3. SOURCES OF FLUORIDE INTAKE AND RISK OF DENTAL FLUOROSIS

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Abstract
Although the predominant beneficial effects of fluoride occur locally in the mouth, the adverse effect, dental fluorosis, occurs by the systemic route. Caries incidence and prevalence has decreased significantly over the last two decades due to the widespread use of fluoride. However, simultaneously, an increase in the prevalence of dental fluorosis has been reported both in communities with fluoridated and non-fluoridated water. The increase in fluorosis prevalence prompted numerous studies on risk factors for fluorosis. This review describes the main sources of fluoride intake that have been identified until now: fluoridated drinking water, fluoride supplements, fluoride toothpaste, infant formulas and other manufactured infant foods and beverages. Recommendations on how to avoid excessive fluoride intake from these sources are also given.
Key words: *fluoride, intake, fluorosis*

ORÍGENES DEL FLUORURO INGERIDO Y RIESGO DE FLUOROSIS DENTAL
Resumen
Los efectos beneficiosos del fluoruro sobre la dentadura ocurren por su acción local, sin embargo su principal efecto adverso, la fluorosis dental, ocurre por vía sistémica. La incidencia y prevalencia de caries ha decrecido significativamente en las pasadas dos décadas debido al amplio uso del fluoruro. Sin embargo, simultáneamente ha aumentado la prevalencia de fluorosis dental, no sólo en comunidades con agua fluorada, sino también en aquellas comunidades con bajos niveles de fluoración en el agua de bebida. Este incremento en la prevalencia de fluorosis dental ha dado origen a numerosos estudios de factores de riesgo predisponentes para la instalación de la fluorosis dental. Esta revisión describe las principales fuentes de ingesta de fluoruro identificadas hasta el momento, como son: aguas fluoradas de consumo humano, comprimidos con fluoruro, pastas dentales, preparaciones para el uso de niños, alimentos y bebidas. Se describen también medidas destinadas a evitar la excesiva ingesta de fluoruro proveniente de las fuentes mencionadas.
Palabras claves: fluoruro, ingesta, fluorosis

Fluoride plays a key role in control of dental caries. In the middle of the previous century it was generally believed that, to exert its maximum protective effect, fluoride had to become incorporated into dental enamel during development. Thus, it was considered unavoidable to have a certain prevalence and severity of fluorosis in a population to minimize the prevalence and severity of caries among children.[1] By 1981, a paradigm shift was proposed concerning the cariostatic mechanisms of fluorides.[1] This considered that the predominant, if not entire, explanation for how fluoride controls caries lesion development lies on its topical effect on de- and remineralization processes taking place at the interface between the tooth surface and the oral fluids. This concept gained wide acceptance [2-5] and brought the possibility of obtaining maximum caries protection without a significant ingestion of fluorides. Having this in mind, researchers in the whole world turned their attention toward controlling the amount of fluoride intake, which associated with the increase in fluorosis prevalence in both fluoridated and in non-fluoridated areas.[6-11]

The most important risk factor for fluorosis is the total amount of fluoride consumed from all sources during the critical period of teeth development.[12-15] The permanent maxillary central incisors are of greatest cosmetic importance and they appear most at risk of fluorosis between ages of fifteen and twenty-four months for males and between twenty-one and thirty months for females.[16] However, a meta-analysis of the risk periods associated with the development of dental fluorosis in maxillary permanent central incisors has shown that the duration of excessive fluoride exposure throughout amelogenesis, rather than specific risk periods, would seem to explain the development of dental fluorosis.[17] Therefore, one should concern about fluoride intake for children up to 3 years of age, in order to prevent fluorosis in upper incisors, which are the most relevant teeth from an aesthetic point of view.

The maximum daily fluoride intake dose, above which the risk of dental fluorosis increases, is

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not precisely defined yet. Some authors regard to 0.1 mg F/kg body weight per day as the exposure level above which dental fluorosis occurs,[18] although other authors have found dental fluorosis with a daily fluoride intake of less than 0.03 mg F/kg body weight per day from water.[19] In the latter study, however, the teeth were dried in order to detect the mildest forms of fluorosis. Despite its dubious genesis, based on empirical evidences, a daily fluoride intake between 0.05 and 0.07 mg/kg body weight per day is generally regarded as optimum for control of dental caries and to avoid aesthetically concerning dental fluorosis.[20,21] Other factors that may increase the susceptibility of individuals to dental fluorosis are altitude,[22, 30] renal insufficiency,[31-34] and malnutrition.[30, 35] Some of these factors, however, can produce enamel changes that resemble dental fluorosis in the absence of significant exposure to fluoride.

Recent data show a prevalence of dental fluorosis of 8.56% in 12-year-old Brazilian children.[36] However, previous Brazilian studies have shown that the prevalence for dental fluorosis changes across the communities, ranging from zero [37] to 97.6%.[38] For the few studies that referred to the major cases of severity, it was attributed to endemic fluorosis and was due to high levels of fluoride in the naturally fluoridated drinking water. Concern with the increase in the prevalence of fluorosis has led many investigators to evaluate the fluoride concentration of potential sources, as well as to estimate the fluoride intake from all sources, especially in children.[39-56] These studies have identified four major risk factors: use of fluoridated drinking water, fluoride supplements, fluoride dentifrice, and infant formulas.[15] Some manufactured infant foods and drinks may also be important contributors to total daily fluoride intake.[55-62] The purpose of this review is to summarize the recent literature on the risk factors for dental fluorosis, describing multiple sources of fluoride intake identified until now, as well as some measures that should be adopted to reduce the fluoride intake. This information is of fundamental interest to clinicians that deal with children, in order that an adequate counseling regarding fluoride intake can be done to their parents.

Fluoridated drinking water

Fluoridation of community drinking water is recognized as one of ten great public health achievements in the world.[63] Although other fluoride-containing products are available, water fluoridation remains the most equitable and cost-effective method of delivering fluoride to all members of most communities, regardless of age, educational attainment, or income level. Mean water fluoridation costs are around US$ 0.72 per person per year in USA [64] and R$ 1.00 (=US$ 0.45) in Brazil.[65]

Since 1942, Dean et al.12 stated that some 10% of children in optimally fluoridated (1.0 ppm) areas were affected by mild or very mild fluorosis in the permanent teeth and that less than 1% were so affected in low-fluoride areas. These degrees of prevalence were recorded prior to the availability of fluoridated dental products, when fluoridated drinking water was the only significant source of fluoride intake. In addition, current studies support the view that dental fluorosis has increased in both fluoridated and non-fluoridated communities.[11,66] In North America, the prevalence of dental fluorosis now ranges between 7.7% to 69% in fluoridated communities, and from 2.9% to 42% in non-fluoridated communities. The studies done after the 1980s have shown the highest prevalences.[15] The studies by Spuznar, Burt [67] and Riordan [68] are in agreement that the risk of fluorosis in areas where the water fluoride concentration is 0.8 ppm is four times higher than in non-fluoridated communities.[67-69] In a systematic review of 214 studies on water fluoridation, McDonagh et al.[70] estimated that at a fluoride level of 1 ppm in the drinking water, 12.5% of exposed people would have fluorosis that they would find of esthetic concern, a prevalence much higher than that reported by Dean 12 who found virtually no cases of moderate or severe fluorosis. However, in fluoridated areas with more than 1 mg F/L, dental fluorosis risk is higher than in sub-optimally fluoridated areas.[71, 72]

Of special interest when analyzing the impact of water fluoride on dental fluorosis are the studies that take advantage of breaks on water fluoridation to assess dental fluorosis on different birth cohorts. In this sense, Burt et al.[73] assessed the impact of an unplanned break of 11 months in water fluoridation and concluded that enamel fluorosis is sensitive to even small changes in fluoride exposure from drinking water, and this sensitivity is greater at 1 to 3 years of age than at 4 or 5 years. However, in a subsequent study the prevalence of enamel fluorosis, that was expected to increase in the next cohort examined due to the resumption of fluoridation, remained stable.[74] Buzalaf et al.[75] analyzed the effect of a 7-year interruption in water fluoridation on the prevalence of enamel fluorosis in Jaú, state of São Paulo, Brazil. The authors found a lower prevalence of enamel fluorosis in the maxillary central incisors of children that were 36, 27 and 18 months old when water fluoridation ceased when compared to children that were born 18 months after fluoridation was interrupted. These results suggest that the fluoridated water is not an important risk factor for enamel fluorosis, since the prevalence of enamel fluorosis was lower when fluoridated water was used.

The present-day prevalence of fluorosis indicates that some young children are ingesting fluoride from sources in addition to that in drinking water. A recent study estimated the total daily fluoride intake of 1-3-year-old children from diet and dentifrice. The constituents of the diet were divided into solids, water plus milk and other beverages, which were analyzed for fluoride separately. The dentifrice alone was responsible for 81.5% of the daily fluoride intake in average, while among the constituents of the diet, water and milk were the most important contributors and were responsible for around 60% of the total contribution of the diet.[51] However, since diet has a low contribution to the total fluoride intake (less than 20%), water fluoride probably has its greatest impact on fluorosis prevalence indirectly, through its use in the processing of infant formulas, and other children's foods and beverages.[21] Taking into account the risks and benefits of public water fluoridation, as well as the prevalence and severity of dental fluorosis found today, it is completely unjustifiable to stop water fluoridation in order to avoid dental fluorosis, especially in countries like Brazil, where many people do not have access to other fluoride sources, such as dentifrices.

In order to minimize the possible impact of water fluoridation on dental fluorosis, some measures are necessary. One of them is the external control over water fluoridation. In Bauru, São Paulo, Brazil, fluctuations in public water fluoride levels had been reported, with values ranging from 0.01 to 9.35 ppm,[53] which is completely unacceptable. In order to contribute to the improvement of the quality of public water fluoridation, a program of external control was implemented by Bauru Dental School, University of São Paulo, in 2004. As part of this program, every month, in random days established by drawing, samples are collected in 60 points of water supply, covering the entire city. The results obtained 1 year after the implementation of this program indicated a significant improvement in the quality of water fluoridation in the city. Around 85% of the samples collected were classified as acceptable (0.55-0.84 ppm F). Thus, the external control is an important measure to assure the quality control of water fluoridation and programs like this should be implemented in all cities that artificially fluoridate their public water supplies.[76]

Another important measure is to avoid the use of fluoridated water (around 1 ppm) to dilute powdered milk, juices, and infant formulas for children. The recommendation in this case is the use of bottled mineral water with relatively low fluoride content instead of fluoridated water.[52, 56, 77] Most of the brands of bottled water in Brazil have low fluoride content and should be adequate for this purpose.[78, 79] However, in some cases it is not possible for the consumers to trust on the information stated on the labels of the products. Unexpected high fluoride concentrations have been reported in several brands of bottled water commercially found in Brazil,[78] differently of the information stated on their labels. This reinforces the need of a more rigorous surveillance by the competent public health authorities, since the consumption of bottled water in some Brazilian cities has been reported to be around 30%.[78]

Fluoride in dentifrices

Association between the use of dentifrice fluoride and prevalence of dental fluorosis has been widely reported both in fluoridated and in non-fluoridated communities.[80]

A study of 157 patients aged 8-17 years attending a university pediatric dentistry clinic in Iowa City identified exposure to fluoride water and fluoride dentifrice as risk factors for dental fluorosis.[81] A larger study of a similar design was conducted in a pediatric dental practice in Asheville, North Carolina.[82] This study found that initiating tooth brushing with fluoride dentifrice prior to age two was significantly associated with dental fluorosis. In addition, for those drinking non-fluoridated water, daily fluoride supplement use was strongly associated with dental fluorosis.

Of particular interest are a series of well-designed case control studies conducted by Pendrys and coworkers [83-85] in both fluoridated and non-fluoridated areas in New England. In these studies, parents completed detailed, self-administered questionnaires regarding infant feeding patterns, residence history, fluoride supplement use, brushing (with fluoridated dentifrice) frequency, and amount of dentifrice used per brushing up to eight years of age. Among residents in fluoridated areas, mild-to-moderate dental fluorosis was associated with inappropriate supplement use, frequent brushing prior age of eight, and use of larger than pea-sized amounts of dentifrice. The estimated percentage of cases of dental fluorosis attributable to greater dentifrice use was 21%.[84, 86]

Among residents of non-fluoridated areas, Pendrys, Katz [83] found that mild-to-moderate dental fluorosis was strongly associated with fluoride supplement use and high household income, but the use of infant formula and fluoride dentifrice were not associated with increased risk for fluorosis. However, a later study [85] identified fluoride supplement use and frequent, early toothbrushing habits as significantly associated with mild-to-moderate fluorosis in both early and late enamel forming surfaces in the permanent teeth.

As a follow up to their trial of low fluoride dentifrice in children between the ages of three to five years in a fluoridated area [87] Holt and co-workers [88] compared the prevalence of dental fluorosis among high (1,055 ppm F) and low (550 ppm) fluoride dentifrice groups, when children were 9-10 years of age. This study found that use of fluoride supplements and use of standard dentifrice (1,055 ppm F) significantly increased the risk of dental fluorosis in the permanent teeth.

In their study of eight-year-old Norwegian children whose water was not fluoridated, Wang and co-workers [89] identified regular supplement use and use of fluoride toothpaste prior to age 14 months as the only significant risk factors for dental fluorosis.

Rock, Sabieha [90] conducted a study of 325 8-9-year-old children living in optimally-fluoridated Birmingham, England and found a strong association between fluorosis in the maxillary central incisors and early dentifrice use and use of dentifrice with a high (1,500 ppm) fluoride concentration. It was also observed that a higher proportion of children without fluorosis had used a commercially available low-fluoride dentifrice.

However, all the studies mentioned above have retrospectively assessed fluoride exposures, often eight to ten years after the exposures had occurred. Thus, all studies relating dentifrice use to dental fluorosis are prone to recall bias. Nevertheless, there is now compelling evidence that the early use of fluoride dentifrice is an important risk factor for dental fluorosis, as young children swallow considerable amounts of dentifrice.[80] In fact, the amount of fluoride ingested is inversely related to the age of the child. Dentifrices with a fluoride concentration of 1,000 ppm contain 1.0 mg of fluoride per gram. In children younger than 6 years of age, the mean quantity of dentifrice per brushing episode is about 0.55 g,[91] corresponding to a fluoride exposure of about 0.55 mg. An average of 48% of this amount is ingested by 2- to 3-year olds, 42% by 4-year-olds and 34% by 5-year-olds.[91-94] Assuming mean body weights of 15, 18 and 20 kg, respectively, fluoride intake from one brushing per day results in ingestion of 18, 13 and 9 µg/kg/day, respectively. So, it is evident that toothbrushing substantially increases the fluoride exposure, particularly for 2- to 3-year-old children, and, of course, especially for children that brush more than once daily.[95] Information like this for economically developing countries is rare.[96] Studies conducted with 2-3-year-old Brazilian children, that lived in areas with fluoridated water, showed that they ingested 0.061 mg fluoride/kg body weight per day (range 0.011-0.142) from dentifrice [97] and that dentifrice contributed with 55% of the total amount of fluoride ingested daily.[67] A more recent study conducted in Brazil [51] involving 1-3-year-old children reported that they ingested 0.106 mg fluoride/kg body weight per day (range 0.004-0.401) from dentifrice, which corresponds to 81% of the total daily fluoride intake.

Based on these findings, it is clear that measures to reduce fluoride intake by children at risk of dental fluorosis are necessary. Two alternatives have been suggested. The first one would be to reduce the amount of dentifrice used. This is an important measure, but we cannot forget that nowadays in most families both parents work and people who take care of the children not always follow parents' instructions. In addition, the flavor of most children dentifrices encourages ingestion. Because of this, it has been proposed that dentifrices with lower fluoride concentrations should be developed and marketed for use by young children, as has been done in many countries.[98, 99] The European Academy of Paediatric Dentistry [100] advises the use of a very small amount of low fluoride dentifrice from 6 months to 2 years of age and the use of a pea-sized (around 0.25 g) amount of 500 ppm fluoride twice daily from 2 to 6 years. A higher fluoride concentration dentifrice (1,000-1,500 ppm) should be used as soon as the first permanent molars erupt. However, in some countries (like USA) the sale of low fluoride dentifrices is not allowed until large clinical trials have demonstrated safety and efficacy. It is possible that reducing the fluoride concentration of dentifrices could reduce the anti-caries effectiveness. Therefore, the ideal lower fluoride dentifrice should not only reduce fluoride ingestion, but also be equally effective in caries control as currently marketed formulations of 1,000-1,100 ppm fluoride. Following this rationale, the reduction of the pH of the dentifrice to 5.5 [101] or 4.5 [102] has been reported to significantly increase the effectiveness of low fluoride (500 ppm) dentifrices with respect to the inhibition of mineral loss of enamel blocks in vitro. The reduction of the pH of the dentifrices also led to an increase in salivary fluoride concentration after toothbrushing, without increasing the bioavailability of fluoride.[103] However, before these formulations can be widely recommended, they have to tested in randomized clinical trials.

There have been many longitudinal clinical trials of the effectiveness of dentifrices with lower fluoride concentrations. Some of them found no significant differences between standard (1,000-1,100 ppm) and low fluoride dentifrices (250-550 ppm fluoride).[104-106]. In contrast, Reed,[107] Mitropoulos and co-workers [108] and Koch and co-workers [109] found the low-fluoride dentifrices to be somewhat less effective than the 1,000 ppm dentifrices. Ammari et al.[110] conducted a systematic review of studies comparing the anti-caries efficacy of children's toothpaste containing 600 ppm of fluoride or less with high fluoride toothpastes of 1,000 ppm or above. Seven randomized controlled trials were included. These were categorized into two groups depending on the fluoride concentration in the low fluoride group (250 and 500 ppm) and analyzed separately. The authors concluded that 250 ppm fluoride dentifrices were not as effective in caries prevention in permanent dentition as dentifrices containing 1,000 ppm For more. However, for the 500 ppm fluoride dentifrices, only two studies were in this category, and one of them failed to present the baseline caries levels, so a meta-analysis could not be carried out. Thus, additional studies are required to test the anticaries efficacy of 500 against 1,000 ppm and above dentifrices.

Even without corroborating studies, it appears that the best balance between prevention of caries and dental fluorosis favors reduced concentrations of about 500-550 ppm fluoride for preschoolers. However, those groups or individuals judged to be at increased risk for dental caries might have a more favorable benefit/risk ratio with the use of standard 1,000-1,100 ppm fluoride dentifrices. While additional studies are needed for young children that are not at high risk for caries but may be at risk for dental fluorosis, it is appropriate to consider recommendations that dentifrices containing 500-550 ppm fluoride be marketed and endorsed for use by preschool children.

Three factors have an important influence on the anticaries efficacy of fluoride dentifrices, namely concentration, frequency of brushing and post brushing rinsing behaviour. Low-fluoride dentifrices (500 ppm) are appropriate for very young children (under 7 years) at low caries risk, particularly if living in fluoridated areas. For other young children, higher concentrations of fluoride should be used. Brushing should be recommended twice daily, whilst rinsing with large volumes of water should be discouraged. Since small amounts of dentifrice are comparable in efficacy to large amounts, to minimize fluorosis risk, parents should be advised to use only a pea-sized amount (0.25 g) of toothpaste and encourage spitting out of excess.[111, 112] In addition, official health organs should review labeling requirements for dentifrice to make the fluoride concentrations more apparent and should formulate guidelines for instructions regarding prudent use in young children. Furthermore, manufacturers should be encouraged to aggressively market dentifrice dispensers with small orifices or fixed amount "pumps" for use by young children. They should be encouraged or required also to warn parents concerning excessive use and ingestion of dentifrices flavored for children.[80]

Dietary Fluoride Supplements

Fluoride supplements are recommended for children living in fluoride deficient areas. The recommended daily dose is based on the age of the child and on the fluoride concentration in the drinking water. However, there are many reports showing that supplements are prescribed inappropriately to children in fluoridated areas.[82, 113, 114]

Many studies have identified fluoride supplements as risk factors for dental fluorosis, both in fluoridated [84, 115, 116] and non-fluoridated areas.[6, 82, 83, 85, 88, 89, 115, 117] In fluoridated areas the risk of dental fluorosis from use of fluoride supplements is almost 4 times higher than in non-fluoridated areas.[15, 69]

The use of fluoride supplements should be more conservative, restricted for children at high caries risk and with low fluoride intake from other sources, including tap water, bottled water, other beverages, foods and even dentifrice.[40, 42, 118] Actually, nowadays, due to multiple sources of fluoride, considering only the fluoride content of tap water is not safe to prescribe fluoride supplements.[41] Fluoride supplements should not be given for children younger than 5 years of age,[95] independently if the children consume or not fluoridated water.

In Brazil, there are many studies reporting a high (and inappropriate) prescription of fluoride supplements by pediatricians and pediatric dentists.[119-123] These findings reinforce the continued need to educate dentists, pediatricians, and other medical practitioners as to the proper use of fluoride, in particular the importance of not prescribing fluoride supplements to children who live in optimally fluoridated areas.

Infant formulas

Consumption of infant formulas has greatly increased in the last years. A study conducted with [107] American babies showed that 37% of 3-month-old infants were exclusively breast-fed, decreasing to 8% at 6 months of age, 2% at 9 months of age and none at 12 months of age. Among babies who consumed infant formulas, the use of powdered concentrated formulas increased from 48% at 3 months of age to 75% at 12 months of age.[40] Commercially prepared infant formulas are available as powders, as concentrated liquids, or ready-to-feed.

Concentration of fluoride in infant formulas shows wide variations. For infant powdered formulas currently marketed in Brazil, Buzalaf et al.[52] found fluoride concentrations ranging from 0.01 to 0.75 ppm when prepared with deionized water, from 0.91 to 1.65 ppm when prepared with fluoridated drinking water (0.9 ppm F), and from 0.02 to 1.37 ppm when prepared with different brands of bottled mineral water. In Australia, Silva and Reynolds [77] found fluoride concentrations ranging from 0.031 to 0.532 ppm for powdered formulas prepared with non-fluoridated water. In Thailand and Japan values ranging from 0.14 to 0.64 ppm and 0.37 to 1 ppm, respectively, were found.45 Latifah and Razak 124 analyzed infant formulas marketed in Malaysia and observed fluoride concentrations ranging from 0.100 to 0.158 ppm when prepared with deionized water, and from 0.346 to 0.395 ppm, when prepared with fluoridated water (0.379 ppm). In the study conducted by Van Winkle et al.,126 fluoride concentration of ready-to-feed, concentrated liquid and powdered formulas prepared with deionized water was 0.17, 0.12 and 0.14 ppm, respectively.

Soy-based infant formulas have been reported to have somewhat higher fluoride concentrations than milk-based formulas.[52, 77, 124, 125] In the study by Latifah and Razak,[124] soy-based formulas showed values ranging from 0.236 to 0.438 ppm when prepared with deionized water and from 0.447 to 0.473 ppm when prepared with fluoridated water (0.379 ppm fluoride). According to Silva and Reynolds,[77] consumption of soy-based formulas would provide a fluoride level above the threshold dose of 0.07 mg F/Kg body weight per day, for 1-month-old children. These findings are in agreement with reports by Buzalaf et al.[52] and McKnight-Hanes et al.[125]

Considering infant formulas as a risk factor for dental fluorosis, the most important factor is the water used for reconstituting them. Many studies have reported that when infant formulas are reconstituted with optimally fluoridated water (around 0.8 ppm), they can provide to infants a daily fluoride intake above that likely to cause some degree of dental fluorosis.[52, 56, 77, 124, 125]

Bottled mineral water has usually low fluoride concentration. Hence, it is recommended to prepare concentrated and powdered infant formulas.[52, 56, 78, 79, 118, 126-129]

Manufactured infant foods and beverages

During infancy important sources of fluoride are considered to be commercially available foods and beverages. Many studies have shown that the fluoride concentrations of infant foods and beverages span a wide range and depend mainly on the fluoride concentration in the water used to manufacture them.[130-132] Market basket studies are important for the knowledge of the fluoride concentration in manufactured foods and beverages, since there is no law that obliges this information to be stated on the products' labels.

Beikost is a collective term for foods other than milk or formula fed to infants. The fluoride concentration of most beikost is quite modest.[131] However, some cereals in Brazil have been shown to have higher fluoride concentrations than would be expected. This is the case for Mucilon and Neston, which have fluoride concentrations of 2.44 and 6.2 ppm, respectively. A relatively high fluoride concentration was also found in a ready-to-drink chocolate milk (1.2 ppm, Toddynho, Quaker). When one of these products is consumed just once a day it can provide as much as 25% of the fluoride intake believed to be associated with increased risk for dental fluorosis of esthetic concern for a 2-year-old child.[59]

Soft drinks have variable contents of fluoride. Fluoride concentration of carbonated beverages in Brazil has been reported to range from 0.05 to 0.79 ppm.133 This variation is due to fluctuations of fluoride levels in the water used to manufacture these beverages.

Powdered juices usually have low fluoride concentrations. Heintze and Bastos [133] found a mean of 0.6 ppm for Brazilian products. In another study conducted by Bastos et al. (2000), 30.76% of the analyzed juices had fluoride concentrations between 0.25 and 0.5 ppm, and 26.2% below 0.1 ppm. The highest values were found for guarana and grape powdered juices. Since it is a common practice to use fluoride containing pesticides for growing grapes, it is believed that contamination of these juices has occurred.[134]

Buzalaf et al.[54] reported fluoride concentrations around 2.57±0.99 ppm for black tea infusions (Camellia sinensis), 0.37±0.20 ppm for ready-to-drink teas, and 1.10±0.15 ppm for tea-containing powdered juices. For the tea with the highest fluoride concentration (black tea, Apichá, 3.99 mg F/mL), when only 200 mL are consumed just once a day, this may provide up to 100% of the upper limit of the ranges of estimates believed to be associated with increased risk of enamel fluorosis for a 2-year-old child (12 kg). Although fluoride present in tea is bioavailable, its contribution to the fluoride intake is low, since its consumption is usually modest.[135]

Regarding the fluoride content of infant foods, Heilman et al.136 reported a wide variation, between 0.01 and 8.30 ppm. Chicken presented the highest values (between 1.05 to 8.38 ppm). In a study conducted by Chittaisong et al.45 foods showed a fluoride concentration between 0.21 and 0.88 ppm, except for one of the brands of fish-based food analyzed that had 2.94 ppm fluoride. These results are not in agreement with those observed by Nishijima et al.[137] that found values ranging from 0.54 to 0.86 ppm for meat and fish-based food. Also Trautner and Siebert[135] reported chicken and fish to be poor sources of fluoride.

Since the manufacturers are not required to have the fluoride content of the products displayed on the labels, only by market baskets researches and fluoride assay it is possible to know their fluoride content. Table 1 presents the fluoride concentration in a variety of foods and beverages commercially available in Brazil (µg fluoride/100 g). It must be highlighted that the general public usually does not have access to these data. Thus, the health professionals must be up-to-date with respect to this information, in order to adequately advise the parents of children at the age of risk to dental fluorosis. The general recommendation is that children under the age of 7 and mainly between 2 and 3 years of age must avoid the consumption of products with high-fluoride content, since they can significantly contribute to the total daily fluoride intake, thus increasing the risk of dental fluorosis, especially when associated with other fluoride sources.

Table 1. Fluoride concentration in Brazilian foods and beverages

Foods and beverages (100 g)	Fluoride concentration (µg)
1 Stewed Rice	11.70
2 Stewed potato / mashed potato	14.20
3 French fries	6.30
4 Non-filled biscuits (Tucs ®)	91.40
5 Filled Chocolate biscuits / wafer	3.30
6 Cereal (Snowflakes®)	164.00
7 Pasta with sauce	15.54
8 Noodles	51.10
9 Bread	43.30
10 Corn starch (Maizena®, Farinha Láctea®, Mucilon®, Cremogema®)	144.30
11 Bean	3.80
12 Pumpkin	3.50
13 Lettuce	2.50
14 Cabbage/ spring greens	5.00
15 Tomato	2.00
16 Tomato sauce	4.20
17 Carrot	0.70
18 Chayote	1.70
19 Manioc	11.90

Table 1. Fluoride concentration in Brazilian foods and beverages

Foods and beverages (100 g)	Fluoride concentration (µg)
20 Banana	1.00
21 Apple / Pear	1.80
22 Orange	0.40
23 Oranje juice	0.40
24 Concentrated pineapple and passion fruit juices	0.60
25 Papaya	1.10
26 Guava	4.30
27 Beef	3.00
28 Stewed meat	3.00
29 Sausage (Perdigão ®)	65.80
30 Ham (Sadia ®)	9.50
31 Liver beef	5.00
32 Chicken	9.60
33 Fish	9.20
34 Egg	1.00
35 Whole UHT milk	1.50
36 Powdered milk diluted with public fluoridated water [3]	141.49
37 Powdered milk diluted with bottled mineral water [3]	43.97
38 Fruit yogurt	86.00
39 Infant yogurt (Danoninho® / Chambinho®)	32.30
40 Fermented milk (Yakult® / Chamyto®)	13.20
41 Butter	68.20
42 Cheese (Tirolez®)	6.80
43 Cheese curds	12.90
44 Sugar	20.88
45 Powdered chocolate (Nescau® / Toddy®)	21.70
46 Cake / Chocolate cake (Dona Benta ®)	25.30
47 Chocolate	11.00
48 Snacks / Chips	31.80
49 Risotto	5.60
50 Meat soup – vegetables / bean / noodle	11.00
51 Soup – vegetables/ bean / noodle	8.00
52 Cheese bread	25.60
53 Cheese Pizza (Perdigão®)	20.90
54 Sandwich	7.70
55 Coffee with sugar	18.49
56 Carbonated soft drinks (Coca-Cola®)	24.00
57 Powdered juice (Tang ®)	25.80
58 Infused manufactured tea	33.50
59 Black tea (Apichá)	302.10
60 Powdered soy milk diluted with public fluoridated water [1]	83.70
61 Powdered soy milk diluted with bottled mineral water [1]	86.18
62 Chocolate flavoured milk (Toddynho®)	118.70
63 Sports drink (Gatorade®)	2.30
64 Cereal (Neston®)	616.30
65 Biscuit (Danyt's®)	706.00
66 Chocolate bar	12.00
67 Chocolate (M&Ms®)	160.00

[1] *30 g powder/184 mL water*

References

1. Fejerskov O, Thylstrup A, Larsen MJ. Rational use of fluorides in caries prevention. *Acta Odontol Scand* 1981; 39: 241-9.
2. Ten Cate JM, Duijsters PPE. Influence of fluoride in solution on tooth demineralization. I. Chemical data. *Caries Res* 1983; 17: 513-9.
3. Ten Cate JM, Featherstone JDB. Mechanistic aspects of the interactions between fluoride and dental enamel. *Crit Rev Oral Biol Med* 1991; 2: 283-96.
4. Ögaard B, Rolla G, Ruben J, Dijkman T, Arends J. Microradiographic study of remineralization of shark enamel in human caries model. *Scand J Dent Res* 1988; 96: 209-11.
5. Ögaard B. Effects of fluoride mouthrinsing on caries lesion development in shark enamel; an in situ caries model study. *Scand J Dent Res* 1991; 99: 372-7.
6. Jackson RD, Kelly SA, Katz B, Brizendine E, Stookey GK. Dental fluorosis in children residing in communities with different water fluoride levels: 33-month follow-up. *Pediatr Dent* 1999; 21: 248-54.
7. Leverett DH. Prevalence of dental fluorosis in fluoridated and in non-fluoridated communities-a preliminary investigation. *J Publ Health Dent* 1986; 46: 184-7.
8. Tabari ED, Ellwood R, Rugg-Gunn AJ, Evans DJ, Davies RM. Dental fluorosis in permanent incisor teeth in relation to water fluoridation. Social deprivation and toothpaste use in infancy. *Br Dent J* 2000; 189: 216-20.
9. Tsutsui A, Yagi M, Horowitz AM. The prevalence of dental caries and fluorosis in Japanese communities with up to 1.4 ppm of naturally occurring fluoride. *J Publ Health Dent* 2000; 60: 147-53.
10. Pereira AC, Da Cunha FL, Meneghim M de C, Werner CW. Dental caries and fluorosis prevalence study in a nonfluoridated Brazilian community: trend analysis and toothpaste association. *ASDC J Dent Child* 2000; 67: 132-5.
11. Khan A, Moola MH, Cleaton-Jones P. Global trends in dental fluorosis from 1980 to 2000: a systematic review. *South Afr Dent J* 2005; 60: 418-21.
12. Dean HT, Arnold FA, Elvove E. Domestic water and dental caries V. Additional studies of the relation of fluoride domestic waters to dental caries experience in 4.425 white children aged 12-14 years in 13 cities in 4 states. *Public Health Rep* 1942; 57: 1155-79.
13. Denbesten PK. Biological mechanisms of dental fluorosis relevant to the use of fluoride supplements. Community *Dent Oral Epidemiol* 1999; 27: 41-7.
14. Evans DJ. A study of developmental defects in enamel in 10-year-old high social class children residing in a non-fluoridated area. *Community Dent Health* 1991; 8: 31-8.
15. Mascarenhas AK. Risk factors for dental fluorosis: A review of the recent literature. *Pediatr Dent* 2000; 22: 269-77.
16. Evans RW, Darvell BW. Refining the estimate of the critical period for susceptibility to enamel fluorosis in human maxillary central incisors. *J Publ Health Dent* 1995; 55: 238-49.
17. Bardsen A. "Risk periods" associated with the development of dental fluorosis in maxillary permanent central incisors; a meta-analysis. *Acta Odontol Scand* 1999; 57: 247-56.
18. Forsman B. Early supply of fluoride and enamel fluorosis. *Scand J Dent Res* 1977; 8: 22-30.
19. Baelum V, Fejerskov O, Manji F, Larsen MJ. Daily dose of fluoride and dental fluorosis. *Tandlaegebladet* 1987; 91: 452-6.
20. Ophaug RH, Singer L, Harland BF. Estimated fluoride intake of 6-month-old infants in four dietary regions of the United States. *Am J Clin Nutr* 1980; 33: 324-7.
21. Burt BA. The changing patterns of systemic fluoride intake. *J Dent Res* 1992; 71: 1228-37.
22. Angmar-Mansson B, Whitford GM. Environmental and physiological factors affecting dental fluorosis. *J Dent Res* 1990; 69(Spec Issue): 706-13.
23. Irigoyen ME, Molina N, Luengas I. Prevalence and severity of dental fluorosis in a Mexican community with above-optimal fluoride concentration in drinking water. *Comm Dent Oral Epidemiol* 1995; 23: 243-5.
24. Mabelya L, Konig KG, van Palenstein Helderman WH. Dental fluorosis, altitude and associated dietary factors (short communication). *Caries Res* 1992; 26: 65-7.
25. Mabelya L, van Palenstein Helderman WH, van't Hof MA, Konig KG. Dental fluorosis and the use of a high fluoride-containing trona tenderizer (magadi). *Comm. Dent Oral Epidemiol* 1997; 25: 170-6.
26. Manji F, Baelum V, Fejerskov O, Gemert W. Enamel changes in two low-fluoride areas of Kenya. *Caries Res* 1986; 20: 371-80.
27. Rwenyonyi C, Bjorvatn K, Birkeland J, Haugejorden O. Altitude as a risk indicator of dental fluorosis in children residing in areas with 0.5 and 2.5 mg fluoride per litre in drinking water. *Caries Res* 1999; 33: 267-74.
28. Whitford GM. The physiological and toxicological characteristics of fluoride. *J Dent Res* 1980; 69(Spec): 539-49.
29. Whitford GM. Determinants and mechanisms of dental fluorosis. *CIBA Found Symp* 1997; 205: 226-45.
30. Yoder KM, Mabelya L, Robison VA, et al. Severe dental fluorosis in a Tanzanian population consuming water with negligible fluoride concentrations. *Comm Dent Oral Epidemiol* 1998; 26: 382-93.
31. Juncos LI, Donadio JVJr. Renal failure and fluorosis. *JAMA* 1972; 222: 783-5.
32. Kaminsky LS, Mahoney MC, Leach J, Melius J, Miller MJ. Fluoride: benefits and risks of exposure. *Crit Rev Oral Biol Med* 1990; 1: 261-81.
33. Porcar C, Bronsoms J, Lopez-Bonet E, Valles M. Fluorosis, osteomalacia and pseudohyperparathyroidism in a patient with renal failure. *Nephron* 1998; 79: 234-5.
34. Turner CH, Owan I, Brizendine EJ, et al. High fluoride intakes cause osteomalacia and diminished bone strength in rats with renal deficiency. *Bone* 1996; 19: 595-601.
35. Rugg-Gunn AJ, Al-Mohammadi SM, Butler TJ. Effects of fluoride level in the drinking water, nutritional status and socio-economic status on the prevalence of developmental defects of dental enamel in permanent teeth in Saudi 14-year-old boys. *Caries Res* 1997; 31: 259-67.
36. Brazilian Health Bureau of State. Project SB Brasil 2003. Oral health conditions of Brazilian people 2002-2003. Brasília DF. 52p (in Portuguese).

37. Campos C, Toledo AO, Bezerra AC. Prevalência de fluorose dentária em escolares de Brasília, Distrito Federal. *Rev Odontol USP* 1998; 12: 225-30.
38. Capella LF, Carcereri DL, Paiva SM, Rosso RA, Paixão RF, Saltori EK. Ocorrência de fluorose dentária endêmica. *Rev Gaúcha Odontol* 1989; 36: 371-5.
39. Ophaug RH, Singer L, Harland BF. Dietary fluoride intake of 6-month-old and 2-year-old children in four dietary regions of the United States. *Am J Clin Nutr* 1985; 42: 701-7.
40.Levy SM, Maurice TJ, Jakobsen JR. Feeding patterns, water sources and fluoride exposures of infants on 1 year-old. *J Am Dent Assoc* 1993; 124: 65-9.
41.Levy SM, Kohout FJ, Guha-Chowdhury N, et al. Infants' fluoride intake from drinking water alone and from water added to formula beverages and food. *J Dent Res* 1995; 74: 1399-1407.
42.Levy SM, Kohout FJ, Kiritsy MC, Heilman JR, Wefel JS. Infants' fluoride ingestion from water supplements and dentifrice. *J Am Dent Assoc* 1995; 126: 1625-32.
43.Levy SM, Warren JJ, Davis CS, et al. Patterns of fluoride intake from birth to 36 months. *J Publ Health Dent* 2001; 61: 707.
44.Clovis J, Hargreaves JA. Fluoride intake from beverage consumption. *Community Dent Oral Epidemiol* 1988; 16: 11-5.
45. Chittaisong C, Koga H, Maki Y, Takaesu Y. Estimation of fluoride intake in relation to F, Ca, Mg, and P contents in infant formulas. *Bull Tokyo Dent Coll* 1995; 36: 19-26.
46. Chowdhury NG, Brown RH, Shepherd MG. Fluoride intake of infants in New Zealand. *J Dent Res* 1990; 69: 1828-33.
47. Guha-Chowdhury N, Drummond BK, Smillie AC. Total fluoride intake in children aged 3 to 4 years – a longitudinal study. *J Dent Res* 1996; 75: 1451-7.
48. Kimura T, Morita M, Kinoshita T, et al. Fluoride intake from food and drink in Japanese children aged 1-6 years. *Caries Res* 2001; 35: 47-9.
49. Lima YBO, Cury JA. Ingestão de fluoreto por crianças pela água e dentifrício. *Rev Saúde Pública* 2001; 35: 576-81.
50. Pessan JP, Silva SMB, Buzalaf MAR. Evaluation of the total fluoride intake of 4-7-year-old children from diet and dentifrice. *J Appl Oral Sci* 2003; 11: 150-6.
51. Almeida BS, Cardoso VES, Buzalaf MAR. Fluoride ingestion from toothpaste and diet in 1-3-year-old Brazilian children. *Comm Dent Oral Epidemiol* 2007; 35: 53-63.
52. Buzalaf MAR, Granjeiro JM, Damante CA, de Ornelas F. Fluoride content in infant formulas prepared with deionized bottled mineral and fluoridated drinking water. *ASDC J Dent Child* 2001; 68: 37-41.
53. Buzalaf MAR, Granjeiro JM, Damante CA, de Ornelas F. Fluctuations in public water fluoride concentrations in Bauru, Brazil. *J Public Health Dent* 2002; 62: 173-6.
54. Buzalaf MAR, Bastos JRM, Granjeiro JM, et al. Fluoride content of several brands of teas and juices found in Brazil and risk of dental fluorosis. *Rev FOB* 2002; 10: 263-7.
55. Buzalaf MAR, Almeida BS, Cardoso VES, et al. Total and acid-soluble fluoride content of infant cereals, beverages and biscuits from Brazil. *Food Add Cont* 2004; 21: 210-5.
56. Buzalaf MAR, Damante CA, Trevizani LM, Granjeiro JM. Risk of fluorosis associated with infant formulas prepared with bottled water. *J Dent Child* 2004; 71: 110-3.
57. Cardoso VES, Ollympio KPK, Granjeiro JM, Buzalaf MAR. Fluoride content of several breakfast cereals and snacks found in Brazil. *J Appl Oral Sci* 2003; 11: 306-10.
58. Buzalaf MAR, Cury JA, Whitford GM. Fluoride exposures and dental fluorosis: a literature review. *Rev FOB* 2001; 9: 1-10.
59. Buzalaf MAR, Granjeiro JM, Duarte JL, Taga ML. Fluoride content of infant foods in Brazil and risk of dental fluorosis. *J Dent Child* 2002; 69: 196-200.
60. Buzalaf MAR, Granjeiro JM, Cardoso VES, Silva TL, Ollympio KPK. Fluoride content of several brands of cereal bars and chocolate cookies found in Brazil. *Pesq Odontol Bras* 2003; 17: 223-7.
61. Buzalaf MAR, Pessan JP, Fukushima R, Dias A, Rosa HM. Fluoride content of UHT milks comercially available in Bauru, Brazil. *J Appl Oral Sci* 2006; 14: 38-42.
62. Buzalaf MAR, Pinto CS, Rodrigues MHC, et al. Availability of fluoride from meals given to kindergarten children in Brazil. *Community Dent Oral Epidemiol* 2006; 34: 87-92.
63. Centers for Disease Control and Prevention. Achievements in Public Health. 1900-1999: fluoridation of drinking water to prevent dental caries. *Morb Mort Wkly Rep* 1999; 48: 933-940.
64. Jones S, Burt BA, Petersen PE, Lennon MA. The effective use of fluoride in public health. *Bull WHO* 2005; 83: 670-6.
65. Narvai PC. Vigilância sanitária da fluoretação das águas de abastecimento público no município de São Paulo, Brasil, no período de 1990-1999 [dissertation]. São Paulo (SP): Faculdade de Saúde Pública; Universidade de São Paulo, 2001.
66. Selwitz RH, Nowjack-Raymer RE, Kingman A, Driscoll WS. Prevalence of dental caries and dental fluorosis in areas with optimal and above-optimal water fluoride concentrations: a 10-year follow-up survey. *Public Health Dent* 1995; 55: 85-93.
67. Szpunar Sm, Burt BA. Dental caries, fluorosis, and fluoride exposure in Michigan schoolchildren. J Dent Res 1988; 67: 802-6.
68. Riordan PJ. Dental fluorosis. dental caries and fluoride exposure among 7-year-olds. *Caries Res* 1993; 27: 71-7.
69. Riordan PJ, Banks JA. Dental fluorosis and fluoride exposure in Western Australia. *J Dent Res* 1991; 70: 1022-8.
70. McDonagh MS, et al. Systematic review of water fluoridation. *Brit Med J* 2000; 321: 844-5.
71. Jackson RD, Kelly SA, Katz BP, Hull JR, Stookey GK. Dental fluorosis and caries prevalence in children residing in communities with different levels of fluoride in the water. *J Public Health Dent* 1995; 55: 79-84.
72. Heller KE, Eklund SA, Burt BA. Dental caries and dental fluorosis at varying water fluoride concentrations. *J Public Health Dent* 1997;57(3):136-43.
73. Burt BA, Keels MA, Heller KE. The effects of a break in water fluoridation on the development of dental caries

and fluorosis. *J Dent Res* 2000; 79: 761-9.
74. Burt BA, Keels MA, Heller KE. Fluorosis development in seven age cohorts after an 11-month break in water fluoridation. *J Dent Res* 2003; 82: 64-8.
75. Buzalaf MA, de Almeida BS, Ollympio KP da S, et al. Enamel fluorosis prevalence after a 7-year interruption in water fluoridation in Jau, Sao Paulo, Brazil. *J Publ Health Dent* 2004; 64: 205-8.
76. Ramires I, Maia LP, Rigolizzo D, et al. External control over the fluoridation of the public water supply in Bauru, SP, Brazil. *Rev Saúde Pública* 2006; 40: 883-9.
77. Silva M, Reynolds EC. Fluoride content of infant formulae in Australia. *Austr Dent J* 1996; 41: 37-42.
78. Ramires I, Grec RHC, Cattani L, et al. Avaliação da concentração de fluoreto e do consumo de água mineral. *Rev Saúde Publ* 2004; 38: 459-65.
79. Villena RS, Borges DG, Cury JA. Avaliação da concentração de fluoreto em águas minerais comercializadas no Brasil. *Rev Saúde Pública* 1996; 30: 512- 8.
80. Warren JJ, Levy SM. A review of fluoride dentifrice related to dental fluorosis. *Pediatr Dent* 1999; 21: 265-71.
81. Skotowski MC, Hunt RJ, Levy SM. Risk factors for dental fluorosis in pediatric dental patients. *J Public Health Dent* 1995; 55: 154-9.
82. Lalumandier JA, Rozier GR. The prevalence and risk factors of fluorosis among patients in a pediatric dental practice. *Pediatr Dent* 1995; 17: 19-25.
83. Pendrys DG, Katz RV. Risk of enamel fluorosis associated with fluoride supplementation, infant formula and fluoride dentifrice use. *Am J Epidemiol* 1989; 130: 1199-208.
84. Pendrys DG, Katz RV, Morse DE. Risk factors for enamel fluorosis in a fluoridated population. *Am J Epidemiol* 1994; 140: 461-71.
85. Pendrys DG, Katz RV, Morse DE. Risk factors for enamel fluorosis in a nonfluoridated population. *Am J Epidemiol* 1996; 143: 808-15.
86. Pendrys DG. Risk of fluorosis in a fluoridated population. Implications for the dentist and hygienist. *J Am Dent Ass* 1995; 126: 1617-24.
87. Winter GB, Holt HD, Williams BF. Clinical trial of a low-fluoride toothpaste for young children. *Int Dent J* 1989; 39: 227-35.
88. Holt RD, Morris CE, Winter GB, Downer MC. Enamel opacities and dental caries in children who used a low fluoride toothpaste between 2 and 5 years of age. *Int Dent J* 1994; 44: 331-41.
89. Wang NJ, Gropen AM, Ogaard B. Risk factors associated with fluorosis in a non-fluoridated population in Norway. *Comm Dent Oral Epidemiol* 1997; 25: 396-401.
90. Rock WP, Sabieha AM. The relationship between reported toothpaste usage in infancy and fluorosis of permanent incisors. *Brit Dent J* 1997; 183: 165-70.
91. Richards A, Banting DW. Fluoride toothpastes. In: Fejerskov O, Ekstrand J, Burt BA (eds.). Fluoride in dentistry. Copenhagen; Munksgaard, 1996. Pp. 328-46.
92. Barnhart Barnhart WE, Hiller LK, Leonard GJ, Michaels SE. Dentifrice usage and ingestion among four age groups. *J Dent Res* 1974; 53: 1317-22.
93. Ericsson Y, Forsman B. Fluoride retained from mouthrinses and dentifrices in preschool children. Caries Res 1969; 3: 290-9.
94. Hargreaves JA, Ingram GS, Wagg BJ. A gravimetric study of the ingestion of toothpaste by children. *Caries Res* 1972; 6: 237-43.
95. Fomon SJ, Ekstrand J, Ziegler EE. Fluoride intake and prevalence of dental fluorosis: trends in fluoride intake with special attention to infants. *J Public Health Dent* 2000; 60: 131-9.
96. Cury JA. Determination of appropriate exposure of fluoride in non-EME countries in the future. *J Dent Res* 2000; 79: 901.
97. Paiva SM, Cury JA. Dentifrício fluoretado e risco de fluorose dentária. *Rev Pós Grad* 2001; 8: 322-8.
98. Beltran ED, Szpunar SM. Fluoride in toothpastes for children: suggestions for change. *Pediat Dent* 1988; 10: 185-8.
99. Horowitz HS. The need for toothpastes with lower than conventional fluoride concentrations for preschool-aged children. *J Public Health Dent* 1992; 52: 216-21.
100. Oulis C, Raadal M, Martens L. Guidelines on the use of fluoride in children: An EAPD policy document. *Eur J Paediatr Dent* 2000; 1: 7-12.
101. Brighenti FL, Delbem AC, Buzalaf MA, et al. In vitro evaluation of acidified toothpastes with low fluoride content. *Caries Res* 2006; 40: 239-44.
102. Alves KMRP, Pessan JP, Brighenti FL, et al. In vitro evaluation of the effectiveness of acidic fluoride dentifrices. *Caries Res* 2007 (in press).
103. Olympio KPK, Bardal PAP, Cardoso VE da S, et al. Low fluoride dentifrices: efficacy and safety. *Caries Res* 2007 (in press).
104. Forsman B. Studies on the effect of dentifrices with low fluoride content. *Comm Dent Oral Epidemiol* 1974; 2: 166-75.
105. Gerdin P. Studies in dentifrices, VIII: Clinical testing of an acidulated, nongrinding dentifrice with reduced fluoride contents. *Swed Dent J* 1974; 67: 283-97.
106. Koch G, Petersson LG, Kling E, Kling L. Effect of 250 and 1000 ppm fluoride dentifrice on caries. A three-year clinical study. *Swed Dent J* 1982; 6: 233-8.
107. Reed MW. Clinical evaluation of three concentrations of sodium fluoride in dentifrices. *J Am Dent Ass* 1973; 87: 1401-3.
108. Mitropoulos CM, Holloway PJ, Davies TG, Worthington HV. Relative efficacy of dentifrices containing 250 or 1000 ppm F in preventing dental caries – Report of a 32-month clinical trial. *Comm Dent Health* 1984; 1: 193-200.
109. Koch G, Bergmann-Arnadottir I, Bjarnason S, et al. Caries-preventive effect of fluoride dentifrices with and without anticalculus agents: a 3-year controlled clinical trial. *Caries Res* 1990; 24: 72-9.
110. Ammari AB, Bloch-Zupan A, Ashley PF. Systematic review of studies comparing the anti-caries efficacy of children's toothpaste containing 600 ppm of fluoride or less with high fluoride toothpastes of 1.000 ppm or above. *Caries Res* 2003; 37: 85-92.
111. Browne D, Whelton H, O'Mullane D. Fluoride metabolism and fluorosis. J Dent 2005; 33: 177-86.
112. Davies RM. Ellwood RP. Davies GM. The rational use of fluoride toothpaste. *Int J Dent Hyg* 2003; 1: 3-8.
113. Pendrys DG, Morse DE. Use of fluoride supplemen-

tation by children living in fluoridated communities. *ASDCJ Dent Child* 1990; 57: 343-7.
114. Szpunar SM, Burt BA. Fluoride exposure in Michigan schoolchildren. *J Public Health Dent* 1990; 50 (1): 18-23.
115. Kumar JV, Green EL, Wallace W, Carnahan T. Trends in dental fluorosis and dental caries prevalences in Newburgh and Kingston, New York. *Am J Public Health* 1989; 79: 565-9.
116. Pendrys DG, Katz RV. Risk factors for enamel fluorosis in optimally fluoridated children born after the US manufacturer's decision to reduce the fluoride concentration of infant formula. *Am J Epidemiol* 1998; 148: 967-74.
117. Kumar JV, Swango PA. Fluoride exposure and dental fluorosis in Newburgh and Kingston, New York: policy implications. *Comm Dent Oral Epidemiol* 1999; 27: 171-80.
118. Toumba KJ, Curzon MEJ. The fluoride content of bottled drinking waters. *Br Dent J* 1994; 176: 266-8.
119. Freire MCM, Macedo RA, Silva WH. Conhecimentos. attitudes e práticas dos médicos pediatras em relação à saúde bucal. *Pesq Odontol Bras* 2000; 14: 39-45.
120. Maltz M, Lacerda P. Conhecimento do pediatra na área de saúde bucal. *Rev ABO Nac* 2001; 9: 210-6.
121. Maria AG, Ramires I, Peres JRB, Lauris JRP, Buzalaf MAR. Conhecimento dos médicos pediatras e odontopediatras de Bauru e Marília a respeito de fontes de ingestão de fluoreto. *Pesq Odontol Bras* 2004; 18 (supl): 100 (Abstract).
122. Santiago BM, et al. Conhecimento dos médicos pediatras acerca da saúde bucal de bebês. *Rev Bras Odontol* 2002; 59: 86-9.
123. Schalka MM, Rodrigues CRMD. A importância do médico pediatra na promoção de saúde bucal. *Rev Saúde Publ* 1996; 30: 179-86.
124. Latifah R, Razak IA. Fluoride levels in infant formulas. *J Pedod* 1989;13: 323-7.
125. Mcknight-Hanes MC, Leverett DH, Adair SM, Shields CP. Fluoride content of infant formulas: soy-based formulas as potential factor in dental fluorosis. *Pediatr Dent* 1988;10(3):189-94.
126. Van Winkle S. Water and formula fluoride concentrations: significance for infants fed formula. *Pediatr Dent* 1995; 17: 305-10.
127. Stannard J, Rovero J, Tsamtsouris A, Gavris V. Fluoride content of some bottled waters and recommendation for fluoride supplementation. *J Pedod* 1990; 14: 103-7.
128. Weinberger SJ. Bottled drinking waters: are the fluoride concentrations shown on the labels accurate? *Int J Paed Dent* 1991;1: 143-6.
129. Chan JT, Stark C, Jeske AH. Fluoride content of bottled waters: implications for dietary fluoride supplementation. *Tex Dent J* 1990; 107: 17-21.
130. Fernandes CM, Tabchoury CM, Cury JA. Fluoride concentration in infant foods and risk of dental fluorosis. *J Dent Res* 2001; 80(Spec Issue): 224 (Abstract).
131. Fomon SJ, Ekstrand J. Fluoride intake by infants. J *Public Health Dent* 1999; 59: 229-34.
132. Vlachou A, Drummond BK, Curzon MEJ. Fluoride concentrations of infant foods and drinks in the United Kingdom. *Caries Res* 1992; 26: 29-32.
133. Heintze SD, Bastos JR de M. Avaliação do teor de fluoreto e pH em bebidas no mercado nacional. *Rev Assoc Paul Cir Dent* 1996; 50: 339-45.
134. Pang DTY, Phillips CL, Bawden JW. Fluoride intake from beverage consumption in a sample of North Carolina children. *J Dent Res* 1992; 71: 1382-8.
135. Trautner K, Siebert G. An experimental study of bioavailability of fluoride from dietary sources in man. *Arch Oral Biol* 1986; 31: 223-8.
136. Heilman JR, Kiritsy MC, Levy SM, Wefel JS. Fluoride concentration of infants foods. *J Am Dent Assoc* 1997; 128: 857-63.
137. Nishijima MT, Koga H, Maki Y, Tadaesu Y. A comparison of dietary fluoride intakes from food samples in Japan and Brazil. *Bull Tokyo Dent Coll* 1993; 34: 43-50.