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Dental caries in 0- to 5-year-old Brazilian children: prevalence, severity, and associated factors

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Objective. This cross-sectional study investigated the prevalence and severity of dental caries and their association with demographic and socio-economic variables in Brazilian preschoolers.

Methods. The study population comprised 1487 0- to 5-year-old children attending government nurseries in Canoas, southern Brazil. Questionnaires regarding information related to the independent variables (age, gender, maternal level of education, and family income) were completed by the parents. Clinical examinations were carried out by five trained examiners and results were expressed using the deft index (World Health Organization criteria), including white spots. The outcomes considered in this study were caries occurrence (deft > 0) and caries severity (deft).

Results. Forty per cent of the children (589/1487) presented dental caries [mean deft (SD): 1.53 (2.75)]. Deft increased with age ($P < 0.001$) and was significantly higher in children from mothers with low educational level ($P = 0.001$) and low family income ($P = 0.001$). The greatest increase in caries prevalence and severity occurred between age groups of 1 and 2 years. Logistic regression demonstrated higher odds of dental caries with mother's completing < 4 years education, after adjusting for confounding.

Conclusion. These findings indicate the need for preventive programmes, which should begin in the first year of life, with special attention given to families with mothers presenting low education levels.

Introduction

Dental caries is a public health problem that affects infants and preschoolers throughout the world, leading to pain, chewing difficulties, speech problems, general health disorders, psychological problems, and lower quality of life[1–5]. The treatment of dental caries in childhood is expensive, sometimes requiring general anaesthesia and hospitalization. Only a minority of disadvantaged children has access to dental services and the condition frequently shows recurrence a few months after restorative treatment[1,6].

Childhood caries requires the implementation of educational and preventive programmes, especially where the disease is highly prevalent[2,7–9]. However, there is still insufficient scientific evidence on which to base public health interventions to prevent childhood caries[1,8], since its aetiology is complex and there are several unexplained interactions among unknown confounders and traditional risk factors, such as the maternal level of education and family income[1]. Although some prediction models have been developed, the impact of each factor may differ in different populations, especially in developing countries[1,6,10]. Additionally, while there are adequate data available for recognition that dental caries is a social problem in disadvantaged communities, the extent of its prevalence at different ages is largely uncertain[2,11]. The literature has emphasized the need for cross-sectional studies starting from the earliest possible age in order to provide information regarding how to promote infant oral health, as well as identifying infants and toddlers who are at risk of developing childhood caries to be targeted for specific and cost-effective preventive measures, especially in disadvantaged communities[1,8,10,12,13].

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Therefore, the purpose of this study was to assess the prevalence and severity of dental caries, as well as to investigate associated demographic and socio-economic factors in 0- to 5-year-old children attending government nurseries in an urban centre in southern Brazil.

Subjects and methods

This cross-sectional study comprised 1487 preschool children aged 0–5 years old attending the nurseries maintained by the municipal government of Canoas. Children from public nurseries in southern Brazil are usually from low socio-economic backgrounds. The city of Canoas has a population of about 300 000 and all households have access to public water supply with fluoride level of 0.8 p.p.m. No other source of fluoride is available for this population. Children with systemic disease and chronic use of medication were excluded from the study. Data collection included a questionnaire and clinical examinations.

Questionnaire

A self-completed questionnaire assessing demographic data (age, gender), socio-economic data, and general health conditions was completed by the children's parents at the nurseries. Trained researchers were available to provide assistance to parents who were not able to read or write. Maternal level of education and family income were chosen to assess the impact of socio-economic status on caries occurrence, because they are complementary variables[14]; the first representing the level of child care and the second expressing the income available for basic needs. Family income and maternal level of education were summed as quantitative variables. The monthly wages of all economically active members of the family were collected (in local currency) and then divided by the Brazilian minimum wage (BMW: about $US150.00). Family income was then stratified by tertile (1st tertile: < 2 BMW; 2nd tertile: 2–3.5 BMW; 3rd tertile: > 3.5 BMW). The cut-off for the lowest category (2 BMW) only covers the cost of food for a family of three people. Maternal level of education was recorded in years of schooling. This variable was stratified in three categories: less than 4 years, mothers who did not completed the first half of fundamental [primary (UK)/infant (US)] level; 4–8 years, mothers who had completed or were attending the second half of fundamental [primary/sary (UK)/junior (US)] level; and mothers who completed or who were attending the intermediate [secondary (UK)/high school (US)] level or higher. The lowest level of maternal education represents functional illiteracy in Brazil.

Clinical examination

Clinical examinations were conducted at the school nurseries by five examiners to evaluate caries experience. The examinations were carried out under natural light, with the children lying on ordinary desks facing a window. First, the teeth were cleaned and dried with gauze. The clinical examination was exclusively visual, with the help of a tongue depressor. Predentulous infants and children with permanent teeth were excluded from the analysis. All primary teeth were examined; teeth with less than two-thirds of the crown erupted were excluded. The subjects were examined using a modification of World Health Organization (WHO) criteria[15], with initial carious lesions (white spots) being included in the deft value. Then, teeth were considered decayed if there was any evidence of dental caries (white spot lesions or cavitation), including filled teeth with recurrent caries. The 'e' component included extracted teeth and decayed teeth indicated for extraction due to caries and the 'f' component included restored teeth without caries. No missing incisor was recorded as extracted to reduce error due to early physiological loss.

Caries prevalence was defined when a child presented at least one decayed, extracted or filled tooth (deft > 0; decayed = white spot or cavitation). To allow for comparison with other studies, the frequencies of dental caries excluding white spot lesions were also described (deft > 0; decayed = cavitation: WHO criteria). All examinations were conducted in the morning and the data were recorded on a standardized clinical form.

Quality control measures included the training and calibration of the examiners before the study began to ensure consistency in examination techniques and interpretation of the criteria of caries diagnosis. Training and calibration were undertaken under the same conditions of the study over a 10-day period by one of the authors (S.H.F.), who is an experienced oral epidemiologist. Immediately preceding the survey, a reproducibility study was carried out on 20 children aged 1–5 years at one of the nurseries. The two dental examinations were conducted 10 days apart. The kappa values for intra- and interexaminer agreement for caries ranged from 0.65 to 0.92 and from 0.75 to 0.92, respectively.

Data analysis

Data analysis was carried out using the software SPSS for Windows, version 8.0, and included descriptive statistics of caries status: deft and caries prevalence (deft > 0). A cut-off point at a deft of 5 was also defined to identify the proportion of children with high caries experience[16]. Due to the positively skewed distribution of caries experience, nonparametric tests (Kruskal–Wallis and Mann–Whitney *U*-tests) were used to compare deft values between categories, as shown in Table 1 (*P*-values set at 0.05). Pairwise comparisons are described in the text and were carried out with Bonferroni correction; *P*-values were set at 0.017 for maternal education and family income and 0.003 for age comparisons.

Differences in the proportion of children with caries experience (deft > 0) between categories of independent variables were assessed initially by the chi-squared test (two-tailed) with values of $P < 0.05$ taken as statistically significant. Simple and multiple logistic regression analyses were also carried out to determine the independent effect of each variable. A hierarchical approach was not used because the explanatory variables assessed in the present study (socio-economic and demographic) comprise the same hierarchical level, as they are traditionally distal determinants of health outcomes. Thus, all variables with a statistical significance of $P < 0.05$ using the chi-squared test were included together in the final model, with calculations of adjusted odds ratios for caries experience and 95% confidence intervals (CI). Goodness-of-fit of the final model was assessed by Hosmer–Lemeshow goodness-of-fit test[17]. Lack of fit was considered statistically significant if the *P*-value was < 0.05.

Table 1. Deft (d = white spots or cavitation) distribution in relation to demographic and socio-economic variables.

Variables	*n* (%)	Deft			*P*-value*
		Minimum	Maximum	Mean (SD)	
Gender					0.409
Male	787 (52.9)	0	17	1.57 (2.82)	
Female	700 (47.1)	0	20	1.49 (2.67)	
Age					0.000
< 1 years	45 (3.0)	0	0	0.0 (0.0)	
1 years	183 (12.3)	0	8	0.42 (1.11)	
2 years	271 (18.1)	0	16	1.08 (2.22)	
3 years	340 (22.9)	0	17	1.64 (2.79)	
4 years	353 (23.8)	0	17	1.87 (2.94)	
5 years	295 (19.9)	0	20	2.34 (3.39)	
Family income (minimum wages)					0.001
< 2.0	440 (31.6)	0	20	1.85 (3.08)	
2–3.5	527 (37.8)	0	17	1.47 (2.61)	
≥ 3.5	427 (30.6)	0	17	1.24 (2.54)	
Mother's education (years)					0.001
< 4	406 (39.6)	0	20	1.89 (2.95)	
4–8	295 (28.8)	0	17	1.60 (2.89)	
> 8	325 (31.6)	0	12	1.21 (2.34)	

*Mann–Whitney (gender) or Kruskal–Wallis (age, family income and maternal education) test.
†The total was smaller than the effective sample (*n* = 1487) due to missing information (family income: *n* = 1394; mother's education: *n* = 1026).

Ethical aspects

This study was approved by the Ethics Committee of the Lutheran University of Brazil (ULBRA), Canoas, Brazil. The procedures, possible discomforts, and risks were fully explained to the children and their parents or guardians, and free informed consent was obtained prior to the investigation.

Results

At the time of the study, 1745 children were attending the 28 public nurseries. Of this population, 77 did not return the written informed consent (reasons not given) and 103 were absent on the days of examination,

making it possible to examine 1565 children (89.7% of the total). A total of 1487 children met the selection criteria and were analysed in this study. All questionnaires were returned, although some of them were incomplete (missing information for family income and maternal level of education). This study population included 787 (53%) boys and 700 girls (47%). The children were divided into the following age groups: less than 1 year (3.0%); 1 year old (12.3%); 2 years old (18.1%); 3 years old (22.9%); 4 years old (23.8%); and 5 years old (19.9%). Income levels were low for most families, with 31.6% (440/1394) living with an income below 2 BMW and 37.8% (527/1394) with an income between 2.0 and 3.5 BMW. Education levels were also low for most mothers, with 39.6% (406/1026) of them completing less than 4 years of education; 28.8% (295/1026) of mothers completed between 4 and 8 years and only 31.6% (325/1026) completed more than 8 years formal education.

Of the 1487 children examined, 589 presented dental caries (deft > 0; decayed = white spots or cavitation), with a prevalence rate of 40%. Thus, 60% of the children examined were classified as caries free (i.e. without any clinical manifest lesions) in primary dentition. Deft ranged from 0 to 20, with an asymmetric distribution (skewness = 2.5); the mean deft (SD) was 1.53 (2.75) and 12% (179/1487) of the children were classified as high caries experience (deft = 5), accounting for over 82% (1867/2277) of all teeth with dental caries. The prevalence of children with high caries experience at different ages were 1.6% (3/180), 7.4% (20/271), 13.2% (45/340), 16.1% (57/353), and 18.3% (54/295) among children aged 1, 2, 3, 4, and 5 years, respectively. When white spot lesions are excluded, the overall prevalence drops to 29.3% (435/1487).

Table 1 shows evidence of the differences in mean deft (including white spots) between categories of age ($P = 0.000$), maternal educational level ($P = 0.001$), and family income ($P = 0.001$), but no difference was found between boys and girls ($P = 0.409$). Statistical analysis by the Mann–Whitney *U*-test with Bonferroni correction revealed that the mean deft was higher for infants aged 1 compared to less than 1 year old ($P = 0.002$), children aged 2 compared to 1 year old ($P = 0.000$), children aged 3 compared to 2 years old ($P = 0.002$), but there was no evidence of a difference between 3 and 4 years ($P = 0.236$) and 4 and 5 years ($P = 0.051$). Pairwise comparisons also showed a higher deft for children whose family income was less than 2 BMW compared to 3.5 BMW or more ($P = 0.000$), but no difference was found between < 2.0 BMW and 2–3.5 BMW ($P = 0.057$) and between 2 and 3.5 BMW and > 3.5 BMW ($P = 0.036 > 0.017$, by Bonferroni correction). The mean deft was significantly higher in children from mothers with less than 4 years of schooling compared to 9 years or more ($P = 0.000$), but there was no evidence of any difference between < 4 and 4–8 years ($P = 0.063$) and between 4–8 years and > 8 years ($P = 0.104$). There were many incomplete questionnaires, mainly with respect to maternal education. To check the influence of this loss, deft was compared between children with and without a complete questionnaire and no difference was found (Mann–Whitney *U*-test; $P = 0.113$). When exclusively considering children with complete questionnaires, the power of the study to detect a difference of 10% in caries prevalence between exposed and unexposed children dropped to 85%, remaining over the typical value of 80%.

Table 2 summarizes the distribution of caries prevalence in relation to categories of independent variables. Caries occurrence was associated with age (χ^2, $P = 0.000$), family income (χ^2, $P = 0.001$), and maternal education (χ^2, $P = 0.003$). Caries prevalence rose from 0% in the youngest group (less than 1 year) to 17.5% (32/183) among children aged 1 year (95% CI: 12.0–23.0); 31% (84/271) at 2 years of age (95% CI: 25.5–36.5); 42.9% (146/340) at 3 years of age (95% CI: 37.6–48.2); 47.6% (168/353) at 4 years of age (95% CI: 42.4–52.8); and 53.9% (159/295) among children aged 5 years (95% CI: 48.2–59.6). Prevalence rates excluding white spots among children aged 1, 2, 3, 4, and 5 years were 4.4, 14.8, 29.4, 40.0, and 49.5%, respectively.

Table 2 also shows crude and adjusted odds ratios after multivariate analysis. Crude odds ratio represent how much greater the probability of

Table 2 Association between demographic and socioeconomic variables with caries (white spots or cavitation).

Independent variables	N*	With caries (deft > 0)		P-value	Crude		Adjusted*	
		n	(%)		OR	(95% CI)	OR	(95% CI)
Gender				0.192			–	
Male	787	324	(41.2)		1.15	(0.93–1.41)		
Female	700	265	(37.9)		1.00			
Age†				0.000				
< 1 years	45	0	(0.0)		–		–	
1 years	183	32	(17.5)		1.00		1.00	
2 years	271	84	(31.0)		2.12	(1.34–3.36)	1.94	(1.11–3.39)
3 years	340	146	(42.9)		3.55	(2.29–5.50)	3.13	(1.84–5.31)
4 years	353	168	(47.6)		4.29	(2.77–6.62)	4.31	(2.55–7.29)
5 years	295	159	(53.9)		5.52	(3.54–8.61)	5.01	(2.93–8.55)
Mother's education (years)‡				0.003				
< 4	406	190	(46.8)		1.67	(1.28–2.31)	1.42	(1.03–1.96)
4–8	295	117	(39.7)		1.25	(0.92–1.75)	1.20	(0.85–1.69)
> 8	325	112	(34.5)		1.00		1.00	
Family income (minimum wages)§								
< 2.0	440	197	(44.8)	0.001	1.66	(1.26–2.17)	1.36	(0.96–1.93)
2.0–3.5	527	208	(39.5)		1.34	(1.05–1.78)	1.34	(0.96–1.86)
> 3.5	427	140	(32.8)		1.00		1.00	

*The total (n = 1487) was smaller for family income (n = 1394) and mother's education (n = 1026).
Odds ratios adjusted for mother's education and family income (†); age and family income (‡); age and mother's education (§).

disease among subjects affected by a risk factor is. Since a hidden effect of a confounder variable may be present, the independent effect of each variable is also presented (adjusted odds ratio). No significant difference in caries prevalence between genders was found. Compared to children who were 1 year old, the odds of caries was two times higher for children aged 2 years, three times higher for children aged 3 years, four times higher for children aged 4 years, and five times higher for children aged 5 years, in both the crude and adjusted models. In the crude model, children whose maternal schooling was less than 4 years showed 67% greater probability of presenting caries compared to those children whose mothers had studied more than 8 years. After adjusting, this difference dropped to 42%, but remained statistically significant. In relation to income, the crude model revealed greater odds of dental caries in the two categories of lower income (< 2.0; 2.0–3.5 BMW) compared to incomes higher than 3.5 BMW. However, the association of this variable with the outcome lost significance after adjustment for the confounding effect of age and mother's education. The Hosmer–Lemeshow goodness-of-fit statistic showed an adequate fit for the final model ($P = 0.662$).

Discussion

An analysis of caries experience in recent years, especially in developing countries, demonstrates that a significant proportion of infants and preschoolers are still affected by the disease with a strong polarization[10]. Some studies showed that about 10–17% of children concentrate 50% of carious lesions and 25–30% bear 75% of the lesions[16,18,19]. The present findings confirm the high deft and caries prevalence reported in the last decade among children from disadvantaged communities[9,20,21], including Brazilian children[3,22]. High caries scores were observed in the present investigation, despite the fluoride content in the water supply (0.8 p.p.m.). The WHO target for oral health by the year 2010[23], which proposes that 90% of 5-year-olds should be caries free (considering caries experience at cavitation level), is still far from being achieved. This is partly due to the lack of an organized preventive oral healthcare system, limited accessibility to preventive and treatment services, and insufficient scientific knowledge or the inability

of practitioners to provide care for young children in Brazil. Furthermore, 12% of the children concentrated 82% of carious teeth, demonstrating a more prominent polarization when compared with other populations. These findings indicate the need for early identification of this high-risk group and clearly demonstrate the requirement for launching professionally applied approaches in this community to reduce childhood caries.

The increased caries experience with age found in the present study has been described in many countries[21,24], but it does not mean that the oldest are the most vulnerable. Actually, measurement of deft is cumulative and caries occurrence also depends on exposure time. The main finding in the present investigation is that the greatest increase in caries prevalence and deft was detected between 1 and 2 years of age. This indicates that educational programmes intended to prevent caries on deciduous teeth should begin in the first year of life, before this condition becomes too advanced to prevent and difficult and expensive to treat. In the early stages of development, dental caries can be largely prevented or controlled by simple and relatively cheap methods of personal care, involving attention to general nutrition, oral hygiene, and fluorides[1,12,24]. Dental care information and oral instructions should include motivation regarding oral health, given as early as possible to the expectant mother at prenatal counseling[6,25]. A recent investigation has demonstrated that dietary advice provided during home visits to mothers in the first year of life of their children reduced early childhood caries occurrence at 1 year of age, with odds for caries being 50% lower for the intervention group[26]. Furthermore, as recommended by the American Academy of Pediatric Dentistry, all infants should be examined at the age of 1 year in order to identify incipient lesions and assess feeding and hygiene practices[1,27].

A significantly higher caries prevalence and mean deft were observed in children whose mothers presented the lowest level of education. The independent effect of this variable in the multivariate analysis is consistent with other studies[21,22,24] and confirms that (1) maternal level of education is a good predictor of dental caries in childhood; and (2) children with mothers presenting low levels of education are particularly vulnerable to dental caries. Additionally, the loss of association between family income and caries occurrence after adjusting for maternal level of education demonstrates that confounding explains, at least in part, the apparent risk observed for income in the initial model. This finding suggests that maternal education is responsible for differences in disease frequency between the categories of family income. Furthermore, it demonstrates a hierarchy defined by maternal level of education rather than family income, with maternal education being more significant when providing oral health for preschool children in this population. The role of socioeconomic conditions on health outcomes is still poorly understood[28]. It is possible that mothers completing higher levels of education are more responsible regarding health, more likely to maintain good dietary and hygiene behaviours, and are likely to have more positive health attitudes[6,12]. Moreover, the widespread belief that primary teeth are temporary and not as important as permanent teeth is likely to be higher among mothers with low levels of education[29]. The recognition that maternal education is a strong determinant of childhood caries confirms that oral health cannot be achieved without educational policies in developing countries[1,12]. Such programmes may have an impact on the health of infants and preschoolers, including dental caries. This comprehensive understanding of childhood caries, which consider the factors associated with its occurrence, appears to be the key for developing community-based and professional preventive approaches to provide oral health.

Some aspects of the methodology of this investigation need to be clarified. First, the loss of information due to incomplete data was fairly high, especially in relation to maternal level of education. The high percentage of missing information may affect the study power which is a function of study sample size and the biological variability in the population, leading to statistical insignificance in the presence of biological significance. However, study sample size remained high even when considering children with complete data, allowing the detection of small differences in the

categories of age and maternal level of education. Additionally, variability in the population is not expected to be a problem, since no difference with regard to deft was detected between children with complete and incomplete questionnaires.

Second, a limited amount of explanatory variables were included, with oral health behaviours not being assessed. The inclusion of these variables would probably clarify how they mediate the effect of distal variables on caries occurrence. However, the absence of these data is unlikely to bias the association between demographic and socio-economic variables with dental caries, one of the main objectives of the present study. In a hierarchical approach, distal determinants (such as age, gender, maternal level of education, and income) and proximal determinants (such as oral health behaviours or microbiological factors) should not be treated as equivalent. Therefore, distal factors should not be adjusted for proximate factors and failure to take these aspects into consideration leads to underestimation of the effects of distal determinants[30]. In addition, the Hosmer–Lemeshow goodness-of-fit statistic showed adequate fit of this model to the data.

Third, different from this investigation, 'cavitation' has been the most common criterion used to define dental caries, mainly because the difficulty in distinguishing white spots from hypoplastic defects may lead to misclassification[31]. Several studies have measured early or noncavitated lesions and have pointed to the importance of scoring caries at this level because noncavitated caries is more prevalent than cavitated during the first 2 years of life and its detection might contribute to early interventions[32]. Interpretation and application of the examination criteria in this study showed optimal reproducibility (based on kappa values). However, scoring caries experience at the level of initial lesions in the conditions of the present study (dental examination of young children under natural light) may have resulted in some misclassification of outcome and this may be a limitation of the study.

Other variables not analysed in this investigation, such as diet and hygiene behaviours, play an important role in caries development on deciduous teeth and must be considered in further studies investigating caries risk assessment in this population.

What this paper adds

- The findings of this study provide a clearer picture of caries prevalence and severity in 0- to 5-year-old Brazilian children.
- Demonstrates that the greatest increase in dental caries occurs between 1 and 2 years of life in developing countries.
- Confirms that dental caries in childhood is strongly related to maternal education, suggesting that educational policies may have an impact on the oral health of infants and preschoolers.

Why this paper is important to paediatric dentists

- Paediatric dentists can use this evidence to support the fact that health promotion strategies should begin in the first year of life.
- Paediatric dentists should understand that preventive strategies for specific populations should take into account socio-economic factors to promote a more positive attitude towards oral health.

Conclusions

The results of this investigation suggest that

1. Caries prevalence and severity are high in Brazilian infants and preschoolers, indicating the need for improvement in the public oral health system, including accessibility to preventive and treatment services for young children.
2. The greatest increase in caries prevalence and deft was observed between 1 and 2 years of age, indicating that community-based preventive programmes and professional care should begin in the first year of life.
3. Mothers with low levels of education may require special attention because their children are at greater risk of caries and would benefit most from preventive efforts.
4. Reducing childhood caries also requires addressing socio-economic factors such as general education to promote healthy parental behaviours and attitudes which may have an impact on the general and oral health of their children.

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