Socioeconomic inequalities in the distribution of dental caries in Brazilian preschool children

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Abstract

Objectives: This study assessed the inequality in caries distribution and the association between socioeconomic indicators and caries experience of preschool children in a city in Brazil.
Methods: A cross-sectional study in a multistage random sample of 455, 1-5-year-old children was conducted on National Children's Vaccination Day in Santa Maria, Brazil. Calibrated examiners evaluated the prevalence of dental caries and parents provided information about several socioeconomic indicators by means of a semi-structured questionnaire. Data were analyzed using Poisson regression model.
Results: The caries prevalence was 23.5 percent and the means for the decayed, missing and filled primary teeth was 0.8. A high inequality in the caries distribution with Gini coefficient of 0.8 and Significant Caries Index of 2.8 was observed. The oldest children, non-white, with mothers having low level of education and from low household income had the highest prevalence of dental caries.
Conclusion: Socioeconomic factors are strong predictors for the inequality in caries distribution in Brazilian preschool children.

Introduction

Oral health inequalities have been observed in both caries experience and distribution among population groups. Such phenomena of disease polarization have been occurring besides the decline of caries experience observed in most developed countries in the last decades (1), leading to a high prevalence of disease in some minorities (2). This is also the same for preschool children (3). In these age-group children, a predefined pattern of dental caries [early childhood caries (ECC)] is still recognized as a significant public health problem because of its high prevalence in most socially and economically disadvantaged minorities, especially in developing countries (4). However, in most developing countries, data about prevalence and distribution of ECC and associated factors are scarce.

Previous studies demonstrated the association between demographic and socioeconomic factors with prevalence of ECC in preschool children (5,6). However, it is important to know the pattern of disease distribution in different population groups. For this goal, Brattahall (2000) have been proposing the calculation of the "Significant Caries Index" (SiC) to those individuals with the highest caries scores in each population. The SiC Index is the mean DMF/dmf of the one-thirds of the study group with the highest caries score (7). The index is used as a complement to the mean DMF/dmf value. In a recent Brazilian study using the SiC Index (8), a high polarization in the distribution of dental caries in 12-year-old adolescents was observed. In that study, the decayed, missing and filled primary teeth (dmf-t) index was 2.45, with a SiC Index of 5.08 and 30 percent of the adolescents being caries-free. It was observed that 70 percent of caries cases were concentrated in 34 percent of the adolescents.

Another important measurement of the inequality in caries distribution is the Gini coefficient (9). This coefficient is a well-documented index of inequality used mainly for income distribution, but previous authors have been advocating its use for dental caries experience (2,10). For instance, this indicator documents that the majority of the caries experience is increasingly being confined to a smaller percentage of the Brazilian population (10).

Although previous studies have assessed both ECC prevalence and severity in Brazilian preschool children (3-6), the patterns of ECC distribution and polarization have not been totally described in this population, especially considering its association with socioeconomic indicators. From a public health perspective, this is important, mainly for the identification of sections of the populations which needs to be more closely monitored.

In this cross-sectional study, we assessed the inequality in caries distribution and the association between socioeconomic indicators and caries experience in a representative sample of Brazilian preschool children.

Methods

Sample

A cross-sectional survey was conducted in a sample of 1-5-year-old children from Santa Maria-RS, Brazil. Santa Maria is a medium-size city located in the south of Brazil. The city has an estimated population of 263,403 including 27,520 children under 6 years old. For the sample calculation to assess the prevalence of dental caries, we adopted the following parameters: standard error of 5 percent, a confidence interval (CI) level of 95 percent and an expected prevalence of 23.5 percent (3). In addition, a design effect of 1.4 and adding 10 percent to nonresponse were applied. The minimum sample size to satisfy the requirements was estimated in 426 children. To explore the association between prevalence of dental caries and independent variables, we adopted the following parameters: 5 percent of standard error, 80 percent of power, 95 percent of CI, design effect of 1.4, 10 percent to nonresponse, ratio unexposed to exposed 2:1 (high/low income), and a prevalence ratio to be detected of at least 1.8. The minimum sample size to satisfy the requirements was estimated in 456 children.

Participants were randomly selected from children attending a National Day of Children's Vaccination. The vaccination program has consistently uptake rates above 97 percent. A sampling quota was selected from all children attending at health centers in the city of Santa Maria. Health centers were used as sampling points because the city was administratively divided into five regions and each had public health centers that were responsible for the vaccination of those living in that area. For this study, eight health centers were cluster selected from a total of 20 health centers in the city. These centers were selected because they are the major health centers in the city, and correspond to nearly 85 percent of the children attending at the vaccination program. During the survey, each fifth child in the queue for vaccination was invited to participate. If the parents did not agree to participate, the next parent in the queue was selected. To avoid selection bias, relatives were excluded. This random process was the same for all of the eight health centers.

Data collection

Data were collected through clinical oral examinations and structured interviews. Eight examiners and 24 supports participated in the study. These dentists were selected based on their previous experience on oral health survey and their highest reliability during the calibration process. They were previously trained and calibrated by two researchers and carried out clinical examinations for recording dental caries. Theoretical and clinical training and calibration exercises were arranged for a total of 36 hours. During the calibration process, children were examined twice by the same examiner – with an interval of 2 weeks between each examination – to assess intraexaminer reliability.

A benchmark dental examiner conducted the complete examiner training and the calibration process. During the survey, each fifth child in the queue for vaccination was invited to participate and was examined only at once. If parents did not agree to participate, the next parent in the queue was selected. This random process was the same for all of the eight health centers. Children were examined in a dental chair. Their teeth were dried and examined under standard illumination provided by a conventional operating light. Caries experience was recorded at using a dmf-t index according to World Health Organization (WHO) criteria (11). Data about socioeconomic status were collected by means of a structured questionnaire. The questionnaire presented a series of multiple choice questions regarding sociodemographic characteristics (age, sex, mother's and father's level of education, race, family income, mother's and father's occupation). Educational level compared fathers and mothers that completed 8 years of formal instruction, which in Brazil corresponds to primary school, with those who did not. Household income was measured in terms of the Brazilian minimum wage (BMW), a standard for this type of assessment, which nearly corresponded to 280 US dollars during the period of data gathering. The feasibility of the questionnaire was assessed previously in a sample of 20 parents during the calibration process.

Analysis

Data analysis was performed using STATA 9.0 software (Stata Corp., College Station, TX, USA). Descriptive and unadjusted analyses were conducted to provide summary statistics and preliminary assessment of the association of predictor variables and the outcome. Two outcomes were used in this study: prevalence of dental caries (dmf-t > 0) and mean caries experience (dmf-t). Poisson regression analyses taking into account the cluster sample were performed to assess the association between the predictor variables and the outcomes. In the analyses, we calculated the prevalence ratio (PR; 95 percent CI) and the rate ratio (RR; 95 percent CI) to assess the predictors for caries prevalence and caries experience (dmf-t), respectively. A backward stepwise procedure was used to include or exclude explanatory variables in the fitting of models. Explanatory variables presenting a P-value ≤ 0.20 in the assessment of correlation with each outcome (unadjusted analyses) were included in the fitting of the model. Explanatory variables were selected for the final models only if they had a P-value ≤ 0.05 after adjustment.

The Sic Index was calculated for one third of the study group with the highest caries score. An online spreadsheet provided by the WHO Collaborating Center in Malmö University, Sweden (12) (available at: http://www.whocollab.od.mah.se/expl/siccalculation.xls) was used for the SIC calculation. The assessment of Gini coefficients was calculated using a spreadsheet available at: http://www.fo.usp.br/arquivos/Gini_calculation_for_caries_distribution.zip. The Gini coefficient varies between 0, which reflect the complete equality and 1, which reflect complete inequality. Graphically, the coefficient is represented by the area between the line of equality and the Lorenz curve (13). For instance, the closer the coefficient is to 1, the more unequal is the caries distribution.

Table 1 Clinical and demographic characteristics of the sample (Santa Maria, Brazil, 2009)

Variable	*n**	(%)
Gender	455	
Male	245	53.8
Female	210	46.2
Age (years)	454	
<2	112	24.7
2	103	22.7
3	120	26.4
≥4	119	26.2
Ethnics	455	
White	345	75.8
Non-white	110	24.2
Income	444	
≥2 BMW	241	54.3
<2 BMW	203	45.7
Mother's level of education (years)	444	
≥8	315	70.9
<8	129	29.1
Father's level of education (years)	414	
≥8	292	70.5
<8	122	29.5
Mother's occupation	447	
Employed	207	46.3
Unemployed	240	53.7
Father's occupation	414	
Employed	382	78.6
Unemployed	32	21.4

* Values lower than 455 due missing data.
BMW, Brazilian minimum wage.

Ethics

The study was approved by the Ethics in Research Committee of Federal University of Santa Maria and parents' consent was obtained prior to the study. A letter was given to all parents explaining the aims of the study and asking them for consent for their children to participate in the study.

Results

The response rate was 98 percent of all children invited. Reasons for nonparticipate were mainly due to children who were not accompanied by their parents in the day of the vaccination. A total of 455 children, 53.8 percent boys and 46.2 percent girls, were enrolled in the study. The Kappa value for interexaminer and intraexaminer agreement for dental caries ranged from 0.70 to 0.85 and from 0.80 to 0.95, respectively.

Table 1 summarizes the demographic characteristics of the sample. The percentage of children participating was similar in different age groups. Children were predominately white with a high caregivers' level of education. More than a half of the mothers were unemployed and 78.6 percent of the fathers were employed. The most of the parents had a household income equal or great than 2 BMW. Prevalence of dental caries was 23.4 percent.

Number and percentage of preschool children with caries experience, mean number of teeth evaluated and SiC Index by age is demonstrated in Table 2. The mean dmf-t was 0.8 [standard deviation (SD) = ±2.0; median = 0]. The decayed component accounted for the majority of the dmf-t index.

Figure 1 provides information for the measurement of inequality in the distribution of dental disease, by displaying Lorenz Curve for the observed sample and average dmf-t. A high inequality in the distribution of dental caries was observed in this study. While the mean dmf-t was 0.8, the SiC Index was 2.8 (Table 2) and the Gini coefficient was 0.8.

Prevalence of dental caries and associated factors are shown in Table 3. The variables that were significant in the unadjusted analysis with prevalence of caries were age, race, and mother's and father's level of education. No associations were found regarding gender, household income, mother's and father's level occupation. In the multiple regression analyses it remained associated with the outcome the variables age ($P < 0.01$), race ($P = 0.01$), and mother's level of education ($P = 0.03$). The oldest children, non-white, and with mother's of low level of education had higher prevalence of caries than other children.

Table 2 Number and percentage of preschool children with caries experience, mean number of teeth evaluated and SiC Index, by age (Santa Maria, Brazil, 2009)

Age groups		Erupted teeth	With caries	dmf-t	dmf-t	dt	mt	ft	
(years)	*n* of children	Mean (±SD)	*n* (%)	Mean (±SD)	Median	Mean (±SD)	Mean (±SD)	Mean (±SD)	SiC Index
<2	112	10.6 (5.0)	2 (1.8)	0.1 (0.5)	0.0	0.1 (0.5)	0.0 (0.0)	0.0 (0.0)	0.2
2	103	18.3 (2.0)	13 (12.6)	0.4 (1.3)	0.0	0.3 (1.2)	0.0 (0.0)	0.0 (0.2)	1.1
3	120	19.8 (1.2)	40 (33.3)	1.0 (2.1)	0.0	0.9 (2.1)	0.0 (0.0)	0.1 (0.5)	3.0
≥4	119	19.8 (0.7)	51 (42.9)	1.7 (2.8)	0.0	1.5 (2.7)	0.0 (0.0)	0.2 (0.8)	4.8
All	454	17.2 (4.7)	106 (23.4)	0.8 (2.0)	0.0	0.7 (1.9)	0.0 (0.0)	0.1 (0.5)	2.4

dmf-t, decayed, missing and filled primary teeth; SD, standard deviation; SiC, Significant Caries Index.

Table 4 expresses the dental caries experience (dmf-t) and associated factors. Unadjusted analyses demonstrated that the variables age, ethnics, income, and mother's and father's level of education were associated with the dental caries experience. The variables that remained associated with the outcome after the adjustment were: age ($P < 0.01$), ethnics ($P = 0.03$), and income ($P < 0.01$). The oldest children, non-white, and from low household income had higher mean of dmf-t than other children.

Discussion

This study showed a marked inequality in dental caries experience and distribution in preschoolers. Even though these results are consistent with previous studies (5,6), the patterns of ECC distribution and polarization have not been totally described in under 5-year-old children, especially considering its association with socioeconomic indicators in a representative sample.

The changing pattern of dental caries with an impressive reduction of caries indices in 5-year-old children in the Brazil is little documented (3). However, this trend now appears to have halted and in addition, the distribution of disease is markedly skewed with the majority of the disease concentrated in a minority of the population (5,6). Our findings confirm this inequality in the distribution of disease and indicate that social inequalities exist, which influence dental caries experience.

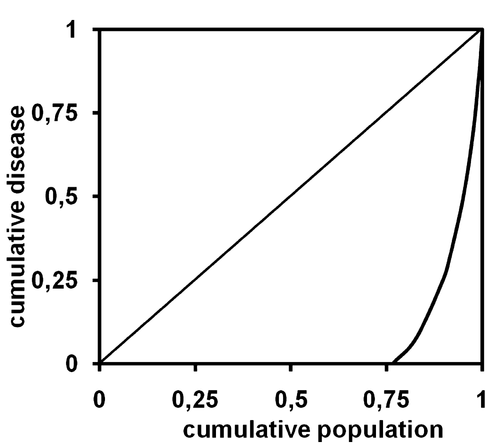

Figure 1 Lorenz curve for the dmf-t distribution (1-5-year-old children) in Santa Maria, Brazil: Gini coefficient = 0.82.

In general, we found a social gradient in caries experience and distribution, namely the low socioeconomic background of the children, the highest their caries experience. The underlying impact of socioeconomic conditions on oral health outcomes is widely recognized (14,15) (Table 4). People from low socioeconomic backgrounds are more easily to be exposed to a various risk factors that affect their oral health. Risk behaviors lie in the causal pathway between socioeconomic position and oral health and are more prevalent among socioeconomically disadvantaged groups (15).

In this study, socioeconomic backgrounds were assessed by means of different variables, being the level of education the better indicator of the socioeconomic status than household income (Table 3). We collected both household income and level of education variables but income information is considered to be sensitive. Information about education (typically measured as years completed or credentials of formal schooling) is more easily obtained and is frequently treated as a proxy for income (16). One could argue that the effect of level of education on prevalence of caries is in dependence of the household income. However, the impact of level of education remained strongly associated with the outcome even after the adjustment for confounders. Our findings are in agreement with previous study that demonstrated a hierarchy on caries distribution defined by maternal level of education rather than family income (5). Previous studies showed that oral health outcomes in children are highly correlated with parents' and especially the mother's level of education (5,6,17,18). Mothers completing higher levels of education are more informed in health questions and these influence various behaviors related to health as to maintain good dietary and hygiene behaviors (5,17,19).

The variable race also remained associated with prevalence of caries in the final model of the multiple regression analyses (Tables 3 and 4). In Brazil, few studies have related ethnics

Table 3 Prevalence of dental caries (dmf-t > 0) and associated factors (Santa Maria, Brazil, 2009)

	With dental caries (dmf-t > 0)				
Variable	*n* (%)	PR (95% CI)	*P*	PR_{adj} (95% CI)	*P*
Gender	107 (23.5)		0.85		
Male	59 (24.1)	1.00			
Female	48 (22.9)	0.94 (0.67-1.32)			
Age (years)	106 (23.3)		<0.001		0.001
<2	2 (1.9)	1.00		1.00	
2	13 (12.3)	7.06 (1.63-30.61)		6.51 (1.24-29.03)	
3	40 (33.3)	18.66 (4.61-75.55)		18.21 (5.52-71.33)	
≥4	51 (42.9)	24.00 (5.97-96.41)		22.20 (5.89-90.44)	
Ethnics	107 (23.5)		0.02		0.01
White	69 (20.0)	1.00		1.00	
Non-white	38 (34.5)	1.72 (1.23-2.41)		1.34 (1.04-2.33)	
Income	102 (23.0)		0.06	**	**
≥3BMW	47 (19.5)	1.00			
<3BMW	55 (27.9)	1.38 (0.98-1.95)			
Mother's level of education (years)	105 (23.6)		<0.01		0.03
≥8	61 (19.4)	1.00		1.00	
<8	44 (34.1)	1.76 (1.26-2.44)		1.42 (1.11-2.13)	
Father's level of education (years)	94 (22.7)		0.02	**	**
≥8	53 (18.1)	1.00			
<8	41 (33.6)	1.85 (1.30-2.62)			
Mother's occupation	105 (23.5)		0.61		
Employed	51 (24.6)	1.00			
Unemployed	54 (22.5)	0.91 (0.65-1.27)			
Father's occupation	93 (22.5)		0.19	**	**
Employed	83 (21.7)	1.00			
Unemployed	10 (31.2)	1.43 (0.83-2.48)			

** = Variables not fitted in the final multiple model after the adjustment.

dmf-t, decayed, missing and filled primary teeth; BMW, Brazilian minimum wage; PR, prevalence ratio; CI, confidence interval.

differentials on caries prevalence (20-22) and only one was performed with preschoolers (22). This influence is complex and appears to be directly related to biological, socioeconomic, behavioral, and psychosocial factors (23). Previous studies attributed ethnic differentials of dental health to discrepant socioeconomic status and access to services between ethnic groups in Brazil, with no further biological fundament (20,21). Socioeconomic differences between racial ethnic groups can reflect racial discrimination at the institutional structural level, personal experience, or both (16).

Besides documenting current levels of dental disease, this study also assessed the inequality of its distribution among preschoolers (Figure 1). We used two important indicators for to measure the disease distribution, the Gini coefficient (9) and the SiC Index (7). These two indicators were used because the dmf/DMF alone provides an incomplete picture of the disease in highly skewed distributions (24). A previous study demonstrated the feasibility of these indexes as interchangeable tools for measure of caries inequality in Brazilian population (2). In the present data, both indicators confirm the figures of high inequality in caries distribution, namely the majority of the caries experience confined in a smaller number of children.

These inequalities in oral health found in our study have been described regarding social inequalities (25). Absolute income and income inequalities have been associated with oral health problems (2,22,26). However, in rich countries, income inequality has been correlated more strongly with childhood dental caries than absolute income (27). This suggests that once a country reaches a certain stage of economic development, income inequality surpasses per capita income as the primary determinant of health (27). Instead of this, in developing countries, like Brazil, where relatively greater income inequality as well as higher absolute poverty rates are often both present, income inequality and low income had independent effects (26). Therefore, poor people living in high income inequality areas had a double burden of exposure (26). This observation accounts for particular attention demanding a public health approach toward sections of populations with higher levels of dental needs.

Some methodological shortcoming need to be discussed when considering the results reported here. The findings are limited by the cross-sectional nature of the data. Therefore, it is not possible to establish a temporal relationship between the outcomes and predictors variables. However, cross-sectional designs are useful to identify risk indicators that can

Table 4 Dental caries experience (dmf-t) and associated factors (Santa Maria, Brazil, 2009)

	dmf-t					
Variable	Mean (±SD)	Median	RR (95% CI)	*P*	RR_{adj} (95% CI)	*P*
Gender				0.90		
Male	0.8 (2.0)	0.0	1.00			
Female	0.8 (2.1)	0.0	1.04 (0.65-1.64)			
Age (years)				0.01		0.02
<2	0.1 (0.5)	0.0	1.00		1.00	
2	0.4 (1.3)	0.0	5.90 (1.14-30.35)		4.78 (1.1-27.56)	
3	1.0 (2.1)	0.0	15.86 (3.37-74.49)		13.85 (3.15-67.00)	
≥4	1.7 (2.8)	0.0	27.42 (5.95-126.25)		22.14 (6.02-121.13)	
Ethnics				0.02		0.03
White	0.7 (1.8)	0.0	1.00		1.00	
Non-white	1.2 (2.6)	0.0	1.85 (1.14-2.98)		1.71 (1.11-2.81)	
Income				0.01		0.02
≥3BMW	0.6 (1.5)	0.0	1.00		1.00	
<3BMW	1.0 (2.4)	0.0	1.81 (1.14-2.89)		1.61 (1.21-2.75)	
Mother's level of education (years)				0.04	**	
≥8	0.6 (1.7)	0.0	1.00			
<8	1.3 (2.6)	0.0	2.03 (1.28-3.23)			
Father's level of education (years)				<0.01	**	
≥8	0.6 (1.5)	0.0	1.00			
<8	1.3 (2.8)	0.0	2.33 (1.43-3.80)			
Mother's occupation				0.41		
Employed	0.7 (1.7)	0.0	1.00			
Unemployed	0.9 (2.3)	0.0	1.24 (0.79-1.95)			
Father's occupation				1.00		
Employed	0.8 (2.1)	0.0	1.00			
Unemployed	0.8 (1.4)	0.0	0.95 (0.48-1.87)			

** = Variables not fitted in the final multiple model after the adjustment.
dmf-t, decayed, missing and filled primary teeth; BMW, Brazilian minimum wage; RR, rate ratio; CI, confidence interval.

be confirmed in further longitudinal designs. We did not address the impact of other biological variables which has been associated with dental caries experience in this age range (28). This issue needs to be addressed in future research. Nevertheless, it was not economically feasible to use microbiological parameters in this survey. The association between predictors and the outcomes were assessed by Poisson regression analysis. When using binary outcome, this analysis estimate the prevalence ratio (PR; CI 95 percent). Frequently, logistic regression is used to modeling binomial health data in cross-sectional studies (29). But when the outcome is not rare the odds ratio overestimate the prevalence ratio (29). Using count outcomes, we also employed Poisson regression, that is an adequate regression method to be used with count results truncated at low values, and highly skewed in the positive direction (30). Dmf-s and dmf-*t*-values usually present these characteristics. Finally, data were gathering in only 8 out of 20 health centers. This fact might underestimate the results and affect the extern validity of the study. However, these centers are equally distributed into different areas around the city and represent the major sample point in their area. Taken together, it corresponds to nearly 85 percent of the children attending at the vaccination program. Therefore, although the option for choosing these target sample point could have, in part, impacted the inference capacity of the study, we believe that our study provides a clearly description of the caries distribution within this population.

Besides of its limitation, our study brings important information about social inequality in dental caries distributions in Brazilian children. We demonstrated that social inequality in dental caries distributions persist in Brazilian children. Our results may help the government implementation and monitoring of their local dental health strategies and facilitate the targeting of resources to help reduce the current inequalities in dental health among preschool children in Brazil. The sample was selected with a random process in different health centers, and so included children living in all of the administrative regions of the city. This random process avoided bias which might occur if the sample is collected in a clinical setting, for example. Therefore, such a process provides a sound conclusion about the research question for preschool children living in the city. Nevertheless, the high response rate and the acceptable level of inter/intra-rate agreement, increase the intern validity of the study.

This study shows that socioeconomic factors are associated with the inequality in the caries distribution in preschool children. The present observation of disease polarization highlights the importance of assessment both dimensions of caries prevalence and inequality according to different socio-economic profiles. Such information could be used as important information to plan community activities and oral health promotion aimed to reduce the levels of dental disease and inequalities in caries experience in more disadvantaged groups.

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