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Original article

Dental fluorosis in the primary dentition and intake of manufactured soy-based foods with fluoride

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SUMMARY

Background & aims: To identify manufactured soy-based products more recommended by pediatricians and nutritionists; to determine fluoride concentrations in these products; to evaluate children concerning fluorosis in primary teeth and its association with the consumption of soy-based products.
Methods: Pediatricians and Nutritionists answered a questionnaire about soy-based products they most recommended to children. Fluoride concentrations of the 10 products more cited were analyzed with the ion-specific electrode. Dental fluorosis exams were performed in 315 4–6-year-old children. Dean's Index was used to assess fluorosis. Among the children examined, 26 had lactose intolerance. Their parents answered a questionnaire about children's and family's profile, besides permitting the identification of soy-based products use. Chi-squared and Multivariable Logistic Regression tests were used ($p < 0.05$).
Results: Fluoride content in the analyzed products ranged from 0.03 to 0.50 μg F^-/mL. Dental fluorosis was detected in 11% of the children, with very mild and mild degrees. Dental fluorosis in primary teeth was associated with lactose intolerance ($p < 0.05$), but there was no significant association with the use of manufactured soy-based products.
Conclusions: Isolated consumption of soy-based products recommended by health professionals to children do not offer risk of dental fluorosis in primary teeth, which had a low prevalence and severity.

1. Introduction

Fluoride is still essential in the prevention of dental caries; however, its ingestion in excessive doses increases the risk for dental fluorosis.[1–3] Dental fluorosis is a developmental disturbance of dental enamel, caused by chronic and excessive ingestion of high concentrations of fluoride during tooth development, leading to enamel with lower mineral content and greater porosity.[4] Mild fluorosis has the appearance of a white spot lesion because of superficial porosity, and more severe forms can display staining, pitting, and/or loss of the enamel. The classic appearance is characterized by whitish bands that follows the development lines of the enamel and by symmetry on homologous teeth.[4,5]

Along with the time period of risk for dental fluorosis development, the amount of fluoride intake must also be considered. The main sources of exposure to fluoride and risk factors are: fluoridated water, infant formulas, supplements, fluoridated dentifrices and infant foods and beverages.[6–9] A very important factor to be considered is the use of fluoridated water (around 1.0 μg F^-/mL) for the dilution of powdered milks, juices and infant formulas, which can significantly contribute to the high levels of fluoride intake.[8,10,11] Thus, children may be exposed to high doses of fluoride due to various sources of ingestion, as well as to the inadvertent intake of fluoridated dentifrice during toothbrushing, and this may lead to excessive fluoride ingestion, potentiating the risk for development of dental fluorosis. Consequently, it is important to know the fluoride content in several kinds of foods consumed by age children develop dental fluorosis.

Soy-based formulas have been widely used as a substitute for breast milk or cow's milk, in cases where breastfeeding is discontinued early

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for any reason, or for children who have lactose intolerance or cow's milk allergy.[12–16] Pediatricians and nutritionists consider not only the soy-protein-based formulas, but also soy-extract-based beverages or juices, as possible substitutes for cow's milk.[17] In addition, these beverages are accessible for the population in general and, easily available in the market. Because of this, it has been widely used by other children, not only by those with milk allergy or lactose intolerance.

Some studies have reported high levels of fluoride in soy-based products.[11,18–20] Two Brazilian studies analyzed fluoride concentrations in both milk-based and soy-based powdered formulas and found higher levels of fluoride in soy-based than milk-based. When prepared with non-fluoridated water, only the soy-based products contained levels of fluoride above the recommended doses; however, when prepared with fluoridated water, either type of product showed levels above the maximum recommendation.[10,19] A total daily fluoride intake of between 0.05 and 0.07 mg F/kg body weight is generally considered as optimum.[21] However, these estimations are still empiric, not considering the individual susceptibility to fluoride exposure.[22,23]

Thus, the identification of the most recommended soy-based products, especially for younger children and for those with a diagnosis of lactose intolerance or cow's milk allergy becomes relevant to minimize the possible risks of fluorosis occurrence. Given that the fluoride content is not available on the products' labels, knowing the levels of fluoride in the most recommended products is important.

Usually, the prevalence and the severity of fluorosis in primary teeth are less than in permanent teeth.[24] Despite some studies which have suggested that fluorosis in primary teeth can have an association with fluorosis development in the permanent teeth[25,26] and there is lack of sufficient information on risk factors and training.

Dental fluorosis in primary teeth suggests chronic and excessive ingestion of fluoride by infants. To avoid occurrence in permanent teeth, it is important to investigate possible sources of ingestion in younger children, at age of primary teeth.

Due to the above-mentioned considerations, the aims of this study were: (a) to identify the manufactured soy-based products more recommended by pediatricians and nutritionists for children; (b) to determine the fluoride concentrations in these products; (c) to evaluate the prevalence and severity of fluorosis in primary teeth of 4–6-year-old children; and (d) to assess the association between the occurrence of fluorosis in primary teeth in children with lactose intolerance and the use of soy-based products.

2. Methods

This study was carried out after the approval by the Research Ethics Committee of Bauru School of Dentistry, University of São Paulo – FOB/USP (process number 110/2006). It was developed in 3 stages.

2.1. Stage 1

Pediatricians currently working in Bauru (0.6–0.8 mg F^-/L), SP, Brazil were located by searching the website of the Regional Council of Medicine of São Paulo State and by the catalog of a medical cooperative system. These strategies allowed the identification of 55 professionals. Concerning the nutritionists, the website of the Regional Council of Nutritionists and the phone catalog of Bauru were searched, and 35 professionals currently working in the city were found.

Thus, the total population of professionals (pediatrician and nutritionists) was 90. The names and addresses of these 90 professionals were collected and they were initially contacted via phone or in person. Pediatricians worked in the private sector and nutritionists worked in both the public and/or private sectors. Out of these, 61 agreed to participate in the study and provided informed consent and questionnaire (35 pediatricians and 26 nutritionists). The questionnaire was the same for both professionals. It investigated if they recommended (yes/no) different types of soy-based products for 1–7-year-old children (age of risk for dental fluorosis) with and without lactose intolerance or milk allergy and what products they were most likely to recommend.

2.2. Stage 2

2.2.1. Sample preparation

The 10 industrialized soy-based products most often cited (*Stage 1*), were purchased in supermarkets and pharmacies at the city of Bauru, São Paulo State, Brazil on three different dates (March, May and July 2007). In order to address possible variations among batches of the same item the products were purchased in different supermarkets and pharmacies in different periods. The products' labels included batch numbers, allowing the verification of these variations. Powdered samples were reconstituted with deionized water, according to the manufacturer's instructions (Table 1) prior to fluoride analysis.

2.2.2. Fluoride analysis

Of 10 products analyzed, 3 were ready to feed and other 7 were reconstituted with deionized water, according to the preparation recommended by manufacturer.

Fluoride determinations were made after overnight HMDS-facilitated diffusion[27,28] using a fluoride ion-specific electrode (Orion Research, Cambridge, MA, USA, model 9409) and a calomel reference electrode (Accumet model 13620-79) coupled with an ion analyzer (Orion Research, Cambridge, MA, USA, model 710A), previously calibrated with 5 standards with known fluoride contents (0.25; 0.50; 1.00; 5.00; 10.00 μgF) prepared by serial dilution from a 100 mg F^-/L stock solution (Orion Research, Cambridge, MA, USA, # 940907). The standards were diffused in triplicate in the same way as

Table 1
Soy-based manufactured products recommended by pediatricians and nutritionists by type of product, manufacturer, recommended age of consumption and preparation, Bauru, Brazil, 2008.

Product	Type	Manufacturer	Recommended age of consumption	Preparation powder (g) + H_2O (mL)
Nan soy	Powdered milk	Nestlé USA	–	13.2 g + 90 mL
Aptamil soja 1	Powdered milk	Kasdorf S.A.	0–6 months	4.3 g + 30 mL
Aptamil soja 2	Powdered milk	Kasdorf S.A.	More than 6 months	4.8 g + 30 mL
Ades (juice)	Ready-to-use	Unilever	–	–
Ades (milk)	Ready-to-use	Unilever	–	–
Soy	Ready-to-use	Olvebra Industrial	–	–
Isomil	Powdered milk	Abbott Laboratories	0–12 months	13.0 g + 90 mL
Soy milk	Powdered milk	Olvebra Industrial	–	30.0 g + 180 mL
Soyos milk júnior	Powdered milk	Gold Nutrition	–	30.0 g + 200 mL
Supra soy	Powdered milk	Josapar	–	26.0 g + 200 mL

*First product (Nan soy) was the most recommended and the last (Supra soy) was the least.