Should We Use Milk Fluoridation? A Review[1]

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This article presents the argument that because of several demonstrated advantages, milk fluoridation provides a valid alternative to water fluoridation when the latter is not possible. Extensive literature describing study of fluoride compounds administered with calcium-rich food, as well as clinical trials and laboratory experiments with fluoridated milk, have demonstrated its effectiveness in caries prevention. The main criticisms of milk fluoridation are decreased bioavailability of the fluoride, the cost and administrative burden involved, and (in some cases) lack of sound clinical conclusions regarding its preventive efficacy. These criticisms are reviewed in the light of evidence now available.

The World Health Organization has recommended specific goals for oral health by the year 2000 (*1*). Among other things, these goals assert that the decayed, missing, and filled teeth index (DMFT)[3] at 12 years of age should be 3 or less. In 1990, only 5 of 38 countries and territories in Latin America and the English-speaking Caribbean (the Bahamas, Cuba, Dominica, Guyana, and Saint Lucia) had such a DMFT index, while 8 countries had DMFT indices exceeding 6.5 (*2*). Thus, although most countries of the Americas have significantly improved the health conditions of their people, oral disease continues to be a highly prevalent health problem.

Indeed, oral health surveys have shown that in most countries of the Americas about 95% of the population has a history of dental caries (*2*). If countries continue to rely on programs based on dental caries treatment rather than prevention, we cannot expect major improvements in this picture, especially since there are many places where a significant part of the population lacks access to regular oral health care. Clearly, a different approach to the problem must be found.

Dental caries is a preventable infectious disease caused by bacteria that accumulate in dental plaque. Fermentation of common dietary carbohydrates by these plaque bacteria leads to formation of acids that cause loss of minerals from the tooth enamel, a process that ultimately produces cavities. Scientific knowledge indicates that dental caries can be prevented by measures that include use of fluorides and fissure sealants, removal of dental plaque, and reduction of fermentable carbohydrates.

The mechanism by which fluorides prevent dental caries has been studied for over 50 years and is now accepted as safe and appropriate (*1, 3–6*). Fluorides are absorbed through the gastrointestinal tract, with a rate and degree of absorption that depends on several elements

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[3]The DMFT index is the arithmetic average of the number of teeth (T) that are decayed (D), missing (M), or filled (F) as a result of caries occurring in permanent dentition. The DMFS index uses the tooth surfaces as the unit of study. The equivalent indices for temporary dentition are dmft and dmfs.

(*7*). After entering the plasma, fluorides are either deposited in the bone or developing teeth, or else they are removed by the kidneys and excreted in the urine. During tooth formation, fluoride is incorporated into each tooth's mineralized structure, providing increased resistance to demineralization by organic acids.

After a tooth erupts, systemic fluorides no longer play a role in its formation. However, when consumed systemically they are excreted through the saliva and can provide surface protection for the tooth throughout its lifetime (*8, 9*). This posteruption effect is responsible for decreased demineralization when teeth are exposed to acids and for increased rates of remineralization (*10*). Fluorides also affect bacterial metabolism and act in other ways to reduce potential tooth enamel destruction (*5, 9, 11*).

The great mass of evidence now available indicates that a 50–65% reduction in dental caries indices can be achieved by adjusting the fluoride content of unfluoridated drinking water to optimal levels (0.7 to 1.2 mg/L) (*1, 5*). However, political, administrative, geographic, and technical factors have commonly precluded drinking water fluoridation, denying this benefit to a large part of the world's population (*12*).

This lack of a fluoridated water supply is not an insuperable barrier to receiving the benefits of fluorides. For instance, in some places where people could not be reached by public water supplies, countries have tested and implemented alternative community-based fluoridation programs at the local, regional, or national levels. Various methods—including salt fluoridation (in Colombia, Costa Rica, France, Germany, Hungary, Jamaica, Mexico, Spain, Switzerland, and Uruguay—*2, 4, 13–15*), school water fluoridation, distribution of fluoride tablets, and use of fluoride mouth rinses (in the United States—*4, 5, 16*)—have been employed by public health programs. These methods provide protection against caries that rivals that provided by fluoridated water. In addition, studies have shown that fluoride provided through other alternative methods can effectively prevent caries (*16*), such methods including use of fluoride solutions or gels topically applied and fluoridation of sugar and various beverages including milk (*4, 5, 9, 17, 18*).

All these alternatives involve some disadvantages that any country must consider within the context of its particular local, regional, or national needs when deciding what is the best method to employ. Such deliberations have led to a variety of conclusions about the merits of water fluoridation alternatives. Within that context, this article reviews scientific data on milk fluoridation and analyzes competing theses in the current debate on the subject to help resolve the question of whether milk fluoridation should be used. To do this, it describes the basic rationale for using milk as a fluoride vehicle and discusses the main objections to milk fluoridation in the light of currently available data.

RATIONALE FOR THE USE OF MILK FLUORIDATION

From a public health standpoint, the community water supply is regarded as the most effective fluoridation vehicle (*3, 17, 19*). In the 1980s the International Drinking Water Supply and Sanitation Decade strongly promoted provision of water supply services to the population. Nevertheless, despite efforts made in the Americas to provide water for all by 1990, in that year approximately 12% of the total urban population still lacked house connections, and in rural zones this proportion was much higher, on the order of 45% (*20*).

According to several researchers (*21–25*), when a water supply is not available milk should rank first among the alternative fluoridation vehicles. After water, milk is considered the most important contributor to total fluid intake (*26–28*). It is also an important food for pregnant women, infants, and children during the period of tooth formation (*4, 22, 29, 30*). Like salt, milk does not require a community water supply system, and so it can reach communities lacking this service and can enable people to have free choice regarding their fluoride intake. Like certain other alternatives, it imposes no major administrative burdens on teachers (*23, 31*) such as those imposed by programs using fluoride mouth rinses or supplements at school, nor does it create a need to ensure compliance (*8*). Indeed, an adequate level of compliance (an adequate intake of fluoridated milk) might be assured if fluoridated milk were needed for its nutritional as well as its cariostatic value, or if children were expected or required to drink it when provided (*32*).

Ericsson (*21*), Poulsen et al. (*22*), Villa et al. (*31*), and Toth et al. (*33*) have proven that fluoride does accumulate in calcified tissues following ingestion of fluoridated milk. Ericsson, who administered F as NaF to rats, reported that femoral F uptake from milk was about 80% of that from water, and that a tooth's retention of F paralleled that of the skeleton at a comparable stage of growth. Animal experiments conducted by Poulsen et al. (*22*) found increased fluoride levels in rat enamel after administration of fluoridated milk. More recently Villa et al. (*31*), who administered F to rats as MFP in milk and NaF in water, found that the femur fluoride concentration was almost two times higher in the milk group than in the water group under normal feeding conditions. In addition, Toth et al. (*33*) found the fluoride content of children's enamel surfaces to be higher after they had consumed fluoridated milk for a year.

The above considerations and findings suggest that milk would be a particularly suitable vehicle for providing systemic fluoride in community fluoridation programs if it reached the right people. In accord with the need to find solutions appropriate for local conditions (*34, 35*), it would be particularly valuable in rural areas, where the population is unlikely to have access to appropriately fluoridated water.

Other authors, however, have concluded that milk is not an appropriate vehicle for fluoridation (*17, 35–37*). Our review of these criticisms has indicated four major areas of concern, these being (1) decreased bioavailability of sodium fluoride (NaF) when ingested with foods rich in calcium such as milk (*38–40*), (2) cost (*36, 37*), (3) administrative burdens (production, delivery, storage and distribution problems) relative to other methods (*17, 36, 37*), and (4) lack of definitive conclusions from clinical trials (*18, 35, 37*).

BIOAVAILABILITY

In the case of fluorides, bioavailability is defined as the percentage of a given fluoride that is absorbed, reaches the circulation, and is available for use by the living organism (*7, 23, 41, 42*). It therefore depends on the amount of free forms of fluoride present (*7*). Hence, any factor that decreases free fluoride levels will decrease bioavailability (*7*).

It is well known that concomitant intake of food and beverages may reduce or enhance various drugs' bioavailability (*43*). Furthermore, the bioavailability of fluorides in the presence of certain foods, milk, and other proteinaceous beverages is known to be less than the bioavailability of fluorides administered as NaF in water under fasting conditions (*39, 42*). (As a standard, studies on fluoride bioavailability take 100% bioavailability to be that of fluoride administered as NaF in water or tablets under fasting conditions—*7, 39*. In these circumstances the absorption rate reaches a peak plasma concentration within 30 minutes of intake—*7, 43*.)

Slower and less complete absorption of F as NaF has been reported with parallel intake of foods rich in calcium, such as milk, the diminished bioavailability being 20% to 50% of that obtained with NaF in water alone (*21, 42, 43*). These findings have been obtained from experiments with both humans (*39, 43–45*) and animals (*21*). This reduced bioavailability might be caused by the combined action of several factors. Among the most influential: the formation of CaF_2, which has decreased solubility in water (*21, 38, 39, 41, 42*); chemical combination of F with organic solids; and entrapment of F by milk coagulation products in the stomach that create a physical barrier preventing access to gastrointestinal surfaces (*21, 42–44, 46–48*).

Other mechanisms causing decreased bioavailability have been proposed. One of these is an increase in gastric pH caused by milk intake (*23, 39, 43, 44*), because when NaF is ingested, it is not F^- that passes through the gastrointestinal wall but HF, which is pH dependant (*30, 42, 46, 47*). In an environment with reduced pH like the stomach, the concentrations of HF and of unbound Ca^{++} from milk may be increased, which would in turn increase the formation of CaF_2 (*21, 39*).

Nevertheless, this reduced bioavailability relating to delayed absorption has been found to prevail mainly during the first hour after ingestion, after which absorption rates level out (*21, 42, 43, 46*), with fluoride levels in the plasma remaining elevated for a longer period of time when the fluoride is administered in milk instead of water. This pattern has been observed in both rats (*21*) and humans (*42, 46*). A similar sort of pattern has been found with respect to urinary excretion of fluorides, which proceeds at a higher level during the second hour if the fluorides are administered with milk rather than water (*21*).

It should also be noted that most of the studies involved have been carried out on fasting individuals or under extreme conditions. For instance, Ekstrand and Ehrnebo (*39*) reported a decreased bioavailability of 30% when NaF tablets were administered with food; but all the food supplied was milk or dairy products, which do not constitute an ordinary diet (*42, 45, 47*). The point is relevant, because of findings that this decreased bioavailability can be reversed if conditions are made to simulate those following a standard breakfast (with ingestion of milk plus food having a low calcium content such as bread, crackers, or cakes) (*42, 45–47*). Under these normal conditions, the ingested foods stay longer in the gastrointestinal tract than does milk alone, giving the fluoride more time to reach absorbing surfaces (*42, 46*). It has also been suggested that under normal feeding conditions the fluoride's mode of administration (e.g., in a beverage, as drops, or as chewed or swallowed tablets) would be of greater importance than its chemical composition (*42, 46, 47*).

Within this context, it is noteworthy that Shulman and Vallejo (*44*) got very different results from an experiment where NaF was administered in water, with milk, and with a normal lunch. Their data indicated that milk consumption did not significantly affect fluoride absorption, but that addition of a normal lunch decreased fluoride absorption by a significant 47%.

Ericsson (*49*) has stated that fluoride bioavailability would differ if the administered compound were MFP rather than NaF, suggesting that F bioavailability from MFP would be less affected by intake of food with a high calcium content. The food's effect would be negligible—because MFP absorption is not pH dependant, involving no formation of HF (*21, 42*); because of the specific absorption mechanism involved; and because of the higher solubility of the Ca-MFP salts (*42, 46, 49*).

Villa et al. (*23, 31*) measured fluoride bioavailability in both preschool children and rats, finding that of MFP fluoride in milk to be at least as high as that of NaF fluoride in water under fasting conditions (which is considered 100%) (*39*). They also found that decreased absorption of F from MFP under normal feeding conditions is less important than decreased bioavailability of F from NaF in water or tablets under the same conditions. Villa et al. (*31*) have also shown absorption of F from MFP to be markedly better in the presence of food, an improvement that does not occur when F is administered as NaF.

However, Trautner and Einwag have presented data (*42, 46*) that fail to confirm the results reported by Ericsson (*49*) and Villa et al. (*23, 31*). Specifically, they have reported that the bioavailability of F as NaF and as MFP was affected comparably by several different experimental conditions (fasting, ingestion with milk, and ingestion with breakfast and milk) (*42*). That is, use of MFP instead of NaF did not increase F bioavailability.

COST AND ADMINISTRATIVE COORDINATION OF MILK FLUORIDATION

Burt (*50*) has noted that the cost of alternative fluoride vehicles must be assessed for each situation, partly because the cost depends on the facilities and resources available in any particular country. In 1972, Stamm (*36*) concluded that using milk as a vehicle could be costly—but this conclusion was based on a 1955 New York City study that clearly could not be expected to reflect the conditions in any country in the 1990s. More recently, the World Health Organization (*51*) has classified milk, together with water and salt, as a highly cost-efficient vehicle for fluorides and has supported milk fluoridation as a community health measure.

When there is an ongoing milk distribution program in the community, or a milk program running in schools, kindergartens, or welfare centers, no additional outlays are required for administration, education, supervision, or distribution (*4, 26, 34, 52*), a circumstance that counters criticisms of milk fluoridation's organizational and administrative cost (*17, 26, 37*). Furthermore, supplying fluoridated milk to children in this way constitutes highly effective resource use, because it requires a much smaller quantity of fluorides for a given population than the fluoridation of an entire water supply (*26, 52*) or even a school water system; nor does it entail marketing or subsidy costs as in the case of salt fluoridation.

In Chile, a food supplement program has worked efficiently for about 40 years, providing over 80% national coverage for children from birth to 6 years (*20*); dairy plants have the know-how to produce a fluoridated milk product; and addition of MFP to milk powder is relatively simple and involves a negligible increase in the latter's cost (*26, 52*). Even adding quality control costs, Villa et al. (*26, 52*) estimated that milk fluoridation under these conditions would be over a thousand times more cost-effective than water fluoridation, and concluded that it offered an economical alternative to water fluoridation in Chile (*26*).

However, there is still the problem of fluoride stability in milk. Variations in the concentration of ionic fluoride have been studied for 72 hours after fluoride was added to milk as NaF (*38*), the results showing estimated recovery at the end of this time to be less than a fifth of the amount added. In fact, fluoride as NaF should not be added to milk more than one hour before consumption (*38*), making it necessary for trained personnel to prepare and supply the product.

As this suggests, the stability problem could be overcome if NaF were added immediately before consumption (*53*), as according to Duff (*38*) the recovery level is on the order of 97% during the first hour. Alternatively, the problem could be overcome by using MFP as the fluoridated compound (*26, 31, 52*), because the F added in MFP has demonstrated stability for a period of 10 months without alteration (*23, 26*). For these reasons, the WHO Group of Experts on Fluorides concluded in 1994 (*4*) that the binding of fluoride to Ca or proteins is not a major problem in milk fluoridation.

MILK FLUORIDATION STUDIES

König (*54*) performed experimental caries prevention studies by administering NaF in water, milk, and food to young rats. Female rats receiving NaF during pregnancy and lactation exhibited increased skeletal fluoride levels. However, in all the experimental groups caries inhibition was observed only when fluoride was given posteruptively. Similar results were obtained by Poulsen et al. (22), who studied the effect of pre- and posteruptive exposure in rats receiving fluoridated milk or water and found that preeruptive exposure had little effect on dental caries. However, posteruptive administration of fluoride caused significant caries reduction on the buccolingual surfaces, even though no effect could be demonstrated on the occlusal or proximal surfaces. These authors did not observe any effect attributable to the fluoridation vehicle (milk or water).

The value of milk as an alternative vehicle for fluoride administration to humans has been noted since the 1950s. Clinical studies using this method have been carried out in Brazil (*55*), Hungary (*53, 56, 57*), Israel (*58*), Japan (*59*), Scotland (*11, 60*), Switzerland (*61, 62*), and the United States (*30, 32*). Tables 1 and 2 summarize some features of the studies relating to permanent and temporary dentition, respectively.

The first work indicating the effectiveness of milk as a vehicle was done in Switzerland by Ziegler (*62*) in the 1950s. He undertook a longitudinal study of 1 302 children (749 test subjects, 553 controls) 9 to 44 months old at the start of the study. After six years Ziegler found significant caries reduction in both primary dentition (up to 31%) and permanent dentition (about 65% in permanent molars), establishing that optimal results

Table 1. Clinical and community experiences with fluoridated milk; permanent dentition comparisons.

Country	Duration	% caries reduction	Age at start	References
Brazil	16 months	Not significant	6–12 years	Sampaio et al. (*55*)
Bulgaria*	5 years	79–89 (DMFT)	3–10 years	BDMF (*67*)
Hungary	10 years	36.8 (DMFT) 40.0 (DMFS)	2–5 years	Gyurkovics et al. (*57*)
Israel	30 months	64.0 (DMFT)	4–7 years	Zahlaka et al. (*58*)
Japan	5 years	33.8 (DMFT)	School age	Imamura (*59*)
Scotland	5 years	31.2 (DMFT) 43.1 (DMFS)	4.5–5.5 years	Stephen et al (*12*)
Switzerland	6 years	65.2 (DMFT)	9–44 months	Ziegler (*62*)
United States of America	3.5 years	70† (DMFT)	6–9 years	Rusoff et al. (*30*)
United States of America	3 years	21.8 (DMFS) (Not significant)	6–9 years	Legett et al. (*32*)

* Community trial.
† First and second bicuspids and second permanent molars.

Table 2. Clinical and community experiences with fluoridated milk; deciduous dentition comparisons.

Country	Duration	% caries reduction	Age at start	References
Bulgaria*	5 years	40 (dmft)	3–10 years	BDMF (*67*)
Hungary	5 years	40.1 (dmfs) 40.1 (dmft)	2–5 years	Bánóczy et al. (*53*)
Israel	30 months	62.9 (dmft)	4–7 years	Zahlaka et al. (*58*)
Scotland	5 years	Not significant	4.5–5.5 years	Stephen et al. (*12, 60*)
Switzerland	6 years	14.8–31.5 (dmft)	9–44 months	Ziegler (*62*)

*Community trial.

are achieved when fluoridated milk intake begins in early childhood.

In the United States, Rusoff et al. (*30*) conducted a pilot study with 129 schoolchildren initially 6 to 9 years old. At the end of almost four years of study, they found a 70% reduction in the incidence of caries on bicuspids and second molars erupting after the study began, and a 36% reduction on first molars newly erupted at the start of the study. However, even though there was a significant overall reduction in the DMFT index of the study group, when broken down by age group the only children to show significant reduction were the 9-year-olds, those 16 children who were 6 years old at the beginning of the study.

Stephen et al. (*12*) reported on a five-year double-blind milk fluoridation study of 187 Scottish children (94 test subjects and 93 controls) who were 4 years 6 months to 5 years 6 months of age. After five years of milk fluoridation, despite attrition of participants in both the test and control groups, significant reductions were observed in both the DMFS index (43.1%) and the DMFT index (31.2%) for permanent teeth in the test group as compared to the controls, while permanent first molars exhibited a significant 74.6% fewer interproximal caries. For buccolingual lesions the difference between the two groups was not significant but showed a trend in favor of the group receiving fluoridated milk.

In Hungary, Bánóczy et al. (*53, 56*) studied the effects of fluoridated milk in 269 institutionalized children 2–5 years old. After five years of fluoridated milk consumption, comparison of test and control groups showed statistically significant reductions in the DMFS (66.6%) and DMFT (60%). A 10-year follow-up that involved a 2-year interruption of the program and included only 162 subjects showed the test group to exhibit significantly less caries increase in permanent dentition (36.8% lower DMFT and 40.0% lower DMFS) relative to the controls (*57*). No information was provided about possible combined effects resulting from exposure to other fluoridated products, including toothpaste.

In Japan, Imamura (*59*) reported that when NaF (as the vehicle for the fluoride ion) was added to milk and soup served daily as part of school meals, after four years a 36.3% reduction in the DMFT index was achieved in the study group.

Effects of milk fluoridation on deciduous teeth have been described less frequently. The five-year study by Bánóczy et al. (*53*) found mean dmft and dmfs values lower by about 40% in the test group. Ziegler in Switzerland (*62*) found a dmft reduction between 14.8% and 31.5% for temporary dentition in the fluoridated group. However, Stephen et al. (*12, 60*) reported no significant caries reduction in previously erupted primary teeth (see Table 2).

Taken together, these clinical studies demonstrate that fluoridated milk consumption can have a significant preventive impact on dental caries. Unfortunately, while the studies are numerous, some suffer from shortcomings that make their interpretation, comparison, and evaluation difficult. Specifically, some were done with small groups of subjects (*11, 30*) or under conditions (such as inappropriate selection of control groups) that might invalidate results (*53, 57*). Others only gave fluoridated milk for short periods of time (no more than three years) (*32, 55, 58*); and indeed only five clinical studies reported results for periods longer than three years (*12, 30, 53, 57, 59, 62*). According to Stephen et al. (*12*), prior to the fourth year of consumption of fluoridated milk, study findings may not show significant reduction in dental caries, even while favoring milk fluoridation.

There is also the question of how much the observed benefits were derived from topical rather than systemic effects of fluoride. The American Dental Association suggests that while it is difficult to quantify the relative importance of preeruptive and posteruptive exposure to systemic fluoride, the measured benefits result from the two combined (*5, 16, 63*). Hence, while the reviewed study results point mainly to systemic influences, the effects observed on erupted teeth suggest that the topical action of fluorides received in milk deserves consideration (*53, 60*). A great deal of evidence also indicates that milk in any form may reduce tooth decay. According to Reynolds and Del Río and other authors (*64–66*) milk has an additional topical effect on tooth enamel, because its casein phosphopeptides produce a protective coating over the tooth resulting in an anticariogenic effect in animals (*64*) and a decreased demineralizing rate *in vitro* (*64*). Also, because of its calcium, phosphate, and protein content, milk could facilitate remineralization of enamel lesions (*64*).

Because some uncertainty exists about whether benefits observed in controlled environments and clinical trials can be obtained in the ecologically complex and uncontrolled world of a community, long-term community-wide studies have been undertaken in collaboration with the World Health Organization's Oral Health Program. So far, five of these have begun—in Bulgaria, Chile, China, the Russian Federation, and the United Kingdom (*4, 67*). One of them, which started in September 1988 in Bulgaria (*67–70*), has provided a regular supply of fluoridated milk to 12 000 nursery school children 3–10 years old (*68*). Results after five years showed that mean DMFT and dmft increased in the control group (which received no fluoridated milk), while the study group exhibited improvement. Compared to baseline data, those who received fluoridated milk for five years had 40% fewer caries in their primary dentition than those in the control group. Regarding permanent dentition the effect was more significant, with a 79–89% reduction in the caries experienced by the study group (*67*).

More recently, a milk fluoridation demonstration project has started in Chile using powdered milk and MFP as the source of fluoride (*67, 70, 71*). This project includes all children living in a rural community, where milk is distributed free of charge under the national complementary feeding program. Within this context it is worth noting that Villa et al. (*23, 31*) have obtained a homogeneous concentration of MFP in powdered milk and excellent stability over the course of a one-year test. When this product was prepared for consumption, the fluid milk obtained was stable, and no sign of Ca-MFP was observed.

CONCLUSIONS

The decision regarding what is the most effective vehicle to use in administering systemic fluorides will always depend on certain unique conditions that apply in any given situation. However, clinical trials over more than 30 years have reported favorable results and seem to support the conclusion that fluoridated milk can have a significant preventive impact on dental caries. Information from these trials indicates that fluoride-containing milk has a caries-preventive effect, though it should be noted that some of these trials were done under conditions that call their findings into question or make them hard to interpret. Community trials, like those now underway in Bulgaria and Chile, will test fluoridated milk's effectiveness under normal conditions prevailing in the study communities and will help to provide final evidence regarding the desirability of using milk as a vehicle when implementing community-based fluoridation programs.

Clearly, when certain administrative conditions are present (such as an ongoing milk distribution program in the community), using milk as the vehicle may improve the cost-effectiveness of fluoridation because no additional costs or administrative loads are required.

Studies of fluoride metabolism have demonstrated that ingestion of F from fluoridated milk raises ionic F in the circulation, thereby paving the way for its deposition in hard tissues including teeth. Although some studies have concluded that milk is an unsatisfactory vehicle for fluoride because of fluoride's decreased bioavailability in calcium-rich environments, no final consensus on bioavailability has been reached. Some experiences have indicated that the bioavailability of fluoride in milk may be satisfactory when MFP rather than NaF is used as the source of F—because MFP does not bind with Ca and because F from MFP is absorbed better under normal feeding conditions.

The conclusion of this review is that, contrary to traditional arguments against using milk fluoridation as a community measure for preventing dental caries, recent evidence suggests that milk fluoridation may be regarded as a valid alternative in areas where water fluoridation cannot be used to provide the desired benefits.

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Meeting on Vitamin A Deficiency

"Virtual Elimination of Vitamin A Deficiency: Obstacles and Solutions for the Year 2000" is the theme of the XVII Meeting of the International Vitamin A Consultative Group (IVACG), to be held from 18 to 22 March 1996 in Guatemala. The program will include invited addresses on the meeting theme, as well as other oral, poster, and video presentations that will be selected from submitted abstracts. Those presentations will focus on population assessment and biological significance of vitamin A deficiency and marginal vitamin A deficiency, and appropriate interventions, especially food-based approaches and food fortification.

More than 300 participants are expected to attend the meeting, including policymakers, scientists, and program implementors. The meeting is sponsored by the IVACG and a local organizing committee coordinated by PAHO's Institute of Nutrition of Central America and Panama (INCAP).

For further information about the meeting, contact:

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