

# Evaluation of appropriate use of dietary fluoride supplements in the US

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**Abstract** – Recent epidemiologic and related evidence suggests the following trends: 1. the prevalence of caries continues to decline in children of the US and several other developed countries; 2. the prevalence of mild dental fluorosis is increasing; 3. the majority of the cariostatic effects of fluoride are topical; and 4. dietary fluoride supplements are a risk factor for dental fluorosis. These trends, and the scientific evidence on fluoride and fluorosis, suggest that it is time to re-evaluate the use of dietary fluoride supplements. This paper examines the evidence for each of the four trends and the use of fluoride supplements in caries prevention today.

**Key words:** dietary fluoride supplements; dental fluorosis; dental caries; dosage schedule

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In the US and other developed countries, dietary fluoride (F) supplements are often prescribed for children as a substitute for water fluoridation. There is no firm documentation on when they first came onto the market, but it seems to have been in the mid-to-late 1940s. The use of these supplements is recommended by the American Dental Association (ADA) in areas where there is no water fluoridation (1). The ADA's recommended dosage schedule (Table 1) has remained unchanged since 1978 (2).

The weight of epidemiologic evidence, however, suggests several major trends observable in the US today: 1. The prevalence of dental caries continues to decline, with the majority of lesions confined to pit and fissure surfaces. 2. The prevalence of mild forms of dental fluorosis appears to be increasing, particularly in non-fluoridated areas.

In addition, studies on fluoride and fluorosis have shown that: 3. Fluoride exerts its anti-cariogenic effects more through remineralization and biochemical effects in plaque, rather than by pre-eruptive systemic uptake. 4. Dietary fluoride supplements have been identified, in several studies, as a risk factor in the development of dental fluorosis.

These trends, and the scientific evidence on fluoride and fluorosis, suggest that it is time to re-evaluate the use of dietary fluoride supplements. These findings, in fact, were key stimuli for a 1991 Workshop at the University of North Carolina (3) to re-evaluate fluoride intake from all sources. In this paper, we examine the evidence which, we be-

lieve, warrants a critical look at the history and current use of dietary fluoride supplements in caries prevention. We then take each of the four issues presented above and assess the evidence for the statements we made. Recommendations for future directions in the use of dietary fluoride supplements are then presented.

## Dietary Fluoride Supplements

### Early rationale for dietary fluoride supplements

In the early days of fluoride research, scientific consensus was that the primary action of fluoride was pre-eruptive. Because dental fluorosis was systemic in origin, it was assumed that the associated favorable effect, caries inhibition, was also of systemic origin (4). Dental research had not yet explored the dynamic processes of remineralization, but focussed instead upon fluoride's ability to improve enamel crystallinity and solubility. Although a number of the early epidemiologic studies (1945-67) also reported a topical (post-eruptive) effect (5-11), this effect was for some reason seen to be "second best" to systemic fluoride (12). There was no hint in these early studies that the primacy of the pre-eruptive effect was ever seriously questioned; even BIBBY's (13) conclusion on post-eruptive effects did not seem to make much impact on prevailing beliefs and practices. At that time, the topical application of fluoride in high concentrations, preceded by a prophylaxis, was employed as yet another method of improving

enamel crystallinity and solubility – a method of "forcing" fluoride into the hydroxyapatite crystal. Given such faith in pre-eruptive fluoride action, it made sense to prescribe dietary fluoride supplements for children who did not consume optimally fluoridated water.

### Efficacy of dietary fluoride supplements

A well-quoted 1978 review of the literature (14) concerning the effectiveness of fluoride supplements in many countries concluded that caries reductions of 50-80% in the primary dentition and 20-40% in the permanent dentition were attainable. This review summarized results from 18 studies of the primary dentition and 28 studies of the permanent dentition, ranging from the years 1949 to 1977. Critical review of many of these studies, as well as other more current studies of supplements, however, reveal inadequacies in study design and operation.

For example, STONES *et al.* (15) compared the effects of topically applied 2.0% potassium fluoride versus the ingestion of 1.5 mg fluoride tablets on the 2-yr incidence of caries in a National Children's Home in England. The only statistically significant finding was that for boys the ingestion of fluoride supplements reduced the incidence of caries in the primary dentition. The study group that received both the topical and systemic fluoride, however, did not experience a significant reduction in dental caries. Possible reasons for the lack of effects found in this study, include that the chil-

Table 1. Supplemental fluoride dosage schedule (in mg F/day\*) according to fluoride concentration of drinking water

Age (yr)	Concentration of fluoride in water		
	<0.3 ppm	0.3-0.7 ppm	>0.7 ppm
Birth to 2	0.25	0	0
2 to 3	0.50	0.25	0
3 to 13	1.00	0.50	0

\* 2.2 mg sodium fluoride contains 1 mg fluoride.

dren were in an institution, that they had relatively low baseline DMF scores, and that they experienced a low annual increment. In addition, the fluoride tablets were specially prepared with a hard coating to prevent dissolution in the mouth, and the tablets were administered with milk. The coating and the presence of calcium could have blocked both the potential topical and systemic actions of the fluoride.

In 1955, BIBBY and his colleagues (13) assessed the caries-preventive effects of sucking fluoride lozenges versus swallowing fluoride supplements. The subjects of the study were children from four different residential institutions in Boston, with readily apparent differences in standards of dental care. Although the three study groups contained almost the same numbers of children at the start of the study, differing rates of loss and withdrawal resulted in groups of unequal sample size at the end of the study. One study group had to be eliminated from the analyses because of attrition. BIBBY *et al.* concluded that fluoride lozenges may reduce dental caries, but that any such effect was brought about by fluoride acting on the external surfaces of the teeth and not a result of systemic absorption. In a study of the effects of fluoride supplements in children, ARNOLD and others (16) reported a "cariostatic effect ... comparable to that experienced by children who have used community water containing approximately 1.0 ppm." Parents of only half of the study group, however, actually continued to give their children the supplements for the necessary number of years. In addition, this investigation lacked a concurrent control group and used a highly selected group of participants (mostly the children of US Public Health Service professionals).

Recommendations for use of the dietary supplements also underwent a change during this study that diminished the

similarity between daily exposure to fluoridated water and the use of supplements. ARNOLD *et al.* (16) reported that at the start of their study parents were given concentrated solutions of sodium fluoride and told "to add a quantity of this solution equivalent to 1.00 mg of fluoride to the child's total drinking water." After 2 yr, it was decided that it would be "wiser and more effective" to find some method of distributing fluoride that would reduce variation in individual measurement and also be more convenient; thus the aqueous solution was replaced by tablets. For infants and toddlers, instructions then became that the tablets should be dissolved in water, and the water used throughout the day, simulating the effects of water fluoridation. The dosages were based on McClure's 1943 estimates of fluoride consumption (17) and later became the basis of the first ADA fluoride dosage schedule (18).

A brief report from MINOGUCHI *et al.* (19) demonstrated a 36% reduction in DMF scores in children taking 0.5 mg sodium fluoride tablets compared to a control group. Few details of the study design, methods, or participation rate were given. In 1969, MARTHALER *et al.* (20) reported mean percentage reductions of 36% for teeth and 47% for sites from the distribution of fluoride supplements in school. They found that second molars, when compared to first molars, did not show an enhanced cariostatic effect in spite of 6 yr of pre-eruptive fluoride exposure. MARTHALER stated that "in contrast to the clear-cut post-eruptive effect, the role of post-developmental pre-eruptive fluoride was much less obvious." MARTHALER proposed that the benefit of pre-eruptive fluoride uptake by superficial enamel was dependent on post-eruptive fluoride. In the investigation, children were not randomly allocated to the study groups and there were considerable interruptions in the fluoride distribution for the older children. No

tablets were taken during vacation periods.

Other studies have also experienced significant problems in their design and conduct. For example, ALLMARK *et al.* experienced a 50% dropout rate over the 6 yr of their study, and tablet consumption among schools was uneven (21). An 11-yr trial performed in Nelson County, Virginia, beginning in 1972, reported a 65% reduction in caries for supplement users (22). Without a concurrent control group, however, it is impossible to know how much of the caries reduction could be attributed to other influences over this time. FANNING *et al.* (23) found a significant association between the length of time of dietary fluoride supplement intake and percentage of zero dmft scores in Australian kindergartners. Occasional users and those who took the tablets daily for periods of less than 2 yr failed to receive any caries protection. Because only 20% of all children attended kindergarten in South Australia, the researchers suggested the study group was an elite group with greater dental consciousness. Also, only 17% of the participants actually received daily doses of fluoride at the required level during the study. THYLSTRUP *et al.* (24) studied the effects of a Danish caries-preventive program where parents of infants were offered prescriptions of fluoride supplements for daily use. In 1976, children who had reportedly received a total of zero, 1-800, 800-1600, and more than 1600 0.25 mg fluoride tablets were examined. Only the children who reported receiving more than 1600 tablets and reported continuous use experienced a reduction in the prevalence of caries in the primary teeth. No differences in caries were observed for the permanent dentition. The researchers then suggested that the topical effects of fluoride appeared to be more important in preventing caries than any systemic effects. Fluoride exposure data from this study may be questionable, however, because the researchers only knew how many fluoride tablets had been dispensed, not how many were actually ingested.

One of the few studies that met acceptable standards for field trials was that of DRISCOLL *et al.* (25) in Wayne County, North Carolina. In this study, children initially in the first and second grades, chewed, rinsed with, and swallowed an acidulated phosphate fluoride tablet con-

taining 1 mg fluoride either once or twice per day. A control group used a placebo tablet in the same manner. Results showed that after 6 yr both fluoride supplement groups experienced about a 30% reduction in decay, and that late-erupting teeth, which received both pre-eruptive and post-eruptive exposure to fluoride, exhibited about half the caries increment seen in early-erupting teeth. A final survey, conducted 4 yr after the regimens were discontinued, showed that the caries-preventive effects persisted in both treatment groups (26).

Thus, other than DRISCOLL (25), the data tend to show lower caries experience in children who ingest fluoride tablets, but cause cannot be attributed in many of these studies because of weak design and control. In addition, there has never been a clinical trial testing the null hypothesis that fluoride does not have a systemic effect (4). Considering the difficulties in study design as well as patient participation in a supplement program, the caries-preventive effect of fluoride supplements may be closer to the low end of the ranges suggested by BINDER *et al.* (14) in their 1978 review.

### Caries decline

The decline in caries experience among children in the industrialized nations of the world has been recognized for some years now (27–36), and further evidence continues to be published (37, 38). In the US, the decline in dental caries in schoolchildren, first clearly documented in 1979–80 (39), has been confirmed by the results of a second national survey conducted in 1987 (40). The increased availability of fluorides, through processed foods and beverages, dentifrices, and mouthrinses, along with other often unspecified factors, has most likely been a factor in reduced caries experience in non-fluoridated communities.

In addition to the change in caries prevalence, the pattern of caries distribution has changed dramatically. The National Preventive Dentistry Demonstration Program found that some 20% of the children experienced nearly 60% of the decay found (41). As shown in the latest NIDR survey of the oral health of children, almost 67% of all caries lesions involved the pit-and-fissure surfaces and the level of interproximal caries was extremely low (40).

### Trends in dental fluorosis

Despite differences in examination criteria and methods (42), recent evidence in several developed countries indicates that the prevalence of mild forms of dental fluorosis is increasing (42–46), though the magnitude of the change may be hard to estimate. Studies also indicate that the relative increase in dental fluorosis is particularly marked in non-fluoridated communities (47–50). Table 2, originally compiled by PENDRY & STAMM (46), presents updated estimates of the prevalence of fluorosis in fluoridated and non-fluoridated areas in the US and Canada. In addition to fluoride supplements (discussed below), other factors that have been associated with the incidence of fluorosis include the use of toothpaste at an early age (51), fluoride mouthrinses (50), the use of infant formulas (51, 52), and the fluoride concentration of the water supply (50, 53).

### Fluoride: pre-eruptive and post-eruptive effects

During the 1989 IADR/ORCA International Symposium on Fluorides in Georgia, THYLSTRUP (54) stated that the most important period for any tooth (in terms of caries development) is between its emergence into the oral environment and its full eruption. Thylstrup also stated that both clinical and laboratory data combine

to support the view that the relative importance of pre-eruptive fluoride to human caries progression is of borderline significance compared with the more important post-eruptive effect. BELTRAN & BURT (27) reached similar conclusions in their 1988 review of the pre- and post-eruptive effects of fluoride in the caries decline. These conclusions suggest that the percentage reductions in caries that have long been attributed to a pre-eruptive effect of fluoride may actually result from the presence of fluoride at the time of emergence into the oral cavity.

As noted earlier, the assumption in most of the fluoride supplementation studies was that the primary action of fluoride was pre-eruptive and systemic. But as early as 1955 BIBBY (13) concluded that the use of fluoride lozenges contributed to the control of dental caries as a result of fluoride acting on the *external* surfaces of the teeth. As we have seen, this view did not get much acceptance at the time. It is unfortunate that more recent studies, even those in the 1970s, were still carried out under the assumption that the primary benefits were pre-eruptive, and were not designed to question this premise. Current evidence, such as that presented by THYLSTRUP (54), supports the view that fluoride supplements are more effective for teeth with pre-eruptive exposure than for those already erupted not solely because of a *systemic* pre-eruptive effect, but also from the

Table 2. Recent estimates of dental fluorosis prevalence in North American fluoridated and non-fluoridated communities

Source of estimate	Date	Subject age (yr)	Sample size	Fluorosis prevalence
<i>Fluoridated</i>				
DRISCOLL <i>et al.</i> <sup>1</sup>	1986	8–16	336	14.6
SEGRETO <i>et al.</i> <sup>1</sup>	1984	7–19	361	39.4
LEVERETT <sup>1</sup>	1986	12–17 <sup>4</sup>	729	25.5
HEIFETZ <i>et al.</i> <sup>2</sup>	1988	8–10	111	28.1
		13–15	94	29.4
SZPUNAR & BURT <sup>2</sup>	1988	6–12	425	31.0
OSUJI <i>et al.</i> <sup>3</sup>	1988	8–10	633	12.9
KUMAR <i>et al.</i> <sup>1</sup>	1989	7–14	539	7.7
ISMAIL <i>et al.</i> <sup>2</sup>	1990	11–17	499	55.0
<i>Nonfluoridated</i>				
DRISCOLL <i>et al.</i> <sup>1</sup>	1986	8–16	316	2.9
SEGRETO <i>et al.</i>	1984	7–19	326	8.6
LEVERETT <sup>1</sup>	1986	12–17 <sup>4</sup>	564	4.1
PENDRY <i>et al.</i> <sup>1</sup>	1986	9–13	4222	25.2
SZPUNAR & BURT <sup>2</sup>	1988	6–12	131	12.2
KUMAR <i>et al.</i> <sup>1</sup>	1989	7–14	510	7.4

<sup>1</sup> Used Dean's Index (DEAN, 1942).

<sup>2</sup> Used TSIF (HOROWITZ *et al.*, 1984).

<sup>3</sup> Used THYLSTRUP & FEJERSKOV Index (THYLSTRUP & FEJERSKOV, 1978).

<sup>4</sup> LEVERETT's original paper reported on 5–17-yr-olds.

presence of topical fluoride *during* the process of eruption. When interpreted in this light, even DRISCOLL'S study does not support a systemic effect, though it does support the efficacy of a fluoride tablet regimen.

DAWES (55) summarized the findings of the 1989 Georgia conference on the primary cariostatic effects of fluoride: fluoride in the dental plaque and saliva both retards demineralization and enhances remineralization. As reported by DAWES, fluoride does not appear to have much influence on the *initiation* of a caries lesion, but can greatly retard its rate of *progression*. His suggestion that it is more important to provide low concentrations of fluoride to the fluid phase of the early lesion than to incorporate it into sound enamel (55) was echoed by many speakers at that conference (56–60). At the same meeting, however, GROENVELD *et al.* (61) suggested from reanalysis of data from the Tiel/Culemborg study (1953–71) that 66% of the greatest reduction in pit and fissure caries resulted from pre-eruptive fluoride, while in smooth surfaces, the effect was about 25%. LEVERETT (4) suggested that this analysis failed to account for the possible effect of primary tooth status, the decline in dental caries that was independent of fluoridation, and the increase in use of topical fluorides during that period. LEVERETT concluded that the Tiel/Culemborg data suggested that a pre-eruptive effect cannot be ruled out; however, no study has ever provided direct evidence that such an effect exists.

FEJERSKOV *et al.* (62) go one step further in the pre- and post-eruptive debate, by stating that fluoride should be considered as a means of *treating* dental caries. "The use of fluoride toothpaste is therefore nothing less than a means by which people are able to treat themselves." Whether one calls it prevention or treatment, implications of these findings support the effectiveness of water fluoridation and the daily use of fluoridated dentifrices in the US, as they provide frequent topical exposure to low concentrations of fluoride.

#### Dental fluorosis and dietary fluoride supplements

In 1974, AASENDEN & PEEBLES (63) reported the effects of fluoride supplementation from birth on the teeth of white,

middle class children. The original American Academy of Pediatrics (AAP) fluoride schedule was employed, providing 0.5 mg fluoride for children under 3 yr of age and 1.0 mg thereafter. The prevalence of dental fluorosis in the supplement group, 67%, was almost twice as high as that of the optimal water fluoridation group, 32%. As a result of this study, the AAP re-examined their fluoride dosage schedule and reduced certain dosages in 1979 (64), making it equivalent to the ADA dosage schedule.

Associations between fluorosis and earlier use of fluoride supplements have been reported from Sweden (65) and New Zealand (66). Swedish children who had consumed fluoride tablets for a period of at least 12 months from the age of 6 months ran a 5.4 times greater risk of developing enamel fluorosis than children with no such consumption. On the other hand, the data showed no apparent reduction in caries experience. DE LIEFDE & HERBISON assessed the prevalence of fluorosis and caries in children receiving different levels of fluoride exposure in 1982 and 1985. Comparing the four exposure groups, children with a history of continuous use of supplements and children with a history of some use of supplements had a higher prevalence of fluorosis than children who had consumed optimally or suboptimally fluoridated water. KUMAR (48), studying changes in fluorosis and caries in Newburg and Kingston, New York, between 1955 and 1986, suggested that the increased prevalence of fluorosis in non-fluoridated Kingston was attributable to the use of fluoride supplements. Exposure to fluoride other than from water or tablets, however, was not assessed. WOOLFOLK *et al.* (67) also found that dietary supplements of fluoride were the only self-reported source of fluoride exposure that were significantly related to dental fluorosis in non-fluoridated areas of Michigan.

PENDRY & KATZ (49) studied the associations between fluorosis and fluoride exposure in teenagers residing in Massachusetts and Connecticut. They reported that mild-to-moderate fluorosis was strongly associated with fluoride supplementation during the first 6 yr of life (Odds Ratio = 4.0) and with median household income (OR = 6.6). In children in the middle median household income group who had used supplements

through the first 6 yr of life there was a 28-fold increase in the risk of fluorosis compared to unexposed subjects in the lower income group.

By using the Fluorosis Risk Index (68), PENDRY & KATZ (49) were also able to determine that fluoride supplementation throughout the third through sixth years of life was a more important risk factor than supplementation during the first year of life, supporting the theory that the maturation phase of enamel development is the more susceptible period as compared with earlier periods of matrix secretion. LARSEN *et al.* (69) and EVANS (70) also suggest that it may be the later stages of enamel development that are most susceptible to the effects of overconsumption of fluoride. Further research is needed to clarify the relative susceptibility of the secretory and maturation phases of enamel development.

Several theories have been advanced to explain the association between fluorosis and fluoride supplements. Although water fluoridation and the ingestion of fluoridated dentifrice also provide pre-eruptive sources of fluoride, the use of dietary fluoride supplements provides this fluoride in one concentrated dose, rather than in small increments throughout the day. Fluoride received by way of supplements is absorbed into the plasma over a relatively brief interval of time (71), which increases its potential for causing fluorosis (72). In a perceptive 1979 review paper, ERICSSON & WEI (73) suggested that the use of fluoride supplements in single daily doses, particularly if administered between meals, is a significant deviation from the dietary supply of fluoride with foods and beverages, and may explain the associations of enamel fluorosis with fluoride supplements. They also suggested that when supplements are used, they should probably be given in such ways that large and rapidly absorbed single doses are avoided, and optimal contact with the surfaces of erupted teeth is obtained. As noted earlier, the 1960 field trial conducted by ARNOLD *et al.* (16) originally used such a method to administer fluoride, but this was later replaced by the once-daily use of tablets and drops.

Another potential reason for the association between supplements and fluorosis is that current fluoride dosage schedules are providing too much fluoride at an inappropriate stage of life. The major



variable that affects the rate of fluoride uptake by bone is age or the stage of skeletal development (74). FEJERSKOV *et al.* (62) estimate that a daily intake of fluoride as low as 0.04 mg/kg body weight can result in dental fluorosis of the permanent dentition. WHITFORD (74) suggests that the dosage schedule for fluoride supplements should be based on narrower age intervals and should be adjusted for body weight. Back in 1978, ADAIR & WEI (75) suggested that no supplemental fluoride was necessary for infants up to 6 months of age, based upon the concentrations of fluoride found in various infant formulas at that time. The ADA continues to suggest the addition of fluoride to the daily water allotment for children under the age of 2 yr (1), though it is not known how well this recommendation is followed.

Even if dosage schedules were refined however, there are still problems with dentist/physician prescription practices and patient compliance. LEVY (76) reported that a large proportion of dentists fail to assay the water supply before prescribing supplements, and others (77-79) have documented the frequent occurrence of inappropriate prescription practices. Additional analyses from our study in Michigan (50) showed that children who were exposed to both fluoridated water (0.8-1.2 ppm) and fluoride supplements were 5.8 times more likely to experience fluorosis than children who lived in a non-fluoridated area and used supplements. Finally, both the cariostatic and fluorotic effect of supplements will depend upon patient compliance. If a child misses a supplement on Monday, but takes two on Tuesday to compensate, then the peak in plasma fluoride on Tuesday probably increases the risk of fluorosis.

Recent studies of the pharmacokinetics of fluorides show that the absorption of fluoride can be influenced by the acid-base status of the individual, the presence of chronic illnesses, or even the timing of the supplement in relation to a meal (74). All of these factors would have an effect

on the amount of fluoride that is absorbed and able to reach the developing dentition.

When water fluoridation and the prescription of supplements were first implemented, these were the primary sources of fluoride available to children. Now, with the almost universal use of fluoridated dentifrice, consumption of foods processed in fluoridated areas by persons in nonfluoridated areas, use of fluoride mouthrinse, and reconstitution of infant foods with water, the routes of fluoride exposure for all children, even in non-fluoridated areas, have increased. Thus it can no longer be assumed that a child residing in a non-fluoridated area will have a minimal background exposure to fluoride, but instead there will be a gradient of exposure, and for some children, the addition of the supplement will increase the total body burden to a level capable of causing fluorosis.

#### Discussion

In 1980, the Food and Nutrition Board of the US National Research Council (NRC) classified fluoride as an essential element because of its role in preventing dental caries (80). In the 10th edition of the Recommended Dietary Allowance (81), however, the NRC concluded that fluoride could not be classified as an essential element, according to accepted standards. Instead, fluoride was recognized as a "beneficial" element for humans, because of its valuable effects on dental health. Paradoxically, although the weight of recent evidence clearly suggests that the risks from dietary fluoride supplements may outweigh the benefits, one dental health objective for USA by the year 2000 is to "... increase use of professionally or self-administered topical or systemic (dietary) fluorides to at least 85% of people not receiving optimally fluoridated water" (82). Despite current thinking on the cariostatic mechanisms of fluorides and concerns about fluorosis, it is evident that many policy-

makers remain convinced of a requirement for systemic fluoride.

When considering the use of dietary fluoride supplements today, one might ask: "Is the relatively small pre-eruptive benefit worth the risk of dental fluorosis?"

To answer the question, one should consider the implications of an increase in mild dental fluorosis. Currently there are two conflicting philosophies on this issue. One states that, from a public health perspective, the only negative effects of mild fluorosis are aesthetic, and even then, in many instances, the presence of fluorosis is only observed by the dental professional, not the patient. For example, HOROWITZ (83) stated: "A small amount of fluorosis is not an unsightly condition, and can be detected only by trained professionals ... It should not be forgotten that having a small amount of fluorosis may be an alternative to having dental decay, which is a disease and may cause a cosmetic problem greater than fluorosis."

From a more biological perspective, one can suggest that dental fluorosis is an early sign of the chronic ingestion of fluoride at levels capable of causing defects in enamel mineralization - no matter how one rates the appearance. FEJERSKOV *et al.* (62) voice this conclusion: "The toxicological effects of fluoride on developing dental enamel should not be equated with cosmetic appearance of dental fluorosis; and ... the subjective assessment of what might be considered to constitute a public health problem has been confused with the objective toxicological effects of fluoride on developing dental enamel ... the concept of "public health significance" is in reality a socially determined value and is one which may alter from time to time, and may vary from one society to another."

Just because the effects of mild fluorosis may "only" be aesthetic today, they are nevertheless important indicators that fluoride exposure has and may continue to increase.

Given the trends in caries and fluorosis that are discussed in this paper, it seems prudent to reassess the fluoride prescription schedule. For example, body weight, altitude, and health status (74) may need to be factored into the prescription schedule. Dosage levels may need to be reduced in the older age groups, when permanent teeth are in the pre-eruptive

Table 3. Revised dietary fluoride supplementation schedule (mg fluoride per day)

Age of child (yr)	Water fluoride concentration		
	<0.3 ppm	0.3 to 0.7 ppm	>0.7 ppm
0-3	0.25	0	0
3-5	0.50	0.25	0
5-13	1.00	0.50	0

maturation phase of development. The age at which supplementation should begin needs to be reconsidered. Perhaps the use of fluoride supplements should be recommended only for special populations – for whom background levels of fluoride exposure can be estimated with some certainty. Dietary fluoride supplementation and water fluoridation are not equivalent methods of fluoride exposure. Supplements provide fluoride in one concentrated dose, in opposition to the concept that the optimal exposure to fluoride occurs with frequent low doses. In addition, this “one shot” of fluoride appears to be associated with enamel fluorosis.

The unintentional ingestion of fluoride from dentifrices, mouthrinses, and infant foods, may also contribute to the increase in the prevalence of fluorosis, but this intake is highly variable and difficult to control. Dietary fluoride supplementation can be controlled more easily. As a step in the right direction, the participants of the North Carolina Conference (3) suggested a revised fluoride dosage schedule (Table 3), and a series of guidelines for the control of appropriate prescription, administration, and further study of fluoride supplements.

During a 1990 Symposium on the appropriate uses of fluorides, LEVERETT (4) suggested that “the desirable effects of systemically administered fluoride are quite minimal or perhaps even absent altogether.” DEPAOLA (84) provided a spirited response in his reaction paper, although the latter’s evidence was rather subjective. DEPAOLA, perhaps inadvertently, illustrated the nature of the beliefs in systemic effects when he said: “The concept of altered morphology has remained controversial ... I am convinced ... from survey work ... that these changes occur.”

We conclude that the evidence shows that continued use of dietary fluoride supplements is not warranted as a routine public health measure because (a) evidence for the efficacy of the pre-eruptive systemic effect is weak, (b) the risk of fluorosis is high, and (c) fluoride is readily available in other forms. Prescription for high-risk individuals may be beneficial, though even this practice deserves careful study.

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