Quilombola children and adolescents show high prevalence of developmental defects of enamel

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Abstract *Teeth with developmental defects of enamel (DDE) have porous and/or uneven enamel, making them more susceptible to the build-up of oral biofilm and development of caries and periodontal diseases. The aim of this cross-sectional study was to determine the prevalence of DDE and associated factors among children and adolescents living in a Quilombola community in the Northeast of Brazil. The study population was census-based and comprised individuals aged three to 14 years. The children's parents/guardians answered a questionnaire devised to collect information on socioeconomic and demographic characteristics, health problems during pregnancy and illnesses during early childhood. DDE was diagnosed using the modified DDE index. The data were analyzed using descriptive statistics and Poisson regression with robust standard errors (p<0.05). A total of 406 individuals were examined. DDE prevalence was 80.5%: 42.2% in deciduous teeth and 61.1% in permanent teeth. There was an association between presence of DDE and age (PR=1.09, 95% CI=1.01-1.17), use of antibiotics during pregnancy (PR=1.14, 95% CI=1.07-1.22) and reported malnutrition during early childhood (PR=1.12; 95% CI=1.03-1.22). The findings reveal high prevalence of DDE among children and adolescents living in the Quilombola community. Associated factors were older age, use of antibiotics during pregnancy and malnutrition during early childhood.*
Key words *Dental enamel, Dental enamel hypoplasia, Risk groups, Cross-sectional studies*

Introduction

Based on the criteria of self-attribution and common history and territory, Quilombolas are an ethnic-racial group with African ancestry characterized by resistance and oppression. Despite social inclusion policies, studies investigating the oral health of these populations are scarce[1,2,3]. Individuals living in Quilombola communities have restricted access to goods and services and consequently experience food insecurity[1,4,5].

Socially vulnerable people generally suffer from nutritional deficiency, which has been shown to be a factor associated with Developmental Defects of Enamel (DDE)[6-11]. These alterations are manifested as opacities or hypoplasias[12-14]. Teeth with DDE have porous and/or uneven enamel, making them more susceptible to the build-up of oral biofilm and, consequently, the development of caries and periodontal diseases[7,14-17].

The etiology of DDE is multifactorial, being associated with both systemic or environmental conditions during amelogenesis[6,14,15]. Epidemiological studies investigating the prevalence of and factors associated with DDE in socially vulnerable populations such as Quilombolas are important for informing the formulation of health policies and implementation of health promotion programs directed at pregnant women and preschoolers, given that these defects are related to alterations during pregnancy and early childhood and to inadequate nutrition. This is the first population-based study that aims to assess the prevalence of DDE and associated factors in Quilombola communities.

Methods

We conducted a cross-sectional study in a rural Quilombola community called Lagoas, located 36 km from São Raimundo Nonato in the south of the State of Piauí. The community consists of 12 centers with a total of 1,498 families and 5,128 individuals distributed across an area of 62,366 hectares. This study was conducted in accordance with the guidelines of the STROBE Statement.

According to the National Institute for Colonization and Agrarian Reform (INCRA)[18], the community had 420 children and adolescents in 2010. The study population was census-based and consisted of children and adolescents of both sexes aged between three and 14 years. Individuals with amelogenesis imperfecta, carious lesions

affecting more than two-thirds of the enamel, using a fixed orthodontic appliance and showing conditions that hindered the diagnosis of DDE were excluded.

School-age study participants were recruited from the community's schools (N = 4). With regard to preschoolers, we performed an active search with the help of community leaders and asked parents/guardians to take their children to the school on the day the examinations were scheduled for the schoolchildren.

Before undertaking the study, three examiners were calibrated in two stages. The first stage consisted of the projection of images of teeth with different types of enamel defects[19]. To remain in the study, examiners had to correctly diagnose at least 80% of the cases. The second stage of the calibration was undertaken with 45 non-participating schoolchildren with all the conditions likely to be observed in the study. After 15 days, the preschoolers were re-evaluated and intra- and inter-examiner agreement (kappa) was greater than 0.80[19].

We conducted a pilot study with 45 children and adolescents enrolled in a public rural school in São Raimundo Nonato who did not participate in the study. No changes needed to be made to the proposed methodology.

Data was collected in two stages: 1) A questionnaire administered to parents/guardians devised to collect information on demographic and socioeconomic characteristics (sex, age, household income, parental education, sanitary conditions and eating habits) and other factors potentially associated with DDE cited by previous studies[8,13,20] (type of childbirth, health problems during pregnancy, and illnesses during early childhood); and 2) Dental examination of the children and adolescents. The questionnaires were administered individually to the parents/guardians by the researchers so that any questions arising while filling out the instrument could be answered.

The dental examinations were performed under artificial fluorescent ceiling lighting with the study participants sat on a chair or stool with their head resting on the examiner's lap. The examination was carried out using a flat mouth mirror, dental explorer probe number 5 (SS-White, Rio de Janeiro, Brazil) and gauze pads to remove excess saliva.

The data were recorded on a form prepared for the study. DDE was diagnosed using the modified DDE index[21], which assess the presence, location and extent of defects and combinations

of defects. Opacities, defined as qualitative defects involving an alteration in the translucency of enamel, were classified as demarcated (opacities with a clearly defined border with the adjacent normal enamel) and diffuse (opacities with a poorly defined boundary with the adjacent normal enamel). Hypoplasias were defined as quantitative defects associated with a localized reduced thickness of the enamel. Location was classified as incisal one-half, gingival one-half, occlusal one-half and cuspal. Extent was classified as less than one-third, between at least one-third and two-thirds, and at least two-thirds of the surface[21].

Teeth with crown fractures, carious lesions and/or extensive restorations (covering more than two-thirds of the surface of the tooth), and extracted or exfoliated deciduous teeth were not included in the study. Single defects measuring less than 1mm in diameter and questionable cases were not recorded[21].

The data were analyzed using SPSS® for Windows version 21.0 (Armonk, NY, USA: IBM Corp). The dependent variable was dichotomized into presence or absence of DDE. The following independent variables were used: sex; age; self-declared skin color; socioeconomic characteristics (such as household income and maternal education); sanitary conditions; health problems during pregnancy (fever or infection, high blood pressure, urinary tract infection, use of antibiotics, bleeding, placental abruption and pre-eclampsia); and health problems during early childhood (diarrhea, chickenpox, pneumonia, asthma, bronchitis, sinusitis, allergic rhinitis, fever, malnutrition, otitis and use of antibiotics)[1,4-7,20].

The data were analyzed using descriptive statistics. Poisson regression with robust standard errors was used to determine the association between the presence or absence of DDE and the independent variables. Strength of association was measured using crude and adjusted prevalence ratios (PR), confidence intervals (95% CI) and p-values. Variables that obtained a p-value of ≤0.20 in the bivariate analysis were included in the adjusted model. Only variables with a p-value of <0.05 were included in the final model.

The study was approved by Piauí Federal University's research ethics committee and was conducted in accordance with in accordance with ethical, legal and regulatory norms and standards for research involving human subjects set out in the Declaration of Helsinki and National Health Council Resolution 466/12.

Results

We examined 406 (96.9%) children and adolescents who met the inclusion criteria. There were no refusals to participate in the study. There were 14 losses: five adolescents using fixed orthodontic appliances, four with amelogenesis imperfecta and five with carious lesions covering more than two-thirds of the surface of the tooth.

Mean age was 8.74 (±3.17) years (ranging from three to 14 years), 52.0% of the sample were male and 35.7% were black. Most of the families (82.5%) had an income of less than or equal to R$500.00. The minimum wage at the time of the study was R$880.00 (US$1.00 = R$3.2403). With regard to parental education, 49.5% of the mothers had less than eight years of formal schooling. The main source of water was water-storage cisterns supplied by water trucks (78.6%) and the main type of water treatment was effervescent chlorine tablets (41.1%) (Table 1).

The prevalence of DDE was 80.5% (Table 1): 42.2% in deciduous teeth and 61.1% in permanent teeth. The most common type of defect in both teeth was demarcated opacities. The most commonly affected areas of the teeth were the incisal one-half and cuspal. Most of the children and adolescents had enamel defects in less than one-third of the tooth surface (Table 2).

DDE prevalence was 9.0% higher in the 11-to-14-year age group than in the 3-to-5-year age group (PR = 1.09; 95%CI = 1.01 − 1.17). With regard to health problems during pregnancy, use of antibiotics (PR = 1.14; 95%CI = 1.07–1.22) was associated with the presence of DDE. Malnutrition during early childhood (PR = 1.12; 95%CI = 1.03–1.22) was also associated with the presence of DDE (Table 3).

Discussion

The findings show that most of the individuals had DDE, which is consistent with the results of previous studies with low-income populations[10,14,15]. The early diagnosis of alterations in dental enamel is clinically important because DDE increases susceptibility to build-up of oral biofilm, which is associated with tooth sensitivity, hampers brushing and negatively affects quality of life[13,17].

Report of malnutrition was one of the factors associated with DDE, which explains the high prevalence of this condition among socially vulnerable groups such as Quilombolas[1,4,5], whose

Table 1. Socioeconomic and demographic characteristics of children and adolescents living in the Lagoas Quilombola community in the south of the State of Piauí, Brazil.

Variables	N (%)	Developmental Defects of Enamel	
		Presence N (%)	Absence N (%)
Age (years)			
3 to 5	79 (19.5)	56 (70.9)	23 (29.1)
6 to 10	191 (47.0)	150 (78.5)	41 (21.5)
11 to 14	136 (33.5)	121 (89.0)	15 (11.0)
Sex			
Male	211 (52.0)	170 (80.6)	41 (19.4)
Female	195 (48.0)	157 (80.5)	38 (19.5)
Self-declared skin color[a]			
Black	145 (35.7)	117 (80.7)	28 (19.3)
White	12 (3.0)	09 (75.0)	03 (25.0)
Other	247 (60.8)	199 (80.6)	48 (19.4)
Maternal education (years of schooling)[a]			
<8	201 (49.5)	167 (83.1)	34 (16.9)
≥ 8	193 (47.5)	155 (80.3)	38 (19.7)
Household income[a]			
≤ R$500.00	335 (82.5)	274 (81.8)	61 (18.2)
> R$500.00	63 (15.5)	47 (74.6)	16 (25.4)
Water treatment[a]			
Yes	319 (78.6)	254 (79.6)	65 (20.4)
No	87 (21.4)	73 (83.9)	14 (16.1)
Type of water treatment			
Chlorine	167 (41.1)	134 (80.2)	33 (19.8)
Filtration	119 (29.3)	101 (84.9)	18 (15.1)
Other	33 (8.1)	19 (57.6)	14 (42.4)
Not treated	87 (21.4)	73 (83.9)	14 (16.1)
Weight at birth (grams)[a]			
< 2,500	141 (34.7)	111 (78.7)	30 (21.3)
≥ 2,500	221 (54.4)	183 (82.8)	38 (17.2)
Health problems during pregnancy			
Yes	289 (71.2)	244 (84.4)	45 (15.6)
No	117 (28.8)	83 (70.9)	34 (29.1)
Illness during early childhood			
Yes	364 (89.7)	298 (81.9)	66 (18.1)
No	42 (10.3)	29 (69.0)	13 (31.0)
Daily frequency of tooth brushing[a]			
< 3 time	192 (47.3)	151 (78.6)	41 (21.4)
≥ 3 times	211 (52.0)	173 (82.0)	38 (18.0)
Total	406 (100.0)	327 (80.5)	79 (19.5)

[a] Totals vary due to missing information.

Source: Author's elaboration.

average household income is less than the minimum wage. Calcium ions in the diet regulate cell activities, such as cellular communication, signal transduction and the activation of enzymes that are essential to the activity of the proteins involved in amelogenesis[22]. Reduced serum phosphorus and calcium levels during pregnancy associated with other complications in this period may also result in defective enamel crystal and mineral formation[23]. In this regard, one of the limitations of the present study was that we did not evaluate malnutrition using a validated assessment instrument.

It is important to emphasize that lack of antenatal and early childhood care can lead to increased likelihood of DDE[9,10,14,15], given that ameloblasts are sensitive to physical, chemical and biological attacks, which can lead to irreversible damage to the enamel of forming teeth[22,24].

Prevalence of DDE was lower in deciduous teeth than in permanent teeth, corroborating the findings in the literature[12,10,15]. However, this result may be masked by difficulties in diagnosing DDE in deciduous teeth due to the presence of white spots, leading to a potential underestimation of structural defects[25]. Another explanation for the lower prevalence of DDE in deciduous teeth is the smaller window of exposure to environmental factors, as in the majority of deciduous teeth calcification occurs in intrauterine life, during which there is placental protection[10,14,15].

The areas most affected by DDE in both teeth were the incisal one-half and cuspal, which is similar to the findings of previous studies[26]. The location of defects depends on the stage of tooth development in which the insults occurred. In this regard, amelogenesis begins at the *cusp tip* or incisal edge and progresses towards the cervical third of the tooth[27]. In most of the individuals, in both teeth the enamel defects covered less than one-third of the tooth surface, confirming the results reported by Wagner[26] (2016), but contrasting with those of Masterson[11] (2017), which showed that in most individuals the defects covered between one-third and two-third of the surface.

The most common type of defect was demarcated opacities, which is consistent with the findings of previous studies[12,14,26,28]. Diffuse opacities such as very mild and mild fluorosis were more common than hypoplasias. This may be due to the intake of fluoride toothpaste during amelogenesis[29], as the region's water supply is not fluoridated and the children and adolescents have lived in the communities since they were born[29].

Table 2. Developmental defects of enamel in deciduous and permanent teeth.

DDE	Deciduous teeth	Permanent teeth
	N (%)	N (%)
Frequency		
Yes	171 (42.2)	248 (61.1)
No	126 (31.0)	85 (20.9)
Type of defect		
Demarcated opacity	83 (20.4)	97 (23.9)
Diffuse opacity	17 (4.3)	43 (10.6)
Hypoplasia	13 (3.3)	10 (2.5)
Diffuse and demarcated opacities	16 (3.9)	58 (14.3)
Demarcated opacities and hypoplasia	30 (7.4)	23 (5.7)
Diffuse opacity and hypoplasia	03 (0.7)	06 (1.5)
Demarcated and diffuse opacities and hypoplasia	09 (2.2)	11 (2.7)
Location		
Gingival one-half	10 (2.5)	50 (12.3)
Incisal one-half	34 (8.4)	39 (9.7)
Occlusal one-half	06 (1.5)	03 (0.7)
Cuspal	61 (15.0)	68 (16.8)
Gingival and incisal one-half	08 (2.0)	06 (1.5)
Gingival one-half and cuspal	07 (1.8)	12 (3.0)
Incisal one-half and occlusal	03 (0.7)	05 (1.2)
Incisal one-half and cuspal	19 (4.7)	46 (11.3)
Occlusal one-half and cuspal	03 (0.7)	06 (1.5)
Gingival, incisal and occlusal one-half	03 (0.7)	01 (0.2)
Gingival and incisal one-half and cuspal	10 (2.5)	06 (1.5)
Gingival and occlusal one-half and cuspal	02 (0.5)	01 (0.2)
Incisal and occlusal one-half and cuspal	01 (0.2)	05 (1.2)
Gingival, incisal and occlusal one-half and cuspal	02 (1.0)	00 (0.0)
Extent		
Less than 1/3	97 (23.9)	151 (37.2)
Between 1/3 and 2/3	23 (5.7)	04 (1.0)
At least 2/3	05 (1.2)	03 (0.7)
Less than 1/3 and between 1/3 and 2/3	28 (6.9)	49 (12.1)
Less than 1/3 and at least 2/3	06 (1.5)	17 (4.2)
Between 1/3 and 2/3 and at least 2/3	02 (0.5)	03 (0.7)
Less than 1/3, between 1/3 and 2/3 and at least 2/3	10 (2.5)	21 (5.2)

*Individuals with missing deciduous teeth n = 109 (26.8%). **Individuals with missing permanent teeth n = 73; Association between frequency of DDE in deciduous and permanent teeth (Pearson's chi-squared test; p=0.018).

Source: Author's elaboration.

Fluorosis was diagnosed using the modified DDE index[21]. Previous studies have shown that the frequency of dental fluorosis in permanent teeth is lower in children whose parents receive guidance on the quantity of fluoride toothpaste that should be used during early childhood[30].

The high prevalence of fluorosis in permanent teeth found in the current study may be due to the intake of fluoride toothpaste during the period of calcification of the crowns, given that the study participants have lived in the communities since they were born and have never left the community for periods longer than 30 days.

Our findings show that DDE prevalence was higher in the 6-10-year age group than in the 11-to14-year group. Amelogenesis is a long process that begins during intrauterine life and extends through early childhood, meaning that perturbations during this process may be a factor that triggers DDE in both deciduous and perma-

Table 3. Association between DDE and socioeconomic and demographic characteristics, health problems during pregnancy and illnesses during early childhood among children and adolescents living in the Lagoas Quilombola community in the south of the State of Piauí, Brazil.

Variables	Developmental Defects of Enamel					
	Yes n (%)	No n (%)	Unadjusted PR (95% CI)	p-value[b]	Adjusted PR (95% CI)	p-value[b]
Socioeconomic and demographic characteristics						
Age (years)						
3 – 5	56 (17.1)	23 (29.1)	1		1	
6 – 10	150 (45.9)	41 (51.9)	1.04 (0.98 – 1.12)	0.201	1.03 (0.95 – 1.11)	0.441
11 – 14	121 (37.0)	15 (19.0)	1.11 (1.04 – 1.18)	0.002	1.09 (1.01 – 1.17)	0.024
Sex						
Male	170 (52.0)	41 (51.9)	1		-	-
Female	157 (48.0)	38 (48.1)	1.00 (0.96 – 1.04)	0.987	-	
Self-declared skin color[a]						
Black	117 (36.0)	28 (35.4)	1.00 (0.96 – 1.05)	0.976	-	-
White	9 (2.8)	3 (3.8)	0.97 (0.84 – 1.12)	0.667	-	-
Other	199 (61.2)	48 (60.8)	1		-	
Maternal education (years of schooling)[a]						
<8	167 (51.9)	34 (47.2)	1.01 (0.97 – 1.05)	0.615	-	-
≥ 8	155 (48.1)	38 (52.8)	1		-	
Household income [a]						
≤ R$ 500.00	274 (85.4)	61 (79.2)	1.03 (0.97 – 1.10)	0.328	-	-
> R$ 500.00	47 (14.6)	16 (20.8)	1		-	
Water treatment[a]						
Yes	254 (77.7)	65 (82.3)	1		-	-
No	73 (22.3)	14 (17.7)	1.03 (0.98 – 1.08)	0.191	-	
Weight at birth (grams)[a]						
< 2.500	111 (37.8)	30 (44.1)	1		-	-
≥ 2.500	183 (62.2)	38 (55.9)	1.02 (0.98 – 1.07)	0.342	-	
Health problems during pregnancy						
Fever or infection[a]						
Yes	60 (19.1)	12 (16.0)	0.98 (0.92 – 1.04)	0.461	-	-
No	254 (80.9)	63 (84.0)	1		-	
High blood pressure[a]						
Yes	75 (23.7)	10 (13.5)	1.05 (1.00 – 1.10)	0.048	-	-
No	241 (76.3)	64 (86.5)	1		-	
Urinary tract infection[a]						
Yes	112 (34.5)	23 (29.1)	0.99 (0.98 – 1.03)	0.470	-	-
No	213 (65.5)	56 (70.9)	1		-	
Use of antibiotics[a]						
Yes	151 (49.3)	19 (27.1)	1.03 (0.98 – 1.09)	<0.001	1.14 (1.07 – 1.22)	<0.001
No	155 (50.7)	51 (72.9)	1		1	
Bleeding[a]						
Yes	20 (6.3)	2 (2.6)	1.03 (0.96 – 1.11)	0.363	-	-
No	298 (93.7)	74 (97.4)	1		-	
Placental abruption[a]						
Yes	22 (6.9)	6 (7.7)	0.98 (0.90 – 1.08)	0.752	-	-
No	298 (93.1)	72 (92.3)	1		-	
Pre-eclampsia[a]						
Yes	2 (0.6)	1 (1.4)	0.89 (0.65 – 1.23)	0.482	-	-
No	310 (99.4)	73 (98.6)	1		-	

Table 3. Association between DDE and socioeconomic and demographic characteristics, health problems during pregnancy and illnesses during early childhood among children and adolescents living in the Lagoas Quilombola community in the south of the State of Piauí, Brazil.

Variables	Developmental Defects of Enamel					
	Yes n (%)	No n (%)	Unadjusted PR (95% CI)	p-value[b]	Adjusted PR (95% CI)	p-value[b]
Illnesses during early childhood						
Diarrhea[a]						
Yes	111 (35.7)	25 (34.2)	0.97 (0.92 – 1.03)	0.351		-
No	200 (64.3)	48 (65.8)	1			-
Chickenpox[a]						
Yes	59 (19.0)	7 (9.5)	1.03 (0.97 – 1.10)	0.263		-
No	252 (81.0)	67 (90.5)	1			-
Pneumonia[a]						
Yes	36 (11.4)	10 (13.3)	0.97 (0.89 – 1.07)	0.578		-
No	281 (88.6)	65 (86.7)	1			-
Asthma[a]						
Yes	37 (11.8)	14 (18.2)	0.97 (0.88 – 1.06)	0.452		-
No	277 (88.2)	63 (81.8)	1			-
Bronchitis[a]						
Yes	17 (5.4)	5 (6.8)	0.98 (0.87 – 1.11)	0.793		-
No	295 (94.6)	68 (93.2)	1			-
Sinusitis[a]						
Yes	26 (8.6)	4 (5.6)	1.04 (0.96 – 1.12)	0.313		-
No	277 (91.4)	68 (94.4)	1			-
Allergic rhinitis[a]						
Yes	31 (9.8)	4 (5.3)	1.01 (0.92 – 1.10)	0.855		-
No	286 (90.2)	71 (94.7)	1			-
Fever[a]						
Yes	152 (49.0)	25 (34.2)	1.02 (0.96 – 1.08)	0.490		-
No	158 (51.0)	48 (65.8)	1			-
Report of malnutrition[a]						
Yes	44 (14.0)	4 (5.3)	1.13 (1.04 – 1.22)	0.003	1.12 (1.03 – 1.22)	0.011
No	270 (86.0)	71 (94.7)	1		1	
Otitis[a]						
Yes	68 (21.2)	11 (15.1)	0.99 (0.92 – 1.07)	0.887		-
No	252 (78.8)	62 (84.9)	1			-
Use of antibiotics[a]						
Yes	154 (51.0)	33 (47.1)	0.98 (0.93 – 1.04)	0.510		-
No	148 (49.0)	37 (52.9)	1			-

[a] Totals vary due to missing information. [b] Poisson regression with robust standard errors. PR = Prevalence Ratio. 95% CI = 95% confidence interval.

Source: Author's elaboration.

nent teeth, depending on the moment in which the insults occurr[8]. In the majority of permanent teeth, calcification occurs in early childhood, when the chances of developing systemic diseases that cause high fever and are associated with DDE are greater[14].

Health problems during pregnancy[27], adverse conditions at birth[28], nutritional deficiency[7] and early childhood illnesses have been associated with DDE. The findings of the current study show that use of medication during pregnancy was associated with presence of DDE, with antibiotics being the most commonly reported medicines by the mothers. These findings are consistent with those of other studies[20]. However, it is important to bear in mind that one of the lim-

itations of cross-sectional studies is recall bias. In this regard, researchers received prior training to ensure they used accessible language when administering the interview to facilitate the study participants' understanding of the questionnaire and technical terms.

This study encompasses a priority group for health research in Brazil. Our findings draw attention to the association between DDE and social factors and oral diseases, thus contributing to the effective planning of health promotion and disease prevention strategies.

In conclusion, the findings of the current study reveal high prevalence of DDE among children and adolescents in the Quilombola community. Associated factors were older age, use of antibiotics during pregnancy and malnutrition in early childhood.

Collaborations

TKXS França contributed to study conception, data collection and interpretation, writing and revising the article, and responding to reviewers' comments. MDM Lima contributed to study conception, data collection and interpretation, critically revising the article and responding to reviewers' comments. CCB Lima contributed to statistical analysis, data interpretation, critically revising the article and responding to reviewers' comments. MS Moura contributed to data collection and interpretation, critically revising the article and responding to reviewers' comments. TSP Lopes contributed to data collection and interpretation, critically revising the article and responding to reviewers' comments. JJS Moura contributed to data collection and interpretation and to writing and critically revising the article. LFAD Moura contributed to study conception and supervision, data collection and interpretation, writing and critically revising the article and responding to reviewers' comments.

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