Developmental enamel defects and their impact on child oral health-related quality of life

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Abstract: This cross-sectional study assessed the impact of Developmental Enamel Defects (DED) on Child Oral Health-Related Quality of Life (COHRQoL). A sample of 944 11- to 14-year-old Brazilian schoolchildren was examined for the prevalence and severity of DED. The children completed the Child Perceptions Questionnaire (CPQ_{11-14}), and socioeconomic status was also collected using a questionnaire. Poisson regression models were used to assess the association between DED and overall and domain-specific CPQ_{11-14} scores. The prevalence of DED was 19.7%. In general, children with DED did not indicate any decrease in self-perception. However, this condition was associated with an impact on the functional limitation domain. The presence of DED may cause negative impacts on a child's perception of oral health and on their daily performance.

Descriptors: Tooth Abnormalities; Dentition, Permanent; Dental Enamel Hypoplasia; Quality of Life.

Introduction

Developmental enamel defects (DED) have been defined as disturbances in hard tissue matrices and their mineralization that arise during odontogenesis.[1] According to their clinical appearances, DED have been classified as demarcated opacity, diffuse opacity or hypoplasia.[1] Enamel opacity is a qualitative defect involving an alteration in the translucency of enamel and may appear white, yellow or brown in color. Enamel hypoplasia is a quantitative defect associated with a reduced enamel thickness.[2]

Data on the prevalence of developmental enamel defects of the permanent dentition have been published; the results range from 21% to nearly 100%.[2-5] The presence of DED has been traditionally measured by recording the presence of enamel defects. However, such normative indicators, when employed alone, do not document the full impact of DED on the oral health of a child.[6] Over the last two decades, increasing attention has been paid to this impact by assessing Child Oral Health-Related Quality of Life (COHRQoL) by using oral-health surveys and clinical trials.[7-8]

DED may have a significant esthetic impact on the maxillary incisors.[4] However, no study has yet addressed the impact of this condition on COHRQoL. It is important to understand the true impact of dental

abnormalities to plan public health policies for the prioritization of care and to evaluate the outcomes from treatment strategies.[6] This is the first study to evaluate the impact of DED on 11- to 14-year-old Brazilian schoolchildren, and the results may contribute to discussions about whether DED is a public health problem. We believe that DED may cause negative consequences on quality of life.

Methodology

A cross-sectional study was performed, which used data collected from a multistage random sample of 11- to 14-year-old schoolchildren from Santa Maria, a city in southern Brazil. The city has 263,403 inhabitants,[9] with nearly 85% of the population of 12-year-old children enrolled in public schools and residing in the city. The main economic activities are construction, services sector and trade.[9] To assess the prevalence of DED and the impact of this condition on COHRQoL, we adopted the following sample calculation parameters: a standard error of 5%, a confidence interval level of 95%, a power of 80% and an expected prevalence of 29.6%.[5] In addition, a design effect of 1.4 was applied, and up to 20% nonresponse was allowed. To achieve a ratio of unexposed to exposed individuals of 3:1 and a prevalence ratio of at least 1.6,[10] the minimum required sample size was estimated to be 510 children. A two-stage random sampling procedure was used to select the study sample. The first-stage units were all public schools in Santa Maria, Brazil. A total of 20 schools were randomly selected.[11] The second-stage units were the children enrolled in each selected school, and a random sample of children was selected from a list encompassing all students enrolled in the 20 schools. Only those subjects who were intellectually and physically capable of responding to the questionnaire were included in this study.[7]

The children were clinically examined in their schools by two examiners. This examination was done under natural light in a sitting position using individual CPI probes (ball point), sterilized mouth mirrors and gloves. Sterile gauze pads were used to clean and dry the tooth surfaces. The calibration process lasted 30 h and included theoretical activities with a discussion on the diagnostic criteria of DED. Moreover, a range of different types of DED based on the diagnosis of photographic images was used in the standardization exercise.[1,4] The examiners were also trained in the assessment of dental caries,[11] dental trauma[12] and tooth erosion,[13] and these diagnoses were included in the clinical exams carried out for almost all clinical dental conditions except for DED and tooth erosion. A total of 15 children were examined twice by each examiner with an interval of two weeks between each examination. A benchmark dental examiner conducted the complete examiner training process.[14]

We excluded children from this study who had fractured teeth, extensive restorations, or were wearing orthodontic appliances, and we add this information in the paragraph.

The Modified Developmental Enamel Defects index[1] was used to diagnose and classify changes in the enamel of the permanent teeth (Figure 1). The buccal surfaces of the following teeth were examined: 11 to 14, 21 to 24, 36 and 46. Each dental examination followed the international criteria standardized by the World Health Organization for oral health surveys. We recorded the prevalence of dental caries using the DMFT index;[11] tooth erosion[13] and dental trauma[12] were identified as possible confounders. Socioeconomic characteristics were collected through a questionnaire that was completed by the parents of each child.[8] CORHQoL

Figure 1 - Modified DED index for use in screening surveys (FDI).

Types of defects	Code
Normal	0
Demarcated opacity	1
Diffuse opacity	2
Hypoplasia	3
Other defects	4
Combinations	Code
Demarcated and diffuse	5
Demarcated and hypoplasia	6
Diffuse and hypoplasia	7
All three defects	8

was measured by using a Brazilian version of the Child Perceptions Questionnaire (CPQ$_{11-14}$),[11] which addresses the frequency of events occurring during the previous three months. The questionnaire is composed of 37 items distributed among 4 domains:

- oral symptoms (6 questions),
- functional limitations (10 questions),
- emotional well-being (9 questions) and
- social well-being (12 questions).

A 5-point Likert scale is used with the following options:

- 'never' = 0,
- 'once/twice' = 1,
- 'sometimes' = 2,
- 'often' = 3, and
- 'every day/almost every day' = 4.

The CPQ$_{11-14}$ scores for each domain are computed by adding all of the item scores under that domain. The total score can vary from 0 to 148, with a higher score denoting a greater impact on CORHQoL.[8]

Data analyses were performed using Stata 9.0 software (Stata Corporation, College Station, USA). The unadjusted analysis provided summary statistics assessing the association between the outcome and predictor variables. In this study, the outcome was considered a count variable and a parametric assessment of scores associated with answers was performed, as originally proposed in the questionnaire.[8] Multivariate Poisson regression models, taking into account the cluster sample, were fitted to assess the covariates for the overall and domain-specific CPQ$_{11-14}$ scores. This strategy allowed the estimation of rate ratios among comparison groups as well as their respective 95% confidence intervals. A forward stepwise procedure was used to include or exclude explanatory variables in the fitting of the models. Explanatory variables presenting a *P*-value ≤ 0.20 in the unadjusted analyses were included in the fitting of the models. Explanatory variables were selected for the final models only if they had a *P*-value ≤ 0.05 after adjustment. DED were entered and retained in the final models regardless of their

P-values.

This study was approved by the Human Research Ethics Committee of the Federal University of Santa Maria, and informed consent was obtained from each student prior to beginning the data collection.

Results

A total of 944 children, 42.5% boys and 57.5% girls, were enrolled in this study. The final sample size was larger than the minimum size necessary to satisfy the selected requirements (N = 510) because the survey included other outcomes that required large samples. The response rate was 94% for all children invited to participate. Reasons for nonparticipation were mainly the lack of parental consent and absence on the day of the exam. For DED, interexaminer and intraexaminer kappa values ranged from 0.62 to 0.80 and from 0.70 to 0.82, respectively.

Children were predominately white (79.4%) and 11-12 years of age (67.5%), with half of them living with a household income equal to or greater than twice the Brazilian Minimum Wage (BMW). The BMW corresponded to nearly 280 US dollars per month at the time of the data-gathering period. The prevalences of dental caries, dental trauma and tooth erosion were 35.3, 13.1 and 7.2%, respectively (Table 1).

Of the 944 children examined, 186 (19.7%) had at least one enamel defect recorded (Table 1). The frequencies of enamel defects found in all examined teeth showed that dental enamel hypoplasia was the dominant type, being present in almost 41% of teeth affected by DED (Table 2).

DED was not associated with the mean CPQ$_{11-14}$ domain and total scores (Table 3). Children with DED did not have higher means of CPQ$_{11-14}$ domain and total scores when compared with their counterparts. In the multivariate analysis, the same patterns were seen, even after controlling for other possible confounders (Table 4). The prevalence of impact (often – fairly often) showed that children with DED reported a higher impact on the functional limitation domain (RP 1.21; 95% CI 1.02; 1.48) (Table 4).

Table 1 - Clinical, demographic and socioeconomic characteristics of the sample (N = 944). Santa Maria. Brazil. 2008.

Variables	N*	(%)
Sex	943	
Male	401	42.5
Female	542	57.5
Race	942	
White	748	79.4
Non-White	194	20.6
Age (years)	944	
11-12	637	67.5
13-14	307	32.5
Household Income	855	
≥ 2BMW	455	53.2
< 2BMW	400	46.8
Mother's schooling	937	
≥ 8 years	533	56.9
< 8 years	404	43.1
Father's schooling	921	
≥ 8 years	515	56.0
< 8 years	406	44.0
Mother's occupation	944	
Employed	839	89.0
Unemployed	105	11.0
Father's occupation	944	
Employed	416	44.0
Unemployed	528	56.0
Tooth Erosion	944	
Without	903	92.8
With	68	7.2
Enamel defects	944	
Without	758	80.3
With	186	19.7
Dental caries	944	
DMF = 0	611	64.7
DMF > 0	333	35.3

* values lower than 944 due to missing data; BMW = Brazilian Minimum Wage = 280 US dollars; DMF = decayed, missed, filled teeth.

Table 2 - Prevalence of enamel defects in Brazilian schoolchildren (N = 944), Santa Maria. 2008.

Types of defects (by tooth)	Prevalence (%)
Demarcated opacity	1.17
Diffuse opacity	0.44
Hypoplasia	40.78
Other defects	0.11
Combinations	
Demarcated and diffuse	0
Demarcated and hypoplasia	2.76
Diffuse and hypoplasia	0.22
All three defects	0.88

Discussion

This is the first study that assessed the impact of DED using CPQ_{11-14}. We found that DED did not have an impact on COHRQoL, except for on the functional limitation domain.

The prevalence of DED found in this study was lower than the majority of findings reported by several other authors in different countries.[2-5,15,16] In Brazil, a population-based study showed a prevalence of 29.7% without the occurrence of dental fluorosis;[5] this result is similar to results found in Malaysia[17] and Tonga.[18] However, a much higher prevalence of DED that could reach 100% was reported among children from China[2] as well as New Zealand.[4] The variation in prevalence is due to the types of defects studied; different classifications of indices or modifying established indices; different field settings and technical examination procedures, such as lighting or whether the teeth were dried or not; and factors in the population, such as genetic, racial, ethnic and socioeconomic status.[4,5]

Among the three types of defects examined, hypoplasia was the most commonly found in examined teeth (40.7%). Similar findings were reported from a study in Iran,[15] in which these defects were more prevalent (32.7%). In other investigations, the prevalence of hypoplasia ranged between 0.8 and 82.8%.[5,16-19] Possible explanations for this discrepancy are attributed to the differences in geographical region, mainly in relation to the amount of fluoride in the drinking water of each target group.[15] Demarcated opacities were the most prevalent enamel defects in several studies,[2,5,20] and diffuse opacities were the most prevalent in others.[16,18]

Table 3 - Unadjusted and Adjusted assessment of DED associating with overall and domain-specific CPQ$_{11-14}$ scores. Poisson regression analysis. Santa Maria. Brazil. 2008.

	With DED Mean (± SD)	Without DED Mean (± SD)	RR Unadj. (95%CI)	p	RR* Adjust (95%CI)	p
CPQ$_{11-14}$ (overall scale)	18.20 (13.33)	18.70 (14.32)	0.97 (0.86;1.09)	0.65	0.96 (0.86;1.08)	0.55
Domains						
Oral Symptoms	5.43 (3.50)	6.07 (3.55)	0.89 (0.81;1.00)	0.06	0.90 (0.81;1.00)	0.06
Functional Limitation	4.88 (4.20)	4.36 (4.28)	1.12 (0.97;1.29)	0.12	1.11 (0.96;1.28)	0.15
Emotional Well-Being	5.06 (5.97)	5.15 (6.35)	0.98 (0.81;1.19)	0.86	0.97 (0.81;1.16)	0.73
Social Well-Being	2.80 (3.30)	3.11 (4.16)	0.90 (0.74;1.09)	0.29	0.91 (0.75;1.10)	0.32

*Adjusted by age, sex, race, parents' education level, parent's occupation, household income, tooth erosion, dental caries and dental trauma; RR – rate ratio.

Table 4 - Association between DED and the prevalence of impacts ("very often"/"fairly often") of overall and domain-specific CPQ$_{11-14}$ scores. Poisson regression analysis. Santa Maria. Brazil. 2008.

	With DED N* (%)	Without DED N* (%)	RP Unadj. (95%CI)	p	RP**Adjust. (95%CI)	p
CPQ$_{11-14}$ (overall scale)	108 (20.93)	408 (79.07)	1.08 (0.94;1.24)	0.28	1.07 (0.93;1.23)	0.32
Domains						
Oral Symptoms	45 (17.37)	214 (82.63)	0.86 (0.65;1.13)	0.27	0.84 (0.64;1.11)	0.21
Functional Limitation	77 (23.19)	255 (76.81)	1.23 (1.01;1.50)	0.04	1.21 (1.02;1.48)	0.05
Emotional Well-Being	38 (19.79)	154 (80.21)	1.00 (0.73;1.38)	0.97	0.96 (0.70;1.31)	0.78
Social Well-Being	23 (19.33)	96 (80.67)	0.98 (0.64;1.49)	0.91	0.98 (0.64;1.50)	0.94

* Number and percentage reporting items "very often" and "fairly often"; * Adjusted by age, sex, race, parents' education level, parent's occupation, household income, tooth erosion, dental caries and dental trauma.

In relation to the diagnosis of DED, enamel hypoplasia and demarcated opacities are easily detected because of their characteristic clinical appearances while diffuse opacities represent more nonspecific changes and do not present a very precise border against the adjacent normal enamel.[21]

To analyze the impact of DED on quality of life, we assessed enamel defects in two forms: the prevalence of children with DED and the prevalence of teeth with enamel defects. In relation to the severity, we considered dental enamel hypoplasia to be the most severe because this type of defect may cause tooth sensitivity or be more susceptible to dental cavities.[16,22]

Although several epidemiologic surveys have collected data regarding the prevalence and severity of DED in children and adolescents,[2-5] the implications of DED on COHRQoL is yet unknown. This oral condition may be associated with altered esthetics[4] that could affect COHRQoL.

The presence of DED did not have a significant impact on the CPQ$_{11-14}$ domain and total scores, except for on the functional limitation domain. In general, children with DED (mainly opacities) rarely showed symptoms or any discomfort at this low level of severity. It is possible that, taken together, the low prevalence of DED found in children when compared with the results of other studies reported in this investigation could have influenced such results. Therefore, the data may have been underestimated, and further studies on a different age-group with a higher level of prevalence of DED are needed to confirm these findings.

However, even at a low level of severity (presence of opacities), the presence of DED may influence a child's dental appearance.[23-24] There is a potential for hypoplasia to cause a negative impact because this type of enamel defect is more severe.

In this study, hypoplasia was more prevalent among the children assessed, and this result may explain the association between DED and impacts on the functional limitation domain (Table 4), which is in agreement with the literature.[16,22]

Our data must be considered with caution because our findings are limited by the cross-sectional nature of the data. Further investigations using different study designs (longitudinal) and different criteria to diagnose DED are needed to confirm these findings. Moreover, some reported results could be due to other oral conditions. To minimize this bias, we also examined the children for other potential confounding variables, such as untreated dental caries.

Despite its limitations, this study offers relevant perspective for public health and the scientific community. The results shown here provide a broad assessment of DED encompassing both subjective and normative measurements of the disease. They may be useful for the evaluation of oral health programs and services and the reorientation of health care according to preferential needs.[8] Moreover, the assessment of the association among the group of affected teeth, the DED type present and the impact on the different domains of quality of life may contribute to a better understanding of the impact of DED on the life of children and adolescents.

Conclusion

Our results indicated that the presence of DED may cause negative impacts on a child's perception of oral health and on their daily performance.

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