

Association of dental caries experience with individual and contextual variables in Brazilian children

Valeria Silva Cândido Brizon, Gabriela Christiel Soto Rojas, Glaucia Maria Bovi Ambrosano, Luciane Miranda Guerra, Antonio Carlos Pereira

Department of Preventive and Social Dentistry, Faculty of Dentistry of Piracicaba, State University of Campinas, São Paulo, Brazil

Address for correspondence:
Dr. Gabriela Christiel Soto Rojas,
Avenue Limeira, 901- Areião - CP
52 13414-903, São Paulo, Brazil.
E-mail: christiel1@yahoo.es

ABSTRACT

Context: There is a trend toward reduction in the caries index in populations of schoolchildren in developed and developing countries. In spite of this reduction, 53.4% Brazilian children present caries experience in primary dentition. **Aims:** To evaluate the association between dental caries experience in 5-year-old Brazilian and individual and contextual variables. **Settings and Design:** An analytical cross-sectional study was conducted. **Materials and Methods:** Data of a national oral health epidemiological survey - SB Brazil 2010 were taken. The outcome studied was caries experience measured by the decayed, missing, and filled teeth (dmft) index. The independent variables were classified into individual (sex, occlusion, treatment need, number of persons' resident in the home, number of bedrooms in the residence, number of goods/assets, and family income) and contextual (family financial aid grand, national health system performance index (Índice de Desempenho do Sistema Único de Saúde [IDSUS]), Gross National Product, per capita, Human Development Index, and fluoridated water) variables. **Statistical Analysis Used:** The data were initially analyzed by the Chi-square test, then was applied the multilevel model. **Results:** Only the contextual variable that evaluates access and quality of public services (IDSUS) was observed to affect the children's dmft index. The individual variables: male sex ($P = 0.0005$), occlusion ($P = 0.0437$), dental treatment need ($P < 0.0001$), number of persons' resident in the home ($P < 0.0001$), number of bedrooms in the residence ($P = 0.0152$), number of goods/assets ($P = 0.0147$), and family income ($P = 0.0044$) were significant. **Conclusions:** There is an impact of social determinants on health at individual level but only the IDSUS contextual variable was associated with dmft. Are necessary development public policies to deal with caries with a focus on these determinants?

Key words

Brazil, dental caries, dental health surveys, multilevel analysis, oral health

INTRODUCTION

National and international researches have demonstrated a trend toward reduction in the caries index in populations of school children in developed^[1] and developing^[2] countries. This fact was observed in Brazil through the last two epidemiological studies in which a reduction in decayed, missing, and filled teeth (dmft) was observed for 5-year-old children from of 2.80 in 2003 to 2.43 in 2010.^[2,3] In spite of this reduction, 53.4% Brazilian children present caries experience in primary dentition.^[3]

Caries not treated in childhood may prevent the healthy growth and development of the child. This caries disease may lead to suppressed growth due to toothache and reluctance to eat; difficulty in communication with others due to speech disturbances; low self-esteem due to bad breath, and school performance may be deficient due to toothache, interrupted sleep, difficulty in concentration, and lost hours of study time.^[4,5] Studies have shown that the experience of decay during early childhood results in a more severe caries experience during adulthood. Children with primary carious teeth often times exhibit

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caries in permanent teeth, while children with caries-free primary dentition remain caries-free in the permanent dentition.^[6]

Taking into consideration the levels of caries experience, theories have been developed to explain the relationships of modulating factors associated with the phenomenon of the disease.^[7] These theories seek to evaluate the influence of individual and contextual risk factors in which the individual is included such as social, income, education, behavioral factors, knowledge, educational level and attitudes, in an endeavor to find an explanation for the causal pathways of the results of oral health, risk behaviors, and the use of oral health services, which may contribute to increase the indices of caries experience, other diseases, and childhood ailments.^[8]

Although inequalities in caries experience in children for the different social gradients have been observed in some studies,^[9] the contribution of contextual factors to the risk of disease still need to be studied better, particularly in needy populations so that the differences within the social environment may be more clearly elucidated,^[10] a fact that justifies new studies.

Therefore, it is important to know the impact of social determinants on health, both at individual and collective level, to contribute to the better direction of the resources of health policies and plan actions to increase the percentages of caries-free children. In view of this scenario, the aim of this study was to identify the indicators of individual and contextual risk for caries experience in 5-year-old Brazilian children.

MATERIALS AND METHODS

The data necessary for elaborating the study were obtained from the epidemiological oral health survey of Brazil (SB Brazil, 2010)^[3] in which the oral health conditions of the Brazilian population in different ages groups were analyzed in both urban and rural areas. The project SB Brazil 2010 was approved by the Ethics Committee on Research with Human Beings, Protocol No. 009/2010.

Brazil has a total of 190,755,799 individuals, made up of 2,931,988 5-year-old children. Data were collected from 7348 children in 172 cities in Brazil.^[3] The sample design consisted of 32 domains (27 state capitals and 5 domains with reference to cities in the interior of each Brazilian region), and for sample calculation, the dental caries parameters of the national survey conducted in 2003^[2] were used for the respective domains studied.

In this study, the clinical exam was performed and the dmft checked (mean number of decayed, missing (extracted), and filled teeth). The examination was based on the World Health Organization (WHO) criteria.^[11]

The field teams formed by an examiner and a note-taker were trained in workshops with duration of 32 h. The capitals had ten field teams and the municipalities in the interior had from 2 to 6 teams, depending on population size. The stages were divided into theoretical discussion, practice, calibration, final discussion, and field strategies.

The calibration technique adopted was consensus, calculating the agreement between each examiner and the results obtained by consensus of the team. The model proposed by the WHO was used as a reference. The pondered kappa coefficient was calculated for each examiner, age group, and disease studied having a value of 0.65 as the minimum acceptable level.

In addition to the traditional indices for verifying oral diseases, data were collected with reference to the following characteristics: (a) Demographic and socioeconomic characterization, (b) use of dental services and oral morbidity reported, and (c) self-perception of and impacts on oral health. The questions were applied to the person responsible for the home to obtain information relative to the family and minors.

The dependent variable studied was caries experience using the dmft (dichotomized as absence/presence).

The independent individual variables included in this study were sex (female/male), dental occlusion (malocclusion/absence of malocclusion: Presence/absence), dental treatment need (caries active/caries free: yes/no), number of persons' resident in the home (1–18), number of bedrooms in the residence (1–18), number of goods/assets (material goods like vehicle, TV, table, others) in the residence (1–11), and monthly family income (up to 250 reais to over Rs. 9,500).

The independent contextual variables relative to the cities were (a) Human Development Index (HDI) of the municipality – MHDI, a measurement that assembles information about longevity, income, and educational level.^[12] (b) Family Financial Grant Program (“Bolsa Família” [BF]), which refers to a program of direct income transfer that benefits families living in poverty or extreme poverty and which are composed of pregnant women, nursing mothers, children (between 0 and 12 years of age), and adolescents (up to 15 years old), defined by the criterion of monetary income per capita of below 70 reais per month. This concerns a variable benefit to the monthly value of 32,00 reais per beneficiary up to a limit of Rs. 160,00 per family (approximately 16 million Brazilians - 8.5% of the general population are benefited).^[13] For the family financial grant (BF), the number of families benefited per municipality per every 1000 inhabitants were obtained.^[13] (c) To evaluate access to and quality of the public oral health services, the National Health Service Performance Index (Índice de Desempenho do Sistema Único de Saúde (IDSUS) was

used. IDSUS was launched on March 1, 2012, as a synthesis of 24 indicators that evaluate the performance of SUS, attributing a score (grade) to each municipality, state and Brazil. The score ranges from 0 to 10 in which the lowest scores would represent the worst rankings in the classification relative to the performance of SUS in the State or Municipality considered. In addition to the score, the municipalities are grouped according to the similarity among them, considering the concomitant analysis of three indices Socioeconomic Development (IDSE), Health Conditions (ICS), and Structure of the Municipal Health System (IESM). These groups are denominated homogeneous and are divided in the following manner: Groups 1 and 2 are formed of municipalities that present the best infrastructure and conditions of service to the population and Groups 3 and 4 have little medium and high complexity structure, while those of Groups 5 and 6 have no structure for specialized attendance/care.^[14] For the analysis, the score the municipality received and the number of the homogeneous group in which it was inserted were used. (d) The Municipal Gross National Product (GNP) per capita corresponds the sum of the salaries of the entire population of the municipality, divided by the number of inhabitants in these municipalities.^[15] For fluoridated water, the data were dichotomized into municipalities with the presence or absence of fluoride in the water for consumption.^[15]

Statistical analysis

The data were initially analyzed by the Chi-square test. For the multilevel model, the data were analyzed using fixed components represented by the variables studied and random components, represented by the cities and by variances in the different levels. Adjustments to the model were made by the *PROC MIXED* procedure of the statistical software program Statistical Analysis System (SAS) 9.2, 2008. In Level 1, the variables relative to individuals were considered. In Level 2, the variables relative to cities, with the dmft (Level 1) being evaluated as a function of the predictive variables of Levels 1 and 2. A model was initially adjusted only with the intercept (Model 1). After this, the predictive effects of the level of individuals (Level 1) were included - Model 2 and of the cities (Level 2) - Model 3. In the selection of the contextual variables, the indicators related to access to and quality of health services (IDSUS), socioeconomic conditions (HDI and GNP per capita), and social vulnerability (Family Financial Grant [BF]) were taken into consideration. The quality of the adjustments was evaluated by the convergence of the model, AIC, AICC, and statistical criteria - 2 times the logarithm of the function of vero similarity. In all the analyses, a level of significance of 5% was used.

RESULTS

Descriptive analysis of the independent variables (frequency and percentage) may be observed in Tables 1 and 2. The

largest portion of the subjects examined (76.13%) lived in the capitals, while there was a balance between the two sexes. Approximately, half the individuals (49.05%) had some treatment need [Table 1]. Seventy-five percent of those examined came from families with a monthly income of up to Rs. 150,000 and 70% resided in homes with 1–3 rooms [Table 2].

In Table 3, it was verified that on an average, the cities from which the participants came had 55.51 families benefited by the Family Financial Grant program (BF) per every 1000 inhabitants, the IDSUS was 5.64; GNP per capita of 17329.76 reais, and HDI of 0.79.

In Table 4, the different estimated multilevel models are presented. In Model 1, it may be observed that the mean dmft score in the cities of the sample was 2.93, with the standard error of 0.11. Furthermore, it was observed that the variation in the caries index among cities was significant ($P < 0.0001$); however, the variation among the volunteers in the same city was around 7 times higher than the variation among the cities. By the intraclass correlation, it could be affirmed that the variation between the cities represented approximately 12% of the total variation. When the variables of the individual level (Model 2) were included, it was observed that they presented a higher dmft of

Table 1: Frequency and percentage of 5-year-old children, according to qualitative independent variables Brazil, 2011

Variable	Category	Frequency	Percentage
Sex	Female	3673	49.99
	Male	3675	50.01
Place of exam	Capital	5594	76.13
	Interior	1754	23.87
Region	North	1818	24.74
	Northeast	2161	29.41
	Southeast	1292	17.58
	South	936	12.74
Occlusion	Midwest	1141	15.53
	No	2604	36.96
Treatment need	Yes	4441	63.04
	No	3540	49.05
Number of persons' resident in home	1	24	0.33
	2	172	2.35
	3	1410	19.23
	4	2211	30.15
	5	1582	21.57
	6	813	11.09
	7	510	6.95
	8	228	3.11
	9	154	2.10
	10	97	1.32
	11 or more	133	1.82

Table 2: Frequency and percentage of 5-year-old children, according to number of bedrooms, goods, and family income Brazil, 2011

Variable	Category	Frequency	Percentage
Number of bedrooms	1	881	12.01
	2	2630	35.87
	3	1678	22.88
	4	763	10.41
	5	592	8.07
	6	332	4.53
	7	184	2.51
	8	118	1.61
	9	60	0.82
	10	44	0.60
	11 or more	51	0.68
Number of goods/assets	0	65	0.89
	1	121	1.66
	2	182	2.50
	3	518	7.10
	4	984	13.49
Monthly family income (reais)	5 or more	5422	74.36
	Up to 250	351	5.01
	12-500	1186	16.94
	12-1500	3754	53.61
	1501-2500	1034	14.77
	2501-4500	431	6.16
Monthly family income (reais)	4501-9500	176	2.51
	Over 9500	70	1.00

Table 3: Frequency, percentage of 5-year-old children favored by fluoridated water and mean and standard deviation of contextual variables Brazil, 2011

Variable	Category	Frequency	Percentage
Fluoridated water	Absence	1509	21.43
	Presence	5533	78.57
Variable		Mean	SD
Family financial grant		55.51	33.42
IDSUS* (scores)		5.64	0.79
IDSUS* (homogeneous group)		1.83	1.38
GNP per capita [†]		17,329.76	12,357.25
HDI [‡]		0.79	0.06

*IDSUS – National health system performance index, [†]GNP – Gross National Product, [‡]HDI – Human Development Index, SD – Standard deviation

individuals of the male sex ($P = 0.0002$), with treatment need ($P < 0.0001$), with a higher number of persons' resident in the home ($P < 0.0001$), lower number of bedrooms in the residence ($P = 0.0204$), lower number of goods/assets ($P = 0.0059$), and lower family income ($P = 0.0015$). In Model 3, the variables of the second level (cities) were included to evaluate the influence of these in the explanation of the variability of dmft. It was observed that only the variable that evaluates access to and quality of the public health services (IDSUS) affected the dmft. The following variables continued to

be significant in caries experience: male sex ($P = 0.0005$), occlusion ($P = 0.0437$), dental treatment need ($P < 0.0001$), number of persons' resident in the home ($P < 0.0001$), number of bedrooms in the residence ($P = 0.0152$), number of goods/assets ($P = 0.0147$), and family income ($P = 0.0044$).

In all the models, the significances were controlled by the other predictors of the model.

DISCUSSION

The results obtained in the present study showed the evidence of an association of the individual level variable with caries experience in 5-year-old children. The male sex presented the highest dmft index in comparison with the female sex, which corroborates the results of the research, which evaluated the pattern of caries prevalence in primary dentition in 5-year-old schoolchildren, showing higher prevalence of boys with caries (47.4%) than in girls (41.1%),^[16] and demonstrating that girls are more conscious of their diet, oral health, and hygiene.^[17] Moreover, another study of assessment of caries prevalence among children below 5 years old shows that caries experience was higher in boys (47.44%) than in girls (40.94%). This difference was statistically significant.^[18]

A higher dmft index was observed in children with greater treatment need and with a higher number of persons' resident in the home. The result of a study that associated the factors related to caries in preschool children is consistent with those of this national research as it verified that only the existence of three or more siblings living in the same house was a predictor of caries in this age group. This is a finding that is also consistent with those of studies that have indicated lower risk for caries among children who did not have siblings or a lower number of them.^[19,20] There are reports linking the higher number of siblings to increased dental caries experience in young children. The number of siblings is a crucial factor in caries prevalence in the primary dentition.^[21] This probably points in the direction of the parents' attention, especially the mother's, who generally is the caregiver and who spends more time with the child. The higher the number of children, the greater the demand, and consequently, the division of care and time spent on each child.

Children who reside in houses with a lower number of bedrooms in the residence, lower number of goods/assets, and lower family income presented a higher dmft index. The conditions of social and material disadvantages to which individuals are exposed may be expressed in terms of greater susceptibility to caries, contributing to the worst oral health conditions.^[22] Family agglomeration and socioeconomic status have been associated with caries, clearly expressing the fact that social privation acts as

Table 4: Multilevel analysis for individual and contextual variables for the decayed, missing filled teeth of 5-year-old children Brazil, 2011

	Model 1		Model 2		Model 3	
	Only the intercept		Variables of Level 1 (cities)		Complete model	
	Estimate	SE	Estimate	SE	Estimate	SE
Variables of Level 1 (individual)						
Intercept	2.93	(0.11)	<0.0001	1.05	(0.19)	<0.0001
Sex (reference male)				-0.23	(0.06)	0.0002
Occlusion (reference number)				0.12	(0.07)	0.0794
Treatment need (reference number)				3.86	(0.07)	<0.0001
Number of persons' resident in home				0.13	(0.02)	<0.0001
Number of rooms in the residence				-0.04	(0.02)	0.0204
Number of goods/assets				-0.04	(0.02)	0.0059
Monthly family income (reais)				-0.12	(0.04)	0.0015
Variables of Level 2 (cities)						
Family financial grant					0.004	(0.003)
IDSUS* (scores)					0.07	(0.08)
IDSUS* (homogeneous group)					0.16	(0.07)
GNP per capita [†]					<-0.0001	(<-0.000)
HDI [‡]					2.67	(2.35)
Fluoridated water					-0.22	(0.20)
Variances						
Variance between cities	1.43	(0.25)	<0.0001	0.63	(0.15)	<0.0001
Variance between volunteers within city	10.51	(0.18)	<0.0001	6.64	(0.12)	<0.0001

*IDSUS – National health system performance index, [†]GNP – Gross National Product, [‡]HDI – Human Development Index. SE – Standard error

a strong indicator of risk to oral health conditions.^[9,23] Epidemiological data obtained from samples composed of subjects with different socioeconomic statuses have revealed that the presence of early childhood caries was strongly related to families with a low socioeconomic level because families with a low social level have material, social, and financial disadvantages that compromise their ability to care for their own health and that of their children. These families have difficulty in obtaining professional healthcare and do not identify dental problems, leaving out preventive care during the initial stages of the disease.^[24]

Moreover, in the present study, the cities with a larger number of families grouped in Groups 5 and 6, in which access to and quality of public services are compromised because they do not have any structure for specialized care and attention and were associated with caries experience. This demonstrates that the impacts of the inequalities in the health profile of the difference social groups are diverse and have been problematized in different countries in the world. Diverse studies have sought to understand how socioeconomic, regional, and sexual inequalities produce an impact on the morbimortality profile of the population and on access to and use of health services.^[2,3,9]

In conceptual models, the health behaviors and use of oral health services are considered proximal factors for

the results of oral health^[25,26] having a greater influence on the socially more vulnerable groups. Health is affected by the psychosocial/stress medium and is directly or indirectly modulated by the individual's behavior.^[27] Thus, we could observe lower topical exposure to fluoridated toothpaste and a worse profile of dental cleanliness resulting in higher levels of dental caries.^[8,9]

It was observed no association between fluoridated water and dmft index. Because it is an ecological study addressing only some municipalities, it could have caused a fallacy of the study because as has been proven, the presence of fluoride in the water has a significant impact on prevention of dental caries.^[5] In Brazil, despite being mandatory fluoridation of the waters, many municipalities have operational problems to do this. For this reason, the supply of fluoridated waters for the entire population is difficult. In the epidemiological survey SB Brazil 2010, cities were chosen by draw into 5 clusters and the power of association has been not strong enough to support the relation between these variables.

However, the results achieved in this study must be analyzed with care, bearing in mind the inherent limitations to the cross-sectional study design adopted, by the difficulty in establishing causal relationships based on a cross-section in time, limiting the confidence in the establishment of the direction of the association.

Furthermore, it should be pointed out that the option for multilevel analysis arose from the fact of the importance of investigating interactions among variables of different levels (individual and contextual). Therefore, greater statistical efficacy, greater power, and less bias are verified than those contained in a multiple analysis such as logistic regression.^[28] This information is useful for backing other researchers and for understanding the influence of the individual and contextual variables on caries experience. In general, the information produced in this study expresses the accumulation of a series of problems that have not been faced, showing evidence of inequalities in health. For an intentional change, integrated health actions, common to those of other childhood diseases, are indicated at diverse levels of the health system.^[29] These actions combine programmed intersectoral actions, for example, the Health Program at School (PSE). Its implementation in preschools is of great importance because it unites the efforts of the health sector with those of the education sector.^[30]

For a reduction in inequalities in health to occur, there must be a greater focus of attention on the less favored groups because reducing inequalities in health is equivalent to working for a more equitable society. The actions must be based on knowledge of and fall on the determinants on health, and the indicators of risk for caries must be identified, considering individual variables in conjunction with contextual variables, which may differ, according to the diverse socioeconomic groups.

CONCLUSION

The present study demonstrated the impact of social determinants on health both at individual and collective level. Therefore, there was a clear need for public policies to deal with caries in 5-year-old children, with focus on individuals of the male sex, aspects connected with occlusion, dental treatment needs, number of persons' resident in the home and the number of bedrooms and goods/assets in the residence, as well as family income. As regards the contextual determinants, the condition of access to and quality of public health service provided by the municipality must be a factor of relevance in the construction of the mentioned policies.

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Conflicts of interest

There are no conflicts of interest.

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