

ETIOLOGICAL FACTORS RELATED TO DENTAL FLUOROSIS AMONG CHILDREN IN POZNAN, POLAND—A PRELIMINARY REPORT

Justyna Opydo-Szymaczek,^a Karolina Gerreth^b

Poznan, Poland

SUMMARY: The aim of this study was to make a preliminary assessment of etiological factors related to dental fluorosis of permanent teeth among children in Poznan, Poland. Included were 19 resident children, aged 8–17 with symmetrical diffuse enamel opacities, along with 19 matched controls. Possible etiological factors of dental fluorosis were recorded by a detailed interview with the parents. Short-duration breastfeeding and the use of tap water for reconstitution of infant formula significantly increased the risk of developing fluoride (F) opacities ($p = 0.02$). There was no statistically significant difference in the distribution of medical problems that have been reported to cause enamel opacities in the study group and the control group.

Keywords: Breastfeeding; Dental fluorosis; Infant formula; Poznan children.

INTRODUCTION

Developmental defects of dental enamel that arise from injury during tooth formation are classified under two main categories: enamel hypoplasia and enamel hypomineralization.¹ Enamel hypoplasia is a quantitative defect, whereas enamel hypomineralization is a qualitative defect resulting from deficient mineral deposition. Clinically, enamel with hypomineralization has normal thickness, but changed translucency, which is presented as white, yellow, or brown opacities.^{1–4} Hypomineralization can be of two main types: diffuse or demarcated opacities. While the diffuse opacities spread over the enamel surface without a clearly defined margin, the demarcated opacities have a clear border separating the abnormal enamel from normal enamel.¹ The etiology of the diffuse enamel lesions in hypomineralization is thought to be associated with the toxic effect of excessive exposure to F during tooth development (dental fluorosis).² Demarcated opacities have a variable etiology: they may be associated with early childhood diseases, antibiotic therapy, and the toxic influence of dioxins on tooth germs.^{5–6} However, it is often difficult to distinguish between F and non-F opacities, since the ameloblasts may respond to different types of injury in similar ways. Consequently, it is possible that the diffuse opacities can result from other systemic insults, such as infections or the antibiotics used to treat the infections.^{5,7}

MATERIALS AND METHODS

The subjects were 19 children aged 8–17 (9 males and 10 females) selected from patients visiting the Department of Pediatric Dentistry of Poznan University of Medical Sciences for periodic check-ups. Children who were included met the following criteria: four first permanent molars and both maxillary central incisors erupted, presence of diffuse enamel opacities appearing symmetrically across the midline.

^aFor correspondence: Department of Pediatric Dentistry, Poznan University of Medical Sciences, Bukowska 70, 60-812 Poznan, Poland. E-mail: jopydo@am.poznan.pl. ^bDepartment of Pediatric Dentistry, Poznan University of Medical Sciences, Bukowska 70, 60-812 Poznan, Poland.

Possible etiological factors of hypomineralization were recorded by a detailed interview with parents including pregnancy and childhood medical history. The questions were about maternal health during pregnancy, length of pregnancy, complications during delivery, perinatal period, birth weight, health of the child during the first three years of life, medications used, the length of breast-feeding time, source of drinking water, and use of F supplements and F toothpaste.

Dental examinations were conducted between October 2011 and June 2012 by two calibrated dentists. Subjects were examined while seated on a dental chair with headrest, artificial light, after a professional cleaning of the teeth and the use of gentle air-drying. The location of enamel opacities was recorded and classified according to the Thylstrup-Fejerskov Index (TFI).⁸ The highest TFI score was used to classify each subject. Photographs of the cases chosen were taken with the use of ShadepilotTM camera (DeguDent).

A separate control group of 19 age and gender matched children without developmental lesions of the enamel was selected from the same child population. Dental examination with the medical history of each of these children was retrieved the same way as for the study group.

According to information from the Sanitary Inspection Department, the natural F concentration in the tap water of the district of Poznan in 1995–2005, measured at various points of the water mains, ranged from 0.3 to 0.9 mg/L.

Data analysis was performed with Statistica (version 8.0) for Windows XP Professional (version 5.1), assuming $p < 0.05$ as the level of statistical significance. The Fisher's exact two-tailed test and chi-square test were used for testing differences between groups. Synergistic action of systemic conditions in the development of enamel defects was assessed by comparing the number of individuals with simultaneous occurrence of two or more health insults and individuals with maximum one insult.⁶ The influence of cumulative F intake was assessed by comparing the number of individuals with at least two F-related risk factors and individuals with maximum one risk factor.

RESULTS

As shown in Table 1, 4 children in the study group had a TFI score of 1, 13 had a TFI score of 2, and 2 had a TFI score of 3. Figures 1–3 present representative photographs of children with these three TFI scores.

Table 1. Number of children age 8–17 in the study group presenting various TFI scores

	TFI 1	TFI 2	TFI 3
Total no.	4	13	2
No. of females	3	6	1
No. of males	1	7	1

Figure 1. TFI score 1 showing narrow white lines corresponding to the perikymata.



Figure 2. TFI score 2 with more pronounced lines of opacity that follow the perikymata, occasionally showing confluence of adjacent lines.



Figure 3. TFI score 3 with merging and irregular cloudy areas of opacity, accentuated drawing of perikymata often visible between opacities.



Diffuse enamel opacities were significantly more common among children who were breastfed for less than 4 months ($p=0.02$), and those whose parents used tap water for reconstituting infant formula ($p=0.02$).

All children taking F supplements developed F opacities as well as one child allergic to cow's milk resulting in serious dietary restrictions. A higher number of children in the study group reported early use of fluoridated toothpaste and swallowing of toothpaste, but the differences were not statistically significant. Subjects with at least two F-related factors (reconstitution of baby formula with tap water, early use of fluoridated toothpaste, swallowing of toothpaste, and ingestion of F supplements) were significantly more likely to have enamel opacities compared to those with only one factor ($p=0.01$).

No statistically significant differences between the study group and the control group were found in the distribution of medical problems that have been reported to cause enamel hypomineralization (Table 2).

Table 2. The distribution of different variables among children with normally mineralized teeth and among children with enamel opacities (Total no. = 19 in each group)

Etiological factor	Study group	Control group	p
Prenatal factors: mother's health problems and/or medications during pregnancy	2	4	0.66
Perinatal factors: preterm delivery <37 th week, or/and low birth weight <2500 g, and/or neonatal medical care	3	5	0.69
Postnatal health problems:	13	13	0.73
—disease 0–1 year of age	9	7	0.74
—disease 1–3 years of age	11	9	0.74
—reported use of antibiotics 0–12 th month of age	5	4	1.0
—reported use of antibiotics 13–36 th month of age	11	9	0.74
Experienced at least two health problems during prenatal, perinatal, and postnatal period	9	9	0.74
Short time of breastfeeding <4 months	11	4	0.02
Short time of breastfeeding <4 months + reconstitution of infant formula with tap water	10	3	0.02
F supplements during 0–3 years of life	3	0	0.23
Allergy to cow's milk resulting in serious dietary restrictions	1	0	0.50
Early use of fluoridated toothpaste—began during first 2 years of life	12	9	0.51
Reported swallowing of toothpaste	7	6	1.0
Reported at least 2 F-related risk factors	9	2	0.01

DISCUSSION

Increased levels of F in the environment have been accompanied by an increasing number of F opacities both in fluoridated and in non-fluoridated

communities.^{5,9-10} In the recent study by Seow et al. in the state of Queensland, Australia, an area with 0.1 ppm F in the drinking water, 20% of the subjects had diffuse enamel opacities.⁵

In Poland, drinking water is not artificially fluoridated. In most of the country, area F concentration in drinking water is below 0.3 ppm, although in some localities it exceeds 1.0 ppm (with a peak value of 3.0 ppm).¹¹ Only limited data are available on the current prevalence of dental fluorosis in Poland. A study on the four populations of 12-year-olds revealed that in the localities with the levels of F in the drinking water were 1.25, 1.35, 1.60, and 0.25 ppm, the prevalence of fluorosis was 18.2, 33.4, 35.7, and 0%, respectively.¹²

In our study, all subjects were lifelong residents of the district of Poznan, and, throughout the critical period for dental fluorosis development, they drank tap water with the level of F ranging from 0.3 to 0.9 mg/L. Although this level is close to WHO recommendations on the optimal F level in the drinking water (0.5–1.0 ppm),¹³ it is too high for the preparation of infant formula.¹⁴⁻¹⁵ Our study on F concentrations in Polish infant formulas revealed that when the water with a F concentration exceeding 0.5 ppm is used to prepare formula, infants may exceed the daily upper tolerable intake level of 0.1 mg F/kg bw.¹⁶⁻¹⁷

Results of the present study confirmed an association between dental fluorosis and the use of infant formula prepared with fluoridated water. As previously shown by many authors, breastfed infants are at lower risk of enamel fluorosis, since the level of F in human milk is extremely low.¹⁸ It is also worth noting that formula-fed infants are probably more likely to consume other dietary sources of F, such as infant beverages containing tea extract.¹⁹

Exposure to fluoridated dental products, especially early introduction of F toothpaste, has also been reported to increase the risk for dental fluorosis.²⁰⁻²¹ In our study, this association was not statistically significant. However, when the subjects reported at least two F-related risk factors they were more likely to develop F opacities than those who reported only one risk factor. It is also worth noting that the distribution of medical risk factors was similar in both the study and control group, thus confirming that the etiology of enamel hypomineralization in the examined subjects should be attributed to overexposure to F rather than to general health issues.

This study provides initial data on the possible risk factors for enamel fluorosis in a community that has what is often cited as an “optimal” amount of F in the drinking water. Our findings confirm that the use of “optimally” fluoridated water for reconstitution of baby formula may result in overexposure to F. The first overt sign of this excessive exposure is dental fluorosis. Some health professionals have concluded that dental fluorosis is not a matter of great concern, since it is most prevalent in a fairly mild form which is not thought to cause aesthetic discomfort.²²⁻²³ However, some studies show that both mild and moderate dental fluorosis have a negative aesthetic effect in the studied population.²⁴ Moreover, it is well documented that long-term excessive ingestion of F during childhood and later in life can lead to other, very serious health problems.^{25,26}

Finally, as emphasized by Ismail and Hasson,²⁷ the increasing prevalence of dental fluorosis, even in its mildest forms, should not be disregarded. Instead, the dental community, as these authors propose, should recommend and develop programs to reduce multiple F exposures during early childhood.

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