; WHO, 1994), and such approaches are supported by a recent systematic review (MRC, 2002; McDonagh *et al*., 2000). In addition, improved use of toothpastes containing fluoride by the population is strongly recommended (Petersen and Lennon, 2004; Marinho *et al*., 2005), while fluoride mouth rinses - under certain conditions - may be relevant for risk groups (Marinho *et al*.,2004)

### *Effective use of fluoride*

Individuals can benefit from fluoride administered in different forms (e.g. tablets, drops, mouth rinse and toothpaste), by professional applications (e.g. vanish and gel) and through community-based automatic fluoridation programmes (e.g. water, milk and salt). There are advantages and limitations of each mode of delivery, which must be examined carefully prior to implementation. The clinical efficacy, technical practicality including existing infrastructure, social and cultural acceptability, potential cost-effectiveness, and political imperatives have to be considered.

### *Use of fluoride in China*

There is a wide range of fluoride concentrations in drinking water in China and, in many areas, the levels of fluoride in drinking water are lower than recommended levels. Unfortunately, according to the 2nd National Oral Health Survey (NOHS) only 17% of 12-year-olds and 10% of 18-year-olds are using toothpaste containing fluoride (Zhu *et al*., 2005), although the figures have improved dramatically in Beijing according to a recent study (Liu *et al*.,2007). The use of toothpaste containing fluoride decreases with age and those who live in rural areas have limited access to affordable toothpaste containing fluoride (Zhu *et al*., 2003 and 2005). Furthermore, 69% of children and adolescents stated that the effect of fluorides in caries prevention is not clear. According to the 2nd National Oral Health Survey (Zhu *et al*.,2003 and 2005), the use of toothpaste containing fluoride apparently is much lower in adults than in children as only 6% of 35-44-year-olds and 4% of 65-74-year-olds reported use of toothpaste containing fluoride; 86% claimed having no knowledge about fluoride.

Given that access to oral health service is limited in China, professionally applied fluorides will most certainly fail to reach those who need them. Automatic fluoridation schemes may be more appropriate (WHO, 1994; Petersen and Lennon, 2004). For example, water fluoridation is the most effective way of reaching the whole population, provided that the infrastructure is in place. However, this may be more challenging in the most needy rural areas. Milk fluoridation, which can be promoted in schools, may be a good alternative, which can form part of a Health-Promoting School strategy (Kwan *et al*., 2005) Initial milk fluoridation schemes in China have shown promise (Bian *et al*., 2003) However, the feasibility of salt fluoridation programmes in this Mega country remains unclear and should be further explored in view of the fact that, the cariostatic effect of salt fluoridation has proven similar to that of water fluoridation and that, with adequate epidemiological surveillance it can be implemented in communities or regions where water fluoridation would not be feasible.

China is a Mega country presenting all levels of development and environments, and it experiences different evolutions in the current shifting disease patterns. There is a need to identify the most feasible strategy for fluoridation programmes in China, taking into account the needs of the population, barriers to implementation, socio-environmental factors and capacity of the oral health system.

## Scope, purpose and objectives of the symposium

With the changing lifestyle and growing consumption of sugars, dental caries may further increase as a major public health problem in China, posing a tremendous challenge to the continuous development of the oral health system. This increasing oral disease burden could lead to considerable personal and health service costs. Thus, there is a need to implement systematic preventive programmes as part of the overall non-communicable disease (NCD) prevention programmes.

Effective use of fluoride is an essential approach to prevent dental caries and forms a vital part of the WHO Global Oral Health Strategy (Petersen, 2003: Petersen and Lennon, 2004). Population-wide automatic fluoridation measures are considered the most effective, supplemented by improved use of toothpastes containing fluoride. In March 2006, the WHO Global Oral Health Programme organized a three-day symposium which was held from 13th to 15th March 2006 in Beijing, People's Republic of China. The aim of the symposium was to bring together international experience and expertise to facilitate policy development for effective use of fluoride in China, highlighting the benefits of, and barriers to, the implementation of different fluoridation programmes at the strategic level as well as for operational planning.

Specific objectives of the symposium were to:

1. analyse the evidence available on effective use of fluorides for prevention of dental caries;

2. share the experiences and barriers from different community-based fluoride prevention programmes implemented in China and other developed and developing countries and in relation to different settings and population groups;
3. analyse the conditions for implementation of automatic fluoridation programmes in PR China (i.e. water, milk and salt);
4. discuss the evaluation of community-based fluoridation programmes based on the WHO recommendations; (Petersen and Kwan, 2004)
5. contribute to the process of increasing public awareness of the relevance of fluoride for dental caries prevention;
6. facilitate translation of science into fluoride action programmes; and
7. promote the evidence-based decision-making for developing community-based systematic use of fluoride for caries prevention.

The programme of the symposium focused on:

- various methods of fluoridation from biological, clinical, and public health perspectives;
- exchange of knowledge and experiences between countries worldwide;
- feasibility of implementing various fluoridation programmes in China;
- public awareness and social acceptability of fluorides;
- the role of the National Committee for Oral Health (NCOH) in promoting the use of fluorides;
- barriers and constraints for various fluoridation programmes in China;
- implications for policy development; and
- how fluoridation schemes can be incorporated into national strategies for non-communicable chronic disease prevention, taking into account the Bangkok declaration on Health Promotion in the 21st century (www.who.int/en/) and the Liverpool Declaration on Oral Health Promotion in the 21st century (www.who.int/oral_health)

## Outline of the structure of the symposium

Twenty-nine participants attended the 3-day symposium, including representatives from the Ministry of Health (MOH), public health administrators, NCOH and university academics from different parts of China, together with world leading experts from seven other countries. There were 10 sessions in total. A number of short papers were presented in each session, followed by a general discussion. The evidence of effective use of fluorides and experiences of various fluoridation programmes in China as well as globally were discussed. This was followed by presentations of policies on, and public awareness of, fluorides in China. The views and impact of anti-fluoridationists in China and globally were considered. During the final day, national strategies for NCD prevention in China, and the role of NCOH, MOH of China and WHO in the promotion of fluoridation, were discussed. Summaries of the presentations are given in the next section. Finally, Dr Poul Erik Petersen (WHO) presented the conclusions and recommendations of the symposium, emphasising the specific roles of MOH, NCOH and WHO.

## Summary of Presentations

### *WHO global policies on use of fluorides for dental caries prevention*

**Dr Poul Erik Petersen**

Dr Petersen described the burden of oral disease globally and particularly in Asia. Despite an improvement in oral health in some high-income countries, dental caries remains a major public health problem, affecting 60-90% of schoolchildren and the majority of adults. A change in the pattern of dental caries experience has been observed in the past few decades. There has been a decline in caries in many industrialised countries and a rise in certain developing countries. Dental caries, as a disease, is not eradicated but only controlled to a certain degree. In the WHO Western Pacific Region, while caries levels have decreased in some countries such as Australia and Japan, prevalence of dental caries is rising steadily in China among 12-year-old children, with the majority of dental caries being untreated. Findings of the 3rd national survey will provide further information. There is a need to strengthen the preventive programmes. Appropriate use of fluoride is considered to be the way forward, and this is a key part of the WHO Global Oral Health Strategy. For countries with limited resources, such as China, automatic fluoridation would go a long way to prevent dental caries, together with other programmes that target risk factors. Currently, China is strengthening its non-communicable disease (NCD) prevention programmes, which provides a wonderful opportunity to integrate dental caries prevention into the overall strategy. There is a need for a situation analysis, particularly in relation to the urban and rural differences, in order to facilitate policy development and action plans.

### *The evidence for use of fluorides: public health perspectives*

**Professor Mike Lennon**

Firstly, Professor Lennon reiterated the value of systematic reviews and their strict methodological procedures. He then made reference to the major reviews on water fluoridation, toothpastes containing fluoride and rinses. Given that access to oral health services is limited in China, fluoride gel and varnish that require professional application were not considered in this presentation. Based on the findings of these systematic reviews, he concluded that (1) water fluoridation reduces the prevalence of dental caries significantly; (2) water fluoridation is not associated with any adverse health effects such as mortality, cancers, bone density and bone fracture; (3) too much fluoride causes mild enamel fluorosis; (4) toothpastes containing fluoride and rinses reduce the caries increment by a quarter; and (5) using water fluoridation and toothpaste containing fluoride together yield additional benefits.

### *The evidence for use of fluorides: biological and clinical perspectives*

**Dr Alberto Villa**

Based on laboratory and clinical research, fluoride is

the most effective caries-preventive agent, particularly when a low level of fluoride is maintained constantly in the oral cavity. Historically, the first community-based programme was the artificial adjustment of fluoride concentration of drinking water to the "optimal" value of 1ppm, a value that was derived from Dean's pioneering epidemiological studies in the Mid-western states of the USA. However, fluoridation may lead to some degree of enamel fluorosis. He then discussed the metabolism of ingested fluoride; a proportion of which will be absorbed into the bone, while the rest will be excreted. It is important to note that other fluoride sources such as fish, tea and coal burning may also contribute to the total fluoride intake. Hence the total fluoride intake of young children must be estimated before implementing any artificial fluoridation programmes. The levels of urinary fluoride provides an estimate of fluoride intake and such a procedure is simple to undertake. In westernised countries, toothpastes containing fluoride are the most significant source of ingested fluoride. A rational use of fluoride has to be based on caries-fluoride interactions as well as pharmacokinetic and toxicological behaviour of the fluoride agents. Cost-effectiveness analysis must also be considered. In conclusion, it is not possible to recommend a *"one and only"* or *"the best"* fluoride programme. Decisions on the most appropriate public health programme should take into account the economic development of the community; living conditions; education levels; caries prevalence, incidence and distribution in the population; oral hygiene habits; access to dental services; dietary practices; use of toothpaste containing fluoride and other fluoride exposure.

### *Fluoridation programmes in low- and middle-income societies*

**Dr Prathip Phantumvanit**

Dr Phantumvanit described the fluoridation programmes in low- and middle-income countries. In low-income countries, many fluoridation programmes have been implemented, such as water and salt fluoridation and school toothbrushing drills with toothpaste containing fluoride. For example in Vietnam, water fluoridation results in substantial caries reduction with a high level of public acceptance. In Costa Rica, salt fluoridation indicated a reduction of caries by 73% over 15 years among 12-year-old children. In middle-income countries, milk fluoridation, fluoride varnish, fluoride releasing dental materials and toothpaste programmes have been considered. For example, a milk fluoridation scheme has been implemented in Bangkok, Thailand since 2000. Overall a 30% caries reduction is observed. In Nepal, silver diamine fluoride varnish has been used as secondary prevention on carious lesions in deciduous teeth where restoration is not available. In conclusion, fluoridation programmes in low-income societies are carried out as part of the ongoing public health measures as well as aiming at high-risk groups, with minimal professional manpower involvement. In middle-income countries, fluoride can be delivered through routine individual and family self-care, by professional applications and public health programmes, supported by public policies and social marketing.

### *Water fluoridation: global experiences*

**Professor Denis O'Mullane**

Professor O'Mullane outlined the history of water fluoridation. Lessons learned from passing the Health Fluoridation Water Supplies Act in the Republic of Ireland in 1960 and the subsequent battles with anti-fluoridationists would be useful to other countries that are campaigning for water fluoridation legislation. Globally, 355 millions people are receiving water fluoridation, and the figure is rising. The benefits of water fluoridation have been well documented worldwide. Comparison between fluoridated Republic of Ireland (now reaching 70% of the population) and non-fluoridated Northern Ireland provides a good natural controlled experiment. Multi-variate analysis shows that water fluoridation is the main reason for the low caries level in Republic of Ireland. Adults and the elderly are also benefiting from it. The effect of water fluoridation and toothpaste containing fluoride is greater than using toothpaste containing fluoride alone. While increasing prevalence of mild fluorosis is a cause for concern, measures have been undertaken to address the problem. Further surveillance is essential. Following the assessment of the best available and most reliable scientific evidence, the Department of Health and Children in Ireland concludes that at the maximum permitted level of fluoride in drinking water of 0.9ppm, human health is not adversely affected. The support for water fluoridation is overwhelming worldwide. It may be necessary to redefine the 'optimal' level of fluoride in water supplies, taking into account local conditions. In Ireland, parents should not use toothpaste when brushing their children's teeth until they reach the age of 2 years. Professional advice should be sought when a child below 2 years of age is considered at high risk of developing caries.

### *Relationship between fluoride content in drinking water and oral health in some big cities in China*

**Professor Zheng Boshan**

Professor Zheng presented the results of the research on fluoride levels in public water supplies, collected during the second National Survey of Oral Health in China. In 74% of cities in China, the fluoride concentration in tap water was less than 0.3ppm; only 6% were over 0.5ppm. None of the cities surveyed had the fluoride levels in water supplies more than 0.7ppm. Public water supplies in Shanghai uniquely contain 0.5 to 0.7ppm of fluoride. Fluoride levels in foods such as corns and tea were also assessed. The fluoride content in the majority of samples was less than 0.5ppm. However, during the drying and storing process, foods can absorb fluoride from burning coal, and fluoride levels in these foods can rise to a harmful level. The major cause of endemic fluorosis in Southwestern China is due to coal burning. The high fluoride content in some teas, in particular brick tea and black tea, is a cause for concern. Urinary fluoride was assessed among individuals aged 16-18 years old living in fluoridated areas. There was a strong relationship in fluoride concentrations between drinking water and urine. The higher levels of fluoride (even lower than 1ppm) were associated with lower caries levels. In conclusion, drinking water is the major source of fluoride intake for Chinese residents. However, fluoride concentrations in water supplies in most cities in China are too low.

## *Water fluoridation: experiences from China Mainland*

**Professor Lin Huancai**

Professor Lin reported the experience of water fluoridation in Guangzhou in Guangdong Province, the only province that has experienced artificial water fluoridation in China. The source of tap water in Guangzhou is from the Pearl River with natural fluoride concentration of 0.2-0.3ppm. In 1965, the fluoridation project was started in Fangcun District of Guangzhou. Later in the same year, the project was expended to the whole urban area of the city, costing only 0.02-0.03 RMB (Chinese currency) per person per year. The average fluoride levels ranged from 0.8ppm to 1ppm from November to April and 0.6ppm to 0.8ppm from May to October. The concentration was determined based on the climate in Guangzhou (annual average temperature of 22°C) and the experience from Hong Kong and Singapore. Evaluation after 6 years showed that there were 40% and 60% increases in number of caries free 5-year-old and 12-year-old children, respectively. However, during 1969-1974, the prevalence of enamel fluorosis had increased. Consequently, the fluoride concentration was readjusted to a lower level and the problem with enamel fluorosis was reduced. Water fluoridation was interrupted during 1976-1978 due to the shortage of sodium silico-fluoride. In 1978, due to objections, water fluoridation was only resumed in Fangcun District of the city, while Guangzhou Epidemic Prevention Station and some dental experts had suggested stopping water fluoridation altogether. Anti-fluoridationists claimed that, because fluoride contents in foods (3.5-4 mg) and tea were high, water fluoridation would cause overexposure. After 18 years of water fluoridation, Guangzhou Bureau of Health decided that the harmful effects were greater than the benefits and therefore informed Guangzhou Tap Water Company to stop water fluoridation in 1983. There are lessons to be learned. The initial fluoride levels could have been set too high and substandard equipment led to inconsistent, and frequently much higher, concentration. The supporters and protesters of the scheme had different research results on enamel fluorosis and fluoride contents in food due to different diagnostic criteria and methods used. In 1988, 5 years after the scheme discontinued, dental caries experience of 4-year-old children had increased by 62%.

## *Salt fluoridation: Global experiences*

**Professor Ramon Baez**

Salt has proved to be a reliable, safe, inexpensive and stable carrier to correct iodine deficiency on a large scale for over 80 years and has paved the way for the introduction of fluoridated salt. Professor Baez outlined the historical background of salt fluoridation and schemes in European countries, such as Switzerland, Spain, France and Germany. The advantages of salt fluoridation were reiterated. In particular, salt fluoridation is ideal for countries or regions with few central water systems. The cariostatic effectiveness of fluoridated salt has been well documented. For example, 84% dental caries reduction among 12-year-olds has been observed over 10 years in Jamaica where all salts are fluoridated. Remarkable caries reduction has also been observed in Colombia (52%), Costa Rica (73%), State of Mexico (43%) and Uruguay (40%). Salt fluoridation has been implemented in several countries in the Americas with various degrees of success that are closely associated with quality control and adequate epidemiological surveillance. The WHO recommends that when considering salt fluoridation or any other community programme using fluorides, it is important to assess existing fluoride exposure and consumption, baseline information on dental caries and fluorosis, available technology, cost and legal requirements. Addition of fluoride to salt is technically possible in salt refineries but not feasible in cases of preferred use of "crude" salt. Fluoridated salt, when feasible, can easily reach entire populations even in remote regions, at very low cost. The cost is about 6c (US) per person per year. Salt fluoridation programmes have the flexibility to be either national or limited geographically, provide choice or be obligatory, be combined with iodised salt or not and still be effective and viable. The development, implementation and maintenance of an epidemiological surveillance system are essential.

## *Salt fluoridation: Experiences in China*

**Professor Bian Zhuan**

Professor Bian described a 3-year single blind, randomised controlled trial (RCT) of the effect of salt fluoridation on dental caries in primary teeth of children in Wuhan city, using 200-250ppm fluoridated salt. The fluoride concentration in drinking water in the city is 0.3ppm and the use of toothpaste containing fluoride is low. In total, 414 3-4 year-old kindergarten children were recruited. All children had 3 meals in the kindergarten each day and the average salt consumption was 3-4g per day. Clinical dental conditions and urinary levels were assessed. Compared with the control group, about 50% reduction in caries experience (mean dmft and dmfs) at the end of the trial was observed. There were no differences in urinary levels between the test and control group. No enamel fluorosis was found during the study period. He then presented the results of the second study that evaluates caries in permanent first molars after salt fluoridation has ceased. After the scheme had stopped for 1 and 2 years, caries prevalence of children in the test group was significantly lower than that of the control group, with a 66% and 48% reduction respectively. However, there were no differences between test and control groups at year 3 and 4. Similar results were found for mean DMFT. However, the mean DMFS of the test group were significantly lower than those of the control group in all 4 years, although the differences were decreasing over time. No enamel fluorosis was found. Professor Bian concluded that 200-250ppm fluoridated salt was an effective and safe way to prevent dental caries in primary teeth and remained effective on permanent first molars after the programme had stopped for 1-4 years. A further RCT, investigating the effect on root caries, supported by NCOH, is in progress. However, he felt that salt fluoridation still has a long way to go as it is only available in certain shops and allowed to be sold around Yangzi River cities where fluoride levels in drinking water are low. Public awareness of fluoridated salt is also poor. In some mountain areas with high levels of fluoride (e.g. Hubei), it would be difficult to control exposure.

### *Milk fluoridation: Global experiences*

**Professor Andrew Rugg-Gunn**

Professor Rugg-Gunn outlined the background, scientific basis, technical aspects and biological plausibility of the effectiveness of milk fluoridation. He then described the current milk fluoridation programmes in 6 countries in different parts of the world using different types of fluoridated milk (fresh pasteurised, UHT and powdered). To date, 19 studies of 15 schemes have been published in 10 countries. Caries prevention in 13 of the 15 programmes is demonstrated. The effectiveness has been shown in both primary and permanent dentitions. This is confirmed by a systematic review published in 2005. However, the review also highlights the need to establish a protocol for high quality evaluations. It is important to assess the fluoride intake before programme implementation and to monitor urinary fluoride levels and enamel fluorosis during and after the scheme.

### *Milk fluoridation in China*

**Professor Wang Wenhui**

Professor Wang described a milk fluoridation scheme in Beijing, China. Prior to implementation, a feasibility study was conducted from 1991-1994. The scheme was approved by the MOH, with full support from local government and the dairy. In November 1994, a 5-year community-based milk fluoridation programme was implemented in Haidian District, involving 4000 preschool children. The first phase evaluation was conducted in June 1997. There were no differences in mean dmft in children between test and control groups. The possible reasons for the results could be due to the high sugar content in fluoridated milk and the number of days in school where children were exposed to fluoride. Some adjustments were made in the second phase to include milk consumption at weekends and to reduce the amount of sugar in milk. The final evaluation was undertaken in June 1999. The mean dmft and caries incidence of the test group were significantly lower, compared with the control group. In conclusion, milk fluoridation is effective, safe and feasible in caries prevention. It is suitable for children with high caries experience in primary teeth. However, given that this was a pilot study, further community-based research is needed.

### *Topical use of fluorides and use of fluoridated toothpaste: global experiences*

**Professor Edward Lo**

Professor Lo focused on toothpastes containing fluoride, mouth rinses, gels, foam and varnishes and their indication and effectiveness, and listed the Cochrane systematic reviews in support of effectiveness. Based on the findings of a systematic review, the effectiveness of toothpastes containing fluoride increases with higher baseline caries levels, higher fluoride concentration, higher frequency of use, and supervised brushing. The effectiveness is not affected by water fluoridation. It is an important public health measure; efforts should be made to extend its use. In contrast, fluoride mouthrinses may be more suitable for high-risk groups and they should not be recommended for children below 6 years of age. Its effectiveness is not significantly related to baseline caries levels, background exposure to fluoride, rinsing frequency and fluoride concentration, according to a Cochrane review. Similarly, fluoride gels and vanishes are more suitable for high-risk individuals. However, they must be used with care. In order to reduce the potential risk of excessive fluoride ingestion following gel application, fluoride foam was developed. Some clinical results show that its effectiveness is similar to that of gels. Silver (diamine) fluoride solution has been used in Japan and Australia for over 30 years and has been shown to be effective in preventing and arresting caries in some studies. In summary, there is a long history and widespread topical use of fluorides globally, both by professionals and as self-care products. There is clear evidence of their effectiveness on caries prevention. Reports on adverse effects are scarce, mainly the risk of developing mild enamel fluorosis when used by young children. There is a clear dose-response relationship for fluoride concentration and frequency of use. However, there is no clear evidence to suggest that any one topical fluoride agent is more effective than others; each with different advantages and disadvantages, with caries reduction ranging from 24% to 46%. The choice of method will depend on the target population and prevailing conditions.

### *Experiences of topical fluoride use in China*

**Professor Hu Deyu**

According to Professor Hu, while toothpastes containing fluoride, foam, varnishes and gels with both foreign and domestic brands are readily available in China, fluoride mouthrinses are not common in shops. Toothpaste containing fluoride called 'Three Stars' was available several years ago in Shanghai. The use of toothpaste containing fluoride has been rising sharply, particularly in the last few years. Sales were 4.5 tubes of toothpaste per person per year in 2005, double the amount in 2000. All foreign brands contain fluoride, constituting 80% of market shares. Numerous studies of topical fluoride products have been published in Chinese journals. Although the majority of publications focus on toothpastes, foam and varnishes, there are 50 papers published in the past two decades on other products such as fluoride solution, dental floss, iontophoresis, sealants and glass ionomer. The stability and concentration of fluoride in the products, plaque and saliva have been investigated, as have the effects on caries, plaque, dentine hypersensitivity and enamel remineralisation. Fluoride content in urine and hair is monitored. In conclusion, topical use of fluorides is safe and effective. The use of toothpaste containing fluoride is the most efficient means of controlling dental caries. Professionally applied fluorides could be increased, especially in dental clinics. Fluoride dental care products will be developed rapidly in the future. Finally, he posed three questions. *'What fluoride concentration in toothpaste is safe and effective in children less than 6 years old?' 'Can fluoride foam be used in schools as a public health measure for preventing dental caries?' 'What concentration is better for fluoride foam and varnish to be used in children?'*

### *Policies on use of fluorides in China*

**Professor Bian Jinyou**

Professor Bian provided an overview and the theoretical basis of policy making. Value tendency, research evidence

and available resources are the three important influencing factors. He then presented an example of making a fluoride policy in China. He examined the distributions of caries status, skeletal and enamel fluorosis due to coal burning, and fluoridation programmes in China. For example, 200 million people live in areas with high exposure of fluoride. Based on the results of the analysis between benefits and adverse effects, a policy on public water fluoridation was developed and approved at the National Political Consultation Congress with promising responses. Plans for expanding milk fluoridation schemes have experienced some difficulties. For salt fluoridation, there are problems with the production, supply and distribution in China. "Social evidence" of effectiveness of fluoridation for policy development is still lacking. Correctly informing the media was important as, for example, they often considered toothpaste containing fluoride was considered as a 'two-edged sword'.

### *Policy on use of fluorides in China*

**Professor Fan Mingwen**

Following Professor Bian's macroscopic views of policy making, Professor Fan presented an example of a national fluoridation policy in China. He listed statistics on fluoride pollution from coal burning and prevalence of enamel and skeletal fluorosis. For example, 14 provinces had fluoride pollution from coal-burning; 2.8 million people were reported to suffer from skeletal fluorosis, and 39 million from dental fluorosis. The fluoridation policy considers both defluoridation in rural areas with overexposure, and fluoridation programmes in other areas with high caries prevalence and water fluoride content below the optimal level. While water fluoridation is considered the most effective and equitable public health measure for preventing dental caries, there must be adequate control and supervision to ensure the procedures are conducted properly. Recommendations on other community-based fluoridation, as well as professionally applied and self-care fluoride agents, were also presented.

### *Public awareness on fluorides in China*

*Professor Zhu Ling*

Professor Zhu reported research findings on the public's awareness of, and attitudes to, fluoride including enamel fluorosis. At present, 69% of toothpastes sold in China contain fluoride. According to the 2nd National Oral Health Survey in 1995, oral health knowledge is poor and nearly half the people surveyed said that they had never received any oral health information. For those who claimed to have received oral health advice, radio and television were the main source. Misleading messages from the mass media about fluorides are a cause for concern. In a study published in a Chinese Journal in 2006 investigating the knowledge and use of toothpaste containing fluoride, over 85% of students, parents and teachers in Haidian District of Beijing were using fluoridated toothpaste. About 3 in 5 of these subjects believed that toothpaste containing fluoride was good for teeth. Again, the main source of information was from the media and authorities' recommendations. There is still a need to provide clear and correct messages about fluorides to the public through effective oral health promotion.

### *Fluoride: Enhance the benefit, remove the hazard*

**Professor Sun Guifan**

Professor Sun examined the arguments for supporting and opposing the implementation of water fluoridation. He reiterated the fact that people's awareness of the benefits and adverse effects of fluoride was poor. He was particularly concerned about the prevalence of fluorosis caused by coal burning in rural villages. As standard of living increased, the use of bottled drinking water will become very popular in China, which should be considered carefully when implementing fluoridation programmes. He then presented the opinions of a public health researcher and put forward some suggestions for consideration. There is a need to inform the public of both benefits and hazards of fluoride and to control fluoride levels in foods and the environment. Fluoridation policies must be based on the principle of enhancing the benefits and removing the harm. It might be prudent to fluoridate the cities first. High quality scientific research and surveillance systems are essential.

### *Discussion on the issues of preventing caries by fluoride*

**Professor Guan Zhizhong**

Professor Guan reviewed the history of fluoride on health. As an anit-fluoridationist, he presented some evidence of the causes of endemic fluorosis such as coal burning. Foods that are dried in the contaminated atmosphere could have high levels of fluoride. He then listed the fluoride contents in some foods and human organs, including the histopathology involved. Effects of fluoride on central nervous system and IQ of humans and on brain tissues of rats were described. The results of the two surveys in China, showing a correlation between higher fluoride intake and lower IQ, were presented. He concluded that it was important to take comprehensive measures for the prevention of both fluorosis and caries, and funding to support fluoride research was essential. However, he did not recommend water fluoridation and believed that well controlled topical fluoride programmes could be sufficient for those who were at risk of dental caries.

### *Global experiences on the impact of anti-fluoridationists*

**Professor John Spencer**

Professor Spencer emphasised that his remarks applied to countries, such as Australia, New Zealand, USA, Hong Kong, Singapore, which have water fluoridation but without endemic fluorosis. He explained the strategies used by anti-fluoridationists – the 'frequently taken paths'. However, their tactics could lead to 'controversy' in the media and uncertainty among decision-makers on the effective use of fluorides. Their influence is disproportionate to their numbers or the veracity of their arguments. The Internet is becoming more and more influential. In order to avoid misleading messages, quality research evidence, education and promotion of the effective use of fluorides are crucial. There is a need to generate new knowledge, as well as to build on existing evidence. Systematic reviews of existing evidence are one of the ways forward, but narrative reviews are also important. It may be necessary to redefine the use of fluoride from

a political/community issues to a public health issue, to stress the right of all to benefit from available scientific research, to target key information gatekeepers and collective decision-making bodies and to build supportive coalitions outside dentistry. It is important to realise that no policy is absolute – it is relevant 'at the time'. He then presented an example of an Action Plan and lessons learned from promoting water fluoridation in Australia. In summary, anti-fluoridationists often follow 'frequently taken paths'. These can be anticipated and an Action Plan, which must be carefully planned and often involves a big team, will increase the likelihood of fluoridation going ahead. Such Action Plans will need elements of research, education and promotion. Programmes that have adopted an Action Plan approach are having success.

### *The role of NCOH in promoting use of fluorides*

**Professor Zhang Boxue**

Professor Zhang gave a brief introduction to the NCOH and its work in promoting the use of fluorides. NCOH was founded in 1988 and worked at three levels – provincial/regional, country/district and city/town. NCOH had seven commissions, of which 'fluorides and caries prevention' was one. There had been important meetings discussing fluoride in 1991 and 1997. Programmes included a milk fluoridation programme in 1994-1999, studying the anti-caries efficacy of toothpaste containing fluoride in kindergarten in 1998-2000, a feasibility study of water fluoridation in Beijing in 2000-2002, assessing the stability of toothpaste containing fluoride in the market in 2004, an investigation on the utilisation of toothpaste containing fluoride in 2004, an evaluation of psychological effects of fluorosis in 2005 and the annual Love Teeth Day Campaign. Professor Zhang said the Committee was also responsible for fluoride products endorsement, professional training and developing the national Oral Health Care Planning Programme. Professor Zhang listed numerous research papers and review articles on various fluoride topics, published in Chinese journals.

### *Using topical fluoride for caries prevention in Shanghai, China*

**Professor Feng Xiping**

Professor Feng's presentation focused on the topical use of fluorides in Shanghai, the most populated city in China. He presented some statistics on the prevalence of dental caries, fluorosis and the fluoride concentration (0.4-0.6ppm) in drinking water in the city. In addition to toothpaste containing fluoride that is used at home, fluoride gel, sealant, mouthrinse, foam and varnish have been used in schools. He then provided further details of these fluoride products. He concluded that there was a need to control the increasing caries prevalence and to improve children's oral health knowledge and awareness. Although there is a relatively high natural fluoride concentration in drinking water and the use of topical fluorides in Shanghai, no increase in the prevalence of enamel fluorosis has been found. He finished his presentation by sharing his experience of problems encountered during oral health promotion.

### *The Oral Health Care Programme in China (2004 – 2010)*

**Professor Zhang Boxue**

Professor Zhang detailed the Oral Health Care Programme in China for 2004-2010. It is led by Government, but is relevant to local conditions. He presented the background to the Programme, followed by the guiding principles, general objectives, specific goals and main strategies and measures. Optimal use of fluorides was one of the key features and children's health was a priority. There was a need to integrate oral health into general health promotion. Progress on fluoridation must be linked to defluoridation.

## Summary of key issues from discussion sessions

During the discussions, many points were made. They were summarised as follows.

- High dental caries levels in primary teeth and low in secondary dentition among children were discussed at length. These contrasting caries patterns among Chinese children have been observed in many low- and middle-income countries worldwide. Numerous reasons were suggested. Sugary powdered formula milk, bedtime dietary habits and nutrition in early years may be important contributing factors. Future research must address these issues.
- As economic status improves, dental caries may increase in the future in China. The outcome will be the result of the competing effects of the rise in caries-promoting consumption of sugars and the increasing use of caries-preventing fluorides.
- Dental caries affects the anterior teeth of pre-school children, while enamel fluorosis occurs in permanent dentition in some regions. This must be borne in mind when considering fluoridation programmes.
- The role of automatic fluoridation in public health is evident. Automatic fluoridation has two distinctive advantages over self-care fluorides in terms of cost-effectiveness, and social equity. Self-care fluorides rely on personal behaviour, often performed among those who are least at risk, more educated people and those with better living conditions.
- Quality control of optimal fluoride levels in water supplies remains a big challenge in China.
- In rural areas when water fluoridation may not be possible, fluoridated milk and salt are good alternatives. For example, in Chile, 70% of the population living in cities receives water fluoridation; this is supplemented by milk fluoridation in rural areas where water fluoridation is not economically viable. Salt fluoridation programmes in the Americas are regulated by the national government. Decrees emanated from the Ministry of Health or standards developed by National Commission of salt fluoridation to ensure quality and characteristics of the ingredients as well as the fluoride content are part of the salt fluoridation programme. Salt fluoridation programmes have the flexibility to be either national or limited geographically, provide choice or be obligatory. If managed properly, several methods of automatic fluoridation

can be implemented at the same time, depending on local circumstances and needs.

- Schools are the most appropriate and cost-effective environment to deliver fluoridated milk to schoolchildren. However, adults and older people can also gain from fluoridated milk, a cradle to grave benefit. While there is a need to extend fluoridated milk consumption beyond children, it may be more difficult to control the intake, particularly among adults and older people who may drink less milk. It may be useful to explore milk consumption patterns in different age groups in China before extending the programme beyond schoolchildren. In some countries, the average daily milk consumption for adults is about 0.5 litres.
- It is necessary to go beyond demonstration programmes to develop sustainable population programmes for milk fluoridation. Milk fluoridation programmes can form part of the overall diet and nutrition strategy for both general and oral health.
- In China, while the Ministry of Agriculture is responsible for national school milk programmes, different regions have different schemes with varying degrees of success.
- There was discussion on whether there is a need for fluoride in toothpaste in areas that have automatic fluoridation. In Thailand, toothpaste containing fluoride is used in addition to automatic fluoridation. The correct dosage is critical. Similarly in Hong Kong, 1000ppm toothpaste containing fluoride is used among young children alongside water fluoridation (with the concentration of 0.5ppm). These findings agree with the Cochrane review, which concludes that water fluoridation does not affect the use of topical fluoride agents; they are complementary.
- Shanghai provides a good natural experiment. Topical fluorides including toothpaste containing fluoride are used in a city with natural water fluoridation and no fluorosis is reported.
- Fluoride concentration in toothpaste has a dose-relationship with the degree of dental caries prevention. Fluoride concentration of 1500ppm is more effective. Over 6 years of age, the role of <1500ppm toothpaste containing fluoride is questionable. This is an important message.
- There are some discrepancies between findings of the national surveys and toothpaste companies' data regarding the use of fluoridated toothpaste in China.
- There are misconceptions about fluorosis that need to be made clear to non-dental personnel and the general public. Fluorosis only occurs during tooth development, which occurs in childhood. The critical age for aesthetically important front teeth is before 6 years of age. The side effect of inadvertent swallowing of toothpaste containing fluoride may lead to mild enamel fluorosis in a small proportion of people, but only when toothpaste ingestion is excessive. There are no risks after tooth eruption.
- The situation in China is unique, with endemic fluorosis due to several sources of excessive fluoride. It is important to control skeletal and enamel fluorosis without jeopardising the prevention of dental caries.
- In China, people move from rural villages to cities and from cities to cities. Such high population mobility in China could be problematic in local application of policies.
- A combination of high fluoride ingestion and inhalation, calcium deficiency and malnutrition may severely increase the occurrence and severity of dental and skeletal fluorosis.
- Sources of fluoride in endemic fluorosis areas merit further investigation. There is a need to bring down the level of ingested fluoride in these areas to an accepted level.
- China is a Mega country that has a variety of situations. Fluoridation policies must be adaptable to local applications. How can a policy be generated nationally and be applied locally in China?
- The Chinese government is spending 30 billions RMB to help rural areas tackle the high fluoride levels in the environment. However, it still has no fluoridation policy on effective use of fluorides to address problems of poor dental health.
- Policy development is a political issue more than a technical issue. The big problem is how to influence policy makers and leaders in China.
- If political leaders are interested in defluoridation, it provides a wonderful opportunity to broaden this policy to bring about the optimal level and effective use of water-borne fluorides, addressing the issues of both overexposure and underexposure.
- In some countries the central government introduces the legislative framework for fluoridation, while local people make the final decision locally. This may not be the case in China as decentralisation of legislation is difficult. However, China has two parallel systems. While some legislation has to be made from the top, some are made at the county level. Similarly in Australia, the national government sets the overall policy with state governments and health ministers; state governments then have the responsibility for implementation.
- High risk and population fluoridation strategies can be considered at the same time to complement each other. There should be no conflict as they are not alternatives.
- A sugar policy should be considered alongside a fluoridation policy.
- Determining an optimal level of fluoride is complex but not insurmountable in China. It has to be made at a level after appropriate risk evaluation.
- In China, developing a fluoridation policy has depended on demonstration projects that were discontinued when funding ended. This limited the scientific base.
- More research is needed to determine the optimal fluoride dose, by examining total fluoride intake and urinary fluoride levels.
- The optimal age for monitoring urine fluoride levels in children is about 3-5 years of age and the important information is the quantity of fluoride excreted in 24 hours. The units used for urinary fluoride should be concentration (mg/L) and excretion rate (μg/h) or (μg/24h).

- China is renowned for its 'one country – two systems' policy. There are no conflicts between different policies in health and fluorides across different areas. However, a common health surveillance system is needed.
- High quality research evidence is needed to inform decision-making, translating science into politics

## Summary of recommendations

- Total fluoride intake should be ascertained and monitored prior to and regularly as part of the fluoridation programme. Operational research may help determine the optimal fluoride intake and urinary fluoride levels and excretion rates.
- Determining an optimal level of fluoride is complex but not insurmountable in China and it has to be made at a local level after appropriate risk evaluation.
- The situation in China is unique with endemic fluorosis due to several sources of excessive fluoride intake. It is important to control skeletal and enamel fluorosis without jeopardising the prevention of dental caries.
- The complexity of formulating fluoridation strategies in China is acknowledged, a vast country with much diversity. Differences between different provinces, cities, and between urban and rural areas are marked, with varying dialects, environmental factors, social determinants, living conditions, lifestyles, diets, fluoride concentrations in water and use of fluorides in general.
- The health service system in China is complex; services are highly centralised and hospital-based. Community-based provision is still lacking. While there are facilities in cities, they only serve about 30% of the total population. The remaining 70% of population mostly living in rural areas are neglected, which adds to the complexity of delivering fluoride programmes in rural areas.
- Similar to many countries, social inequalities exist in China. However, the manifestation is different. With changing lifestyles and increasing sugar consumption, dental disease levels in developing countries are rising and there is no exception in China. Politicians are often concerned about how to bridge the gap between the rich and poor. Automatic fluoridation (i.e. fluoridation through drinking water, salt or milk) can help reduce oral health inequalities. Fluoridation of salt has been demonstrated to be an efficient public health measure, inexpensive and safe method for prevention of dental caries and its use in developing countries may have an added benefit since it is compatible with the use of toothpaste containing fluoride.
- Population-wide strategies may be more appropriate than high-risk strategies in tackling public health issues, promoting Health for All.
- There is a need to develop sound fluoride policies, ensuring that these match the needs of the population. A multi-tier policy making strategy at national, 'sub-national' and provincial levels will have to be considered.
- Politicians and health professionals must have sound evidence. The 1st, 2nd and 3rd Oral Health Surveys in China will help inform policy making, as will local surveys of oral diseases, fluoride exposure, milk and salt consumption and dietary habits.
- It may also be necessary to identify those with highest burden of disease.
- A number of platforms for action programmes have been suggested for consideration, such as healthy environments, risk factor approaches, Health-Promoting Schools, mass communication and health education; working with health authorities, industries and the media.
- Given that Health-Promoting Schools have been adopted by the Chinese government, it may be useful to strengthen the use of fluorides through them. Linking oral health with the overall non-communicable chronic disease prevention will prove valuable, addressing common risk factors.
- China is in the process of reorienting health services, and this change provides an excellent opportunity to incorporate automatic fluoridation (water, milk or salt) in the overall agenda and national programme development.
- Promotion of health in general can be strengthened through promoting the use of fluorides.
- Working in partnership with health professionals, researchers, opinion leaders, politicians, policy makers, CSA, NGOs and other agencies is crucial.
- It is important to act promptly while there is a political will to consider fluoridation.
- The specific roles of the Chinese Centre for Disease Control at the Ministry of Health, the National Committee for Oral Health and WHO (both at Headquarters and the Western Pacific Regional Office) are emphasised.

## Conclusion

*Dr. Poul Erik Petersen*

Formulating fluoridation strategies in China is complex, a vast country with much diversity. Differences between different provinces, cities, and between urban and rural areas are marked, with varying dialects, environmental factors, social determinants, living conditions, lifestyles, diets, fluoride concentrations in water and use of fluorides in general. The health service system in China is considered complex; services are centralised and hospital-based. Community-based provision is still lacking. While there are facilities in cities, they only serve about 30% of the total population. The remaining 70% of population living in rural areas are underserved or neglected, which adds to the complexity of delivering fluoride programmes in rural areas. Similarly to many countries, social inequalities exist in China. However, the manifestation is different. With changing lifestyles and increasing sugars consumption, dental disease levels in low and middle income countries are rising and there is no exception in China. Politicians are often concerned about how to bridge the gap between the rich and poor. Water fluoridation can help reduce oral health inequalities. Population-wide strategies will be more appropriate

than high-risk strategies in tackling public health issues, promoting Health for All. There is a need to develop a sound policy, ensuring that the system matches the needs of the population. A multi-tier policy making strategy at national, 'sub-national' and provincial levels could be considered. Politicians and health professionals must have sound evidence. The 1st, 2nd, 3rd and 4th National Oral Health Surveys in China will help inform policy making, as will local survey findings of oral diseases, fluoride exposure, milk and salt consumption, dietary habits, and knowledge of health issues and behaviour. It is necessary to identify those with the highest burden of disease.

A number of action programmes have been suggested for consideration. Given that the Health-Promoting Schools framework has been adopted by the Chinese government, it may be useful to strengthen the use of fluorides through this programme. Linking oral health with the overall NCD prevention will prove valuable, addressing common risk factors. The isolation of oral health promotion must come to a stop. Currently, China is in the process of reorienting health services, which provides an excellent opportunity to incorporate fluoridation in the overall agenda and national programme development. He believed that promotion of health in general could be strengthened through promoting the use of fluorides. Working in partnership with health professionals, researchers, opinion leaders, politicians, policy makers, CSA, NGOs and other agencies is crucial. He urged everybody to act promptly while there is a political will to consider fluoridation. Finally, the role of the Centre for Disease Control at the Ministry of Health, NCOH and WHO, both at Headquarters and the Western Pacific Regional Office, is critical to take this initiative forward.

In summary, China is a Mega country with much diversity and disparity. The situation in China is unique with endemic fluorosis due to other 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 maximise the benefits and minimise the possible untoward of fluorides, controlling fluorosis without jeopardising the prevention of dental caries. Various complementary fluoridation programmes can be considered for different groups with varying needs, strategies that bring about additive effects. A multi-tier policy making approach at national, regional and provincial levels can be employed, based on sound evidence. The roles of WHO, MOH and NCOH shall be emphasised.

By working together, Mega countries can raise a powerful voice in support of the global health policy agenda and help to bring about positive outcomes. While this initiative focuses mainly on China, it provides a useful model for other Mega countries, contributing to information sharing of experiences, and successful health promotion policies and programmes. Lessons learned from the Chinese experience will prove invaluable to other countries that are in the same process of developing and implementing fluoridation policies and programmes.

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