The effective use of fluorides in public health

Sheila Jones,[1] Brian A. Burt,[2] Poul Erik Petersen,[3] & Michael A. Lennon[4]

Abstract Dental caries remain a public health problem for many developing countries and for underprivileged populations in developed countries. This paper outlines the historical development of public health approaches to the use of fluoride and comments on their effectiveness. Early research and development was concerned with waterborne fluorides, both naturally occurring and added, and their effects on the prevalence and incidence of dental caries and dental fluorosis. In the latter half of the 20th century, the focus of research was on fluoride toothpastes and mouth rinses. More recently, systematic reviews summarizing these extensive databases have indicated that water fluoridation and fluoride toothpastes both substantially reduce the prevalence and incidence of dental caries. We present four case studies that illustrate the use of fluoride in modern public health practice, focusing on: recent water fluoridation schemes in California, USA; salt fluoridation in Jamaica; milk fluoridation in Chile; and the development of "affordable" fluoride toothpastes in Indonesia.

Common themes are the concern to reduce demands for compliance with fluoride regimes that rely upon action by individuals and their families, and the issue of cost. We recommend that a community should use no more than one systemic fluoride (i.e. water or salt or milk fluoridation) combined with the use of fluoride toothpastes, and that the prevalence of dental fluorosis should be monitored in order to detect increases in or higher-than-acceptable levels.

Keywords Fluorides/therapeutic use; Fluorides, Topical/therapeutic use; Dental caries/prevention and control; Fluoridation; Water supply; Milk; Sodium chloride, Dietary; Toothpaste/therapeutic use; Case reports; Meta-analysis; Review literature; United States; Jamaica; Chile; Indonesia (*source: MeSH, NLM*).

Mots clés Fluorures/usage thérapeutique; Fluorure usage local/usage thérapeutique; Carie dentaire/prévention et contrôle; Fluoration; Alimentation eau; Lait; Chlorure sodium diététique; Pâte dentifrice/usage thérapeutique; Étude de cas; Méta-analyse; Revue de la littérature; Etats-Unis; Jamaïque; Chili; Indonésie (*source: MeSH, INSERM*).

Palabras clave Fluoruros/uso terapéutico; Fluoruros tópicos/uso terapéutico; Caries dental/prevención y control; Fluoruración; Abastecimiento de agua; Leche; Cloruro de sodio dietético; Pasta de dientes/uso terapéutico; Casos clínicos; Meta-análisis; Literatura de revisión; Estados Unidos; Jamaica; Chile; Indonesia (*fuente: DeCS, BIREME*).

Arabic

Bulletin of the World Health Organization 2005;83:670-676.

Voir page 674 le résumé en français. En la página 675 figura un resumen en español.

Introduction

WHO recently published a global overview of oral health, which included a description of the WHO Oral Health Programme's approach to promoting further improvement in oral health during the 21st century (*1*, *2*). According to this report, dental caries continue to pose an important public health problem in most developed countries, where it affects 60–90% of schoolchildren and the vast majority of adults. It 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, the WHO report anticipates that, in the light of changing living conditions and dietary habits, the incidence of dental caries will increase in many of the developing countries in this continent. The principal reasons for this increase appear to be increasing consumption of sugar and inadequate exposure to fluorides (*3*). Few developing 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 China, while the use of fluoride toothpaste is becoming more common, its use is not the norm even among

[1] British Fluoridation Society, Ward 4, Booth Hall Children's Hospital, Charlestown Road, Manchester M9 7AA, England. Correspondence should be sent to this author (email: bfs@bfsweb.org).

[2] Department of Epidemiology, School of Public Health, University of Michigan, USA.

[3] Oral Health Programme, World Health Organization, Geneva, Switzerland.

[4] Department of Oral Health and Development, School of Clinical Dentistry, University of Sheffield, England.

Ref. No. **04-020289**

(*Submitted: 13 April 2005 – Final revised version received: 23 June 2005 – Accepted: 24 June 2005*)

those who brush twice a day, and it is more likely to be used in urban than in rural communities (*4*, *5*).

Fluoride is a key agent in reducing the prevalence of dental caries, which it achieves in at least three ways (*6*, *7*):

- by encouraging repair (remineralization) of early damage to enamel caused by acid produced by the breakdown of sugar by plaque bacteria;
- by improving the chemical structure of the enamel, making it more resistant to acid attack; and
- by reducing the ability of the plaque bacteria to produce acid.

The *WHO oral health report 2003* (*2*) noted that the prevalence and incidence of dental caries can be controlled by the joint action of communities, professionals and individuals. In many developing countries, however, access to oral health services is very limited, while in developed countries significant numbers of population groups are underserved. For these reasons, professionally applied fluorides were not considered to be relevant to this review. Rather this review will focus on public health approaches including:

- water fluoridation
- salt fluoridation
- milk fluoridation; and
- the development of affordable fluoride toothpastes.

The paper will outline the historical development of these approaches, comment on their effectiveness and illustrate their use in modern-day public health practice by means of four case studies.

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 — % of the population with decayed missing and filled primary teeth (dmft)/decayed missing and filled permanent teeth (DMFT) > 0 — by an average of 15%, and reduces the incidence of 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 has benefits in addition to those associated with the use of fluoride toothpastes alone (*8*, *10*).
- There is no credible evidence that water fluoridation is associated with any adverse health effects (*8*, *9*).
- Water fluoridation (fluoride, 1 mg/l) is associated with an increase of 13% in the risk of unaesthetic dental 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). At the present time, the public water supply in 43 out of the 50 largest cities in the USA is fluoridated. The average cost of water fluoridation in the USA has been estimated at US$ 0.72 per person per year (1999 prices) (*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). The recent and interesting example of California is described in case study 1.

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 authors 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 example (see case study 2), because virtually all salt destined for human consumption on the island has been fluoridated since 1987 (*29*, *30*).

Case study 1

Community water fluoridation in California, USA

The United States Healthy People 2010 goals (*23*) include increasing the proportion of the population of the USA that receives fluoridated water supplies from the current level of 67% to at least 75%. The extent of fluoridation in individual states varies widely, California being at the lower end of the range with fluoridated water supplies in 2002 reaching less than 30% of the state's population (*24*).

In terms of population, California is by far the largest state in the USA, with a current population of around 34 million. This population is largely urban, including many socially and economically disadvantaged citizens. National studies of dental caries in children in the USA in the 1970s and 1980s demonstrated that children in states in the Pacific region, including California, were among those with the worst dental health in the country. Although more than 98% of the population of California receives drinking-water from public water systems, in 1992 only around 16% of its population (4.8 million people) received supplies that were fluoridated (compared with more than 62% of the total population of the USA) (*24*). In 1994, an assessment of the oral health needs of California's children quantified the extent of the dental health problem (*25*) — particularly among children from poor families — and, in 1995, state-wide legislation was enacted that mandated water fluoridation for communities of 10 000 water connections or more (provided that funding was available). In 2000, a report from California's Children's Dental Health Initiative Advisory Committee stressed the benefits of water fluoridation, and recommended that access should be expanded (*26*).

Today the number of California's citizens benefiting from fluoridated supplies has increased to 9 million (28%) — including long-standing programmes in San Francisco, Long Beach, and Oakland, as well as in cities where the water supply has recently been fluoridated — Los Angeles, Sacramento, Mountain View, Escondido, and Santa Maria. Furthermore, the number is expected to increase significantly in the near future when one of California's largest water suppliers, Metropolitan Water District, implements its recently announced decision to fluoridate supplies to a further 10.5 million people in 23 major cities. This will increase the Californian population served by fluoridated supplies to around 20 million (59%). Clearly, these recent programmes in California demonstrate that community water fluoridation remains a relevant public health measure in the USA.

The concentrations of fluoride in salt used around the world range from 90 mg/kg to 350 mg/kg, although later studies suggested an optimal concentration of around 250 mg/kg (*31*). Marthaler & Petersen (*27*) provide a helpful overview of some practical aspects relating to the implementation of salt fluoridation programmes. One concern expressed — for example, in the United Kingdom — 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, those who make this objection rather misunderstand the approaches used in France, Switzerland and elsewhere. The populations of these countries 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.

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 Banoczy 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*). The latter is described in more detail in case study 3. 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

Case study 2

Salt fluoridation in Jamaica

Salt fluoridation was introduced into Jamaica (population, 2.5 million) in 1987; all salt for human consumption is fluoridated (*30*). Fluoride toothpastes had been available in the country since 1972, and while their use may have had a protective effect (*32*), the notable decline in the prevalence of dental caries after 1984 may be considered to be primarily attributable to the introduction of fluoridated salt (*27*).

In 1984, a survey of oral health carried out by the Ministry of Health reported that Jamaican children had an alarmingly high incidence of dental caries (mean DMFT, 6.7 at age 12 years). Naturally occurring concentrations of fluoride in water were uniformly low (< 0.3 mg/l), but the complexities of the public water supplies ruled out water fluoridation as a measure to address these very high levels of disease. However, as there was only one producer of salt for the whole population, salt fluoridation seemed to be the ideal alternative.

After studies of household salt consumption, a recommendation to implement a salt fluoridation programme was widely endorsed, and was approved by the Parliament in 1986 (*29*). With technical assistance from the Pan American Health Organization (PAHO), salt was fluoridated using potassium fluoride at a concentration of 250 mg/kg. Studies of the urinary excretion of fluoride, conducted at baseline in 1987 and 20 months later, indicated that concentrations of fluoride were not above those associated with water fluoridation in temperate climates.

A national survey of oral health in 1995 confirmed striking reductions in the incidence of caries in all age groups (Table 1).

Jamaica's salt fluoridation programme is apparently working well (*29*). As discussed above, salt fluoridation does not in general constrain consumer's freedom of choice. Interestingly, however, because the only salt available on Jamaica is fluoridated, that advantage clearly does not apply in this case; nevertheless, fluoridated salt is apparently well accepted by the public.

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.

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 developed 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. Uptake and use has not been uniform and is less likely among underprivileged groups. In the United Kingdom, for example, the incidence of dental caries in children was uniformly high in all social groups in the late 1950s; indeed, in Edinburgh, DMFT values for children aged 14 years were slightly higher in groups of higher social class than in those of lower social class (*44*). 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 now exists in the United Kingdom (*45*) and in many other countries (*46*).

In response to this and similar situations in many parts of the world, the WHO Oral Health Programme has promoted the development and use of "affordable" fluoride toothpaste. The annual cost of toothpaste in the USA is between US$ 6 and US$ 12 per person per year (1999 prices) (*22*). 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*). A school-based programme for "affordable" fluoride toothpaste in Indonesia is described in case study 4. This study confirms 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*).

Table 1. **Mean number of decayed, missing or filled permanent teeth (DMFT) in Jamaican children, 1984 and 1995**

Age (years)	Mean number of DMFT		Decrease in DMFT (%)
	1984	1995	
6	1.71	0.22	1.49 (87%)
12	6.72	1.08	5.64 (84%)
15	9.60	3.02	6.58 (68%)

Source: (*29*).

Discussion

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 in the 21st century. Everyone should be encouraged to brush daily with a fluoride toothpaste. In addition, 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 favourable public opinion, water fluoridation using fluoride at a concentration of 0.5–1 mg/l is the method of choice (*48*). Salt fluoridation is a widely practised

Case study 3

Milk fluoridation project in Chile

In Chile, the National Complementary Feeding Programme (PNAC) was established by the government in the early 1960s. Under this programme, every Chilean child is entitled to receive 2 kg of powdered cows' milk per month from birth until age 2 years, at no charge. After that, and until age 6 years, the child is eligible for 1 kg of milk–cereal product per month. The national coverage of this programme is around 90%. Although water fluoridation is practised extensively in Chile, it is not always practical or economic in rural communities. In 1994, the Institute of Nutrition and Food Technology of the University of Chile established a programme to assess the feasibility of using PNAC products as a vehicle for disodium monofluorophosphate. Studies of the bioavailability and absorption of fluoride derived from disodium monofluorophosphate in milk were undertaken. The community trial was undertaken in the rural community of Codegua, 100 km south of Santiago, with the similar community of La Punta, some 10 km from Codegua, being used as the control. The daily dose of fluoride from fluoridated powdered milk was 0.25 mg for infants aged 0–2 years, 0.5 mg for children aged 2–3 years and 0.75 mg for children aged 3–6 years. Results obtained after 4 years of milk fluoridation indicated that it was possible to reduce the prevalence and severity of dental caries in the primary dentition, especially in those children either born after the start of the programme or aged around 1 year when it started. The fluoride programme did not cause an additional administrative burden on the existing programme for the distribution of powdered milk and milk-cereal. Termination of the programme resulted in a deterioration in the dental health of the children in Codegua. In 2002, 3 years after the programme ended, the prevalence of dental caries was higher than that recorded immediately after the end of the programme and was equivalent to that of the children in La Punta, the community that had been used as a control. The authors recommended the extension of milk fluoridation to other rural and semi-rural areas in Chile where water fluoridation was not technically feasible (*39*, *42*).

Case study 4

Affordable toothpaste in Indonesia

The province of West Kalimantan, Indonesia, which had a relatively high prevalence of caries (DMFT, 7.15 for children aged 14 years in 1984–88), was selected as the setting for a WHO study to assess the efficacy of a toothpaste specifically manufactured as an "affordable fluoride-containing toothpaste" in a developing country with high prevalence of caries (*47*).

In 1990, major manufacturers of toothpaste were asked by WHO to consider producing an affordable fluoride toothpaste. Colgate-Palmolive was the first to bring forward a product ready for field testing, and in 1992 it was decided to conduct a school-based intervention study where the intervention group had one daily supervised tooth-brushing activity with the new affordable fluoride toothpaste, and the control group received no intervention.

Four primary schools in urban areas, and four in rural areas in each of three districts of the capital of the province, Pontianak, were selected for the study. Two urban and two rural schools in each district were allocated to the intervention group, while the remaining selected schools served as the control group, i.e. 12 schools receiving the intervention and 12 control schools in total. Baseline examinations of 2141 children aged from 6 to more than 10 years in the intervention and control groups were performed in 1993.

Children receiving the intervention carried out supervised brushing at school for at least one minute once a day using toothbrushes and the specially developed affordable toothpaste, containing fluoride at a concentration of 1000 mg/kg, supplied for the study. They were allowed to rinse with water only once after brushing. The study was evaluated after 3 years, and, in terms of caries, the DMFT increment in the children (all age groups combined) receiving the intervention was significantly (23%) less than in the children in the control group, with the younger age groups benefiting more than the older (children aged 8 years at baseline had a 40% lower DMFT increment).

This study demonstrated that it is possible to produce an affordable fluoride toothpaste that is effective in controlling caries. The study also demonstrated that, despite transportation problems and many other more urgent needs, given the commitment of the schools and the Ministry of Health, supervised school dental health programmes can also be effective in an area with "scarce resources and different living conditions" from those in which toothpaste trials are usually conducted (*47*). The next step of this evaluation should be to consider whether, if affordable fluoride toothpaste were to be marketed, what would be the uptake among populations that do not currently have access to, or make adequate use of, existing products.

alternative that has the advantage of allowing consumer choice. It should be emphasized that "topical" fluorides such as toothpaste can also have a "systemic" effect when they are inadvertently ingested by young children. Indeed, three independent studies in Australia, Canada and the USA indicate that 47–72% of dental fluorosis in children can be attributed to the systemic effect of fluoride toothpastes (*49*). Dispensing a pea-sized amount of toothpaste, encouraging parents to supervise toothbrushing by their young children, and the use of toothpastes containing less fluoride by young children are approaches to ameliorating this problem. 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 or other sources, should be taken when the prevalence of fluorosis is found to be excessive (*48*).

In parallel, 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 (*50*);
- better understand 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. ■

Competing interests: Sheila Jones is a paid officer of the British Fluoridation Society — a not-for-profit organization funded largely by United Kingdom government health promotion grants to support water fluoridation initiatives. Michael A. Lennon is unpaid Chairman of the British Fluoridation Society.

Résumé

Usage efficace du fluor en santé publique

Les caries dentaires demeurent un problème de santé publique pour de nombreux pays en développement et pour les populations démunies des pays développés. Le présent article présente l'évolution historique des stratégies de santé publique concernant l'utilisation du fluor et des observations quant à leur efficacité. Les premiers travaux de recherche et développement portaient sur les fluorures véhiculés par l'eau (d'origine naturelle ou ajoutés) et leurs effets sur la prévalence et l'incidence des caries dentaires et de la fluorose dentaire. Au cours de la seconde moitié du XX^{e} siècle, les recherches se sont focalisées sur les dentifrices et les bains de bouche au fluor. Plus récemment, des revues systématiques récapitulant le contenu des grandes bases de données ainsi obtenues ont indiqué que la fluoration de l'eau, comme la présence de fluorures dans les dentifrices, permettaient de réduire substantiellement à la fois la prévalence et l'incidence des caries dentaires. L'article présente quatre études de cas illustrant l'utilisation du fluor en santé publique moderne et portant sur :

- les programmes récents de fluoration de l'eau en Californie, États-unis,
- la fluoration du sel en Jamaïque,

- la fluoration du lait au Chili, et
- la mise au point de dentifrices au fluor « abordables » en Indonésie.

On se préoccupe actuellement de réduire la nécessité de suivre des régimes fluorés reposant uniquement sur l'action des individus et de leurs familles et de diminuer les coûts de la supplémentation en fluor.

L'article recommande aux communautés de ne pas recourir à plus d'un support systémique d'ingestion du fluor (à savoir la fluoration de l'eau, du sel ou du lait) en association avec les dentifrices au fluor, et de surveiller la prévalence de la fluorose dentaire afin de détecter les augmentations de concentration de fluor et les dépassements du niveau acceptable par ces concentrations.

Resumen

Uso eficaz de fluoruros en la salud pública

La caries dental sigue siendo un problema de salud pública en muchos países en desarrollo y en las poblaciones desfavorecidas de los países desarrollados. En este artículo se describe a grandes rasgos la historia de las estrategias de uso de fluoruros en el ámbito de la salud pública y se comenta la eficacia de las mismas. Las primeras actividades de investigación y desarrollo se centraron en el consumo de fluoruros a través del agua, ya fuera porque ésta los contuviera naturalmente o porque se añadieran a ella, así como en sus efectos en la prevalencia y la incidencia de caries dental y fluorosis dental. En la segunda mitad del siglo XX las investigaciones pasaron a centrarse en los dentífricos y los colutorios fluorados. Más recientemente, las revisiones sistemáticas efectuadas en las amplias bases de datos existentes al respecto muestran que la fluoración del agua y los dentífricos fluorados han contribuido ambos a reducir sustancialmente la prevalencia y la incidencia de caries dental. Presentamos aquí cuatro estudios de casos que ilustran el uso de los fluoruros como parte de las prácticas modernas de salud pública. Los estudios versan sobre lo siguiente:

- sistemas recientes de fluoración del agua en California, EE.UU.;
- fluoración de la sal en Jamaica;
- fluoración de la leche en Chile; y
- desarrollo de dentífricos fluorados «asequibles» en Indonesia.

El interés por reducir las exigencias de observancia de los regímenes de administración de fluoruros que dependen de la acción de los individuos y sus familias, así como el aspecto de los costos, son cuestiones recurrentes.

Recomendamos que en cada comunidad se utilice sólo un tipo de fluoración sistémica (es decir, del agua, la sal o la leche), combinándola con el uso de dentífricos fluorados, y que se vigile la prevalencia de fluorosis dental para detectar cualquier aumento de la incidencia y evitar que supere los niveles admisibles.

Arabic

References

1. Petersen PE. The World Oral Health Report 2003: continuous improvement of oral health in the 21st century — the approach of the WHO Global Oral Health Programme. Community Dentistry and Oral Epidemiology 2003;31 Suppl 1:3-23.
2. *The world oral health report 2003.* Geneva: WHO; 2003. Available from: http://www.who.int/oral_health
3. Varenne B, Petersen P, Ouattara S. Oral health behaviour of children and adults in urban and rural areas of Burkina Faso, Africa. *International Dental Journal* 2005 (in press).
4. Zhu L, Petersen PE, Wang HY, Bian JY, Zhang BX. Oral health knowledge, attitudes and behaviour of children and adolescents in China. *International Dental Journal* 2003;53:289-98.
5. Zhu L, Petersen P, Wang H, Bian J, Zhang B-X. Oral health knowledge, attitudes and behaviour of adults in China. *International Dental Journal* 2005 (in press).
6. Featherstone JD. The science and practice of caries prevention. *Journal of the American Dental Association* 2000;131:887-99.
7. Fejerskov O, Ekstrand J, Burt BA. *Fluoride in dentistry.* Copenhagen: Munksgaard; 1996.

8. McDonagh MS, Whiting PF, Wilson PM, Sutton AJ, Chestnutt I, Cooper J et al. Systematic review of water fluoridation. *BMJ* 2000;321:855-9.
9. Demos LL, Kazda H, Cicuttini FM, Sinclair MI, Fairley CK. Water fluoridation, osteoporosis, fractures — recent developments. *Australian Dental Journal* 2001;46:80-7.
10. Marinho VCC, Higgins JPT, Logan S, Sheiham A. *Fluoride toothpastes for preventing dental caries in children and adolescents (Cochrane Review).* The Cochrane Library, Chichester, UK: John Wiley & Sons Ltd; 2004. Available from: http://www.update-software.com/abstracts/ab002278.htm
11. Marinho VCC, Higgins JPT, Logan S, Sheiham A. *Fluoride mouth rinses for preventing dental caries in children and adolescents (Cochrane Review).* The Cochrane Library, Chichester, UK: John Wiley & Sons Ltd; 2004.
12. Medical Research Council. *Working Group Report: water fluoridation and health.* London: MRC; 2002. Available from: http://www.mrc.ac.uk/index/public-interest/public-news-4/public-news_archive/public-news-archive_sep_oct_02/pdf-publications-water_fluoridation_report.pdf
13. McDonagh M, Whiting P, Bradley M, Cooper J, Sutton A, Chestnut I et al. *A systematic review of public water fluoridation.* York: The University of York NHS Centre for Reviews and Dissemination. Report 18; 2000. Appendix K, page 235.Available from: http://www.york.ac.uk/inst/crd/fluores.htm
14. Arnold FAJ, Dean HT, Knutson JW. Effect of fluoridated public water supplies on dental caries prevalence. Results of the seventh year of study at Grand Rapids and Muskegon, Michigan. *Public Health Reports* 1953;68:141-8.
15. Ast DB, Smith DJ, Wacks B, Cantwell KT. Newburgh-Kingston caries-fluorine study XIV. Combined clinical and roentgenographic dental findings after ten years of fluoride experience. *Journal of the American Dental Association* 1956;52:314-25.
16. Blayney JR, Hill IN. Fluorine and dental caries. *Journal of the American Dental Association* 1967;74:233-302.
17. Hutton W, Linscott B, Williams D. Brantford fluorine experiment; interim report after 5 years of water fluoridation. *Canadian Journal of Public Health* 1951;42:81-7.
18. Kwant GW, Houwink B, Backer Dirks O, Pot TJ. Artificial fluoridation of drinking-water in the Netherlands; results of the Tiel-Culemborg experiment after 16 1/2 years. *Netherlands Dental Journal* 1973;80:6-27.
19. Ludwig TG. The Hastings Fluoridation Project V — dental effects between 1954 and 1964. *New Zealand Dental Journal* 1965;61:175-9.
20. Ministry of Health Scottish Office Ministry of Housing and Local Government. The conduct of the fluoridation studies in the United Kingdom and the results achieved after five years. Reports on Public Health and Medical Subjects No. 105. London: HMSO; 1962.
21. Department of Health and Social Security Scottish Office Welsh Office. *The fluoridation studies in the United Kingdom and the results achieved after eleven years.* Reports on Public Health and Medical Subjects No. 122: London: HMSO; 1969.
22. United States Department of Health and Human Services Centers for Disease Control and Prevention. Recommendations for using fluoride to prevent and control dental caries in the United States. *Morbidity and Mortality Weekly Report* 2001;50.
23. United States Department of Health and Human Services. *Healthy people 2010: understanding and improving health.* 2nd ed. Washington, DC: Government Printing Office; 2000.
24. Centers for Disease Control and Prevention. Populations receiving optimally fluoridated public drinking-water — Unites States, 2000. *Morbidity and Mortality Weekly Report* 2002;51:144-7.
25. Pollick HF, Isman R, Fine JI, Wellman J, Kipnis P, Ellison J. *Report of the California oral health needs assessment of children, 1993–94: Background, methodology, findings.* Oakland, CA: The Dental Health Foundation; 1999.
26. Children's Dental Health Initiative Advisory Committee. *The oral health of California's children: halting a neglected epidemic. Selected recommendations from the Children's Dental Health Initiative Advisory Committee.* Oakland, CA: The Dental Health Foundation; 2000.
27. Marthaler TM, Petersen PE. Salt fluoridation — an alternative in automatic prevention of dental caries. *International Dental Journal* 2005 (in press).
28. Burt BA, Marthaler T. Fluoride tablets, salt fluoridation, and milk fluoridation. In: Fejerskov O., Ekstrand J., et al., editors. *Fluoride in dentistry.* 2nd ed. Copenhagen: Munksgard; 1996.
29. Estupinan-Day SR, Baez R, Horowitz H, Warpeha R, Sutherland B, Thamer M. Salt fluoridation and dental caries in Jamaica. *Community Dentistry and Oral Epidemiology* 2001;29:247-52.
30. Warpeha R, Beltran-Aguilar E, Baez R. Methodological and biological factors explaining the reduction in dental caries in Jamaican school children between 1984 and 1995. *Pan American Journal of Public Health* 2001;10:37-44.
31. Marthaler T. Practical aspects of salt fluoridation. *Revue mensuelle suisse d'odonto-stomatologie (SSO)* 1983;93:1197-214.
32. Meyer-Lueckel HT, Satzinger T, Keielbassa AM. Caries prevalence among 6- to 16-year-old students in Jamaica 12 years after the introduction of salt fluoridation. *Caries Research* 2002;36:170-3.
33. Ziegler E. Milk fluoridation. *Bulletin der Schweizerischen Akademie der Medizinischen Wissenschaften* 1962;18.
34. Stephen KW, Boyle IT, Campbell D, McNee S, Boyle P. Five-year double-blind fluoridated milk study in Scotland. *Community Dentistry and Oral Epidemiology* 1984;12:223-9.
35. Banoczy J, Zimmermann P, Hadas E, Pinter A, Bruszt V. Effect of fluoridated milk on caries: 5 year results. *Journal of the Royal Society of Health* 1985;105:99-103.
36. Ketley CE, West JL, Lennon MA. The use of school milk as a vehicle for fluoride in Knowsley, UK; an evaluation of effectiveness. *Community Dental Health* 2003;20:83-8.
37. Pakhomov GN, Ivanova K, Moller IJ, Vrabcheva M. Dental caries-reducing effects of a milk fluoridation project in Bulgaria. *Journal of Public Health Dentistry* 1995;55:234-7.
38. Woodward SM, Ketley CE, Pealing R, West J, Lennon MA. School milk as a vehicle for fluoride in the United Kingdom. An interim report. *Community Dental Health* 2001;18:150-6.
39. Mariño R, Villa A, Guerrero S. A community trial of fluoridated powdered milk in Chile. *Community Dentistry and Oral Epidemiology* 2001;29:435-42.
40. Legett BJ, Jr., Garbee WH, Gardiner JF, Lancaster DM. The effect of fluoridated chocolate-flavored milk on caries incidence in elementary school children: two and three-year studies. *ASDC Journal of Dentistry for Children* 1987:18-21.
41. Bian JY, Wang WH, Wang WJ, Rong WS, Lo EC. Effect of fluoridated milk on caries in primary teeth: 21-month results. *Community Dentistry and Oral Epidemiology* 2003;31:241-5.
42. Mariño R, Villa AE, Weitz A, Guerrero S. Caries prevalence in a rural Chilean community after cessation of a powdered milk fluoridation program. *Journal of Public Health Dentistry* 2004:101-5.
43. Bratthall D, Hansel-Petersson G, Sundberg H. Reasons for the caries decline: what do the experts believe? *European Journal of Oral Sciences* 1996;104:416-22.
44. Mansbridge JN, Brown MD. Changes in dental caries prevalence in Edinburgh children over three decades. *Community Dental Health* 1985;2:3-13.
45. Steele J, Lader D. *Children's dental health in the United Kingdom, 2003. Social factors and oral health in children.* London: Office for National Statistics; 2004. available from: http://www.statistics.gov.uk/cci/nugget.asp?id=1000
46. Petersen PE, Lennon MA. Effective use of fluorides for the prevention of dental caries in the 21st century: the WHO approach. *Community Dentistry and Oral Epidemiology* 2004;32:319-21.
47. Adyatmaka A, Sutopo U, Carlsson P, Bratthall D, Pakhomov G. *School-based primary preventive programme for children. Affordable toothpaste as a component in primary oral health care. Experience from a field trial in Kalimantan Barat, Indonesia.* Geneva: World Health Organization; 1998.
48. World Health Organization Expert Committee on Oral Health Status and Fluoride Use. *Fluorides and oral health.* WHO Technical Report Series No. 846. Geneva: World Health Organization; 1994.
49. Pendrys DG. Risk of fluorosis in a fluoridated population — implications for the dentist and hygienist. *Journal of the American Dental Association* 1995;126:1617-24.
50. *Guidelines for drinking-water quality. Third Edition.* Recommendations. Geneva: World Health Organization; 2004. Available from: http://www.who.int/water_sanitation_health/dwq/gdwq3/en/