

# Dental caries in 12-year-old schoolchildren: multilevel analysis of individual and school environment factors in Goiânia

## *Cárie dentária em escolares de 12 anos: análise multinível dos fatores individuais e do ambiente escolar em Goiânia*

Lorena Batista de Oliveira<sup>I</sup>, Rafael da Silveira Moreira<sup>II</sup>, Sandra Cristina Guimarães Bahia Reis<sup>III</sup>, Maria do Carmo Matias Freire<sup>IV</sup>

**ABSTRACT:** The aim of this study was to investigate the association between dental caries index among 12-year-old schoolchildren and individual and contextual factors related to the schools in the city of Goiânia, Goiás, Brazil. A cross-sectional study was carried out with 2,075 schoolchildren using the 2010 National Survey of Oral Health methodology. The dependent variable was the decayed, missing, and filled teeth (DMFT) index and the independent variables were individual (sex, race, and maternal education) and contextual ones (type of school, health district, and the presence of oral programs). Multilevel analysis and log-linear negative binomial regression were performed, considering the complex sampling design. Mean DMFT index was 1.51. Female students, whose mothers had lower schooling, those attending public schools, located in districts with the worst socioeconomic indicators, and covered by the Family Health Strategy had higher caries levels. The dental caries index was low and associated with the schoolchildren sociodemographic characteristics and factors related to the schools, showing inequalities in distribution.

**Keywords:** School health. DMF index. Dental caries. Socioeconomic factors. Dental health services. Multilevel analysis.

<sup>I</sup>Graduate Program in Collective Health, *Universidade Federal de Goiás* – Goiânia (GO), Brazil.

<sup>II</sup>Ministry of Health, *Fundação Oswaldo Cruz* – Recife (PE), Brazil.

<sup>III</sup>Health State Secretariat of Goiás – Goiânia (GO), Brazil.

<sup>IV</sup>School of Dentistry, *Universidade Federal de Goiás* – Goiânia (GO), Brazil.

**Corresponding author:** Lorena Batista de Oliveira. Rua Comendador Negrão de Lima, quadra 38, lote 02/17, apto. 1602, torre 2, Portal das Dunas, Setor Negrão de Lima, CEP: 74650-030, Goiânia, GO, Brazil. E-mail: lorena6cd@hotmail.com

**Conflict of interests:** nothing to declare – **Financial support:** none.

**RESUMO:** O objetivo deste estudo foi investigar a associação entre o índice de cárie em escolares de 12 anos e fatores individuais e contextuais relacionados às escolas no município de Goiânia, Goiás. Estudo transversal realizado em 2.075 escolares, com base na metodologia da Pesquisa Nacional de Saúde Bucal de 2010. A variável dependente foi o índice dentes permanentes cariados, perdidos e restaurados (CPOD) e as variáveis independentes foram individuais (sexo, cor/raça e escolaridade da mãe) e contextuais (natureza administrativa da escola, distrito sanitário e presença de programas de saúde bucal). Foi realizada análise multinível e regressão log-linear binominal negativa, considerando o plano complexo de amostragem. O CPOD médio foi 1,51. Escolares do sexo feminino, cujas mães tinham menor escolaridade, que frequentavam escolas públicas localizadas nos distritos com os piores indicadores socioeconômicos e com cobertura pela Estratégia Saúde da Família apresentaram índices de cárie mais elevados. O índice de cárie foi baixo e associado a fatores individuais e contextuais do ambiente escolar, evidenciando iniquidades em sua distribuição.

**Palavras-chave:** Saúde escolar. Índice CPO. Cárie dentária. Fatores socioeconômicos. Serviços de saúde bucal. Análise multinível.

## INTRODUCTION

Although there have been improvements in the oral health of populations from several countries, there are still some global issues that require some actions to be overcome<sup>1</sup>. Dental caries is considered to be an important public health issue worldwide due to the pain and suffering caused to subjects, to the high cost of its treatment, and to the impact on quality of life. There is evidence that the disease distribution in the population of both developed and developing countries happens unequally, being strongly associated with socioeconomic conditions<sup>2-4</sup>. The oral health of 12-year-old schoolchildren has been investigated in epidemiological studies all around the world as an indicator of caries attack in permanent dentition. Usually, at school, a reliable and simpler operational sample can be obtained through the education system.

In Brazil, several papers analyzed the administrative nature of the school as an indicator of schoolchildren's socioeconomic level, showing higher rates of caries in public schools in relation to private ones<sup>5,6</sup>. The influence of geographic location of the school has also been investigated, and there is evidence that schoolchildren from institutions located in areas with better socioeconomic conditions present lower levels of dental caries<sup>7,8</sup>. The presence of health programs is another factor of the school environment that can be investigated with regard to caries.

Considering that health can be influenced by individual and contextual or environmental factors, the use of statistical methods for multilevel analysis helps in better data treatment because observations begin to present a hierarchical structure<sup>9</sup>.

Few studies used this approach in Brazilian schoolchildren and were carried out based on interviews concerning oral health nationally and in a city at the Southeast<sup>10-12</sup>. Investigations about the contextual factors regarding schools can contribute to extending knowledge about the determinants of dental caries in this population group, besides being important for planning and evaluating these health actions at a regional level. Furthermore, conducting studies in Brazilian cities that were not fully investigated can contribute to clarifying the possible social inequalities in the distribution of dental caries in the country. Hence, the objective of this study was to investigate the association between dental caries index among 12-year-old schoolchildren and individual and contextual factors associated with schools in the city of Goiânia, Goiás, in 2010, using the multilevel approach.

## **METHODS**

### **TYPE OF STUDY AND DATA SOURCE**

This cross-sectional study was performed using data from the epidemiological survey of oral health among 12-year-old schoolchildren in Goiânia, Goiás, Brazil, in 2010. The research methodology followed the Brazilian National Survey of Oral Health of 2010<sup>13</sup>. Clinical examinations were performed according to the diagnosis criteria of the World Health Organization (WHO)<sup>14</sup>.

For studying the variables regarding school environment, secondary data obtained in the Municipal Health Secretariat of Goiânia were used.

### **SAMPLE**

The sample included 12-year-old schoolchildren of both genders that attended public and private schools in the urban area, located in seven sanitary districts (SDs) in the city. Each SD has a geographic area with a specific population and administrative purposes.

The two-stage cluster sampling was applied, and initially primary unities (schools) were chosen in the SD, followed by second-stage unities (schoolchildren). The schools were chosen randomly and balanced, in which every school of each SD had the same probability of participating in the sample, concerning its contribution to the total of schools and of schoolchildren in the specified category<sup>14</sup>.

According to data obtained in the Education Secretariats in the city of Goiânia and in the State of Goiás, in 2009, the total number of 12-year-old schoolchildren enrolled was 17,911. The formula used to know the prevalence of the disease in infinite populations was used to calculate the minimum size of the sample, which is available in the

Epi Info software, version 3.5.1. Taking into consideration the 95% confidence interval (95%CI), the sampling error margin of 2%, and caries prevalence of 65.3%, found in 2003<sup>5</sup>, the minimum number of students participating in the research was 2,171. To avoid possible clustering sampling biases, a simplified and conservatory correction by multiplying the sample size by 1.2 was necessary. Therefore, a final sample of 2,605 subjects was achieved.

To calculate the number of schools, we used a formula that comprised multiplying the number of existing schools by the number of school-aged children of the sample, divided by the total number of 12-year-old students in Goiânia, finding a sample of 41 schools. The total of schoolchildren was proportionally distributed into the seven SDs of the city: Central Area-Campinas, East, Northwest, North, West, Southwest, and South.

## DATA COLLECTION

The permanent dental caries experience was investigated by six teams, which were formed by a dental surgeon and an annotator. The calibration process was carried out during the Brazilian National Oral Health Survey<sup>13</sup>. Kappa coefficient for inter-rater reliability for dental caries varied from 0.708 to 0.899 with good reproducibility.

Intraoral examinations were performed at school under natural lighting with the examiners and schoolchildren sitting on chairs, one in front of the other. Plane oral mirror and periodontal probe of the WHO were the instruments used.

During examination and with students' registrations at the school, information was collected about the following demographic and socioeconomic characteristics of the students: gender, self-reported color or race, and maternal education (schooling).

## STUDIED VARIABLES

The dependent variable consisted of the number of decayed, missing, and filled teeth (DMFT index). The independent variables were studied in two classifications: individual (gender, schoolchildren's race/color of the skin, and maternal education) and contextual variables related to schools (administrative nature, geographic location by SD, and presence of health programs).

For the schoolchildren's color or race description, the criterion proposed by the Brazilian Institute of Geography and Statistics (IBGE), based on self-statement, was used: white, black, yellow, *mulatto*, or indigenous. Categories were grouped by "white" and "non-white." The maternal education level was based on schooling years, which were scored according to the rules of the Brazilian Education School System: less than 8, from 8 to 11, and more than 11 years.

To study the contextual factors, which comprised the characteristics of the social environment where the subject was inserted, we investigated the following variables regarding schools: administrative nature (public and private), geographic location by SD of the city, and coverage of public health programs focusing on oral health. The chosen programs were the following: Family Health Strategy (FHS) with Oral Health Teams (OHT), Monitored Brushing Program (MBP), and Dentistry Attention Program to the Schoolchild (DAPS). The last two ones were analyzed both separately and together.

According to the information provided by local authorities, the seven SDs were grouped into three categories based on their socioeconomic characteristics, such as sanitation conditions, housing conditions, and income level. The SD Central Area-Campinas had the best indicators and was categorized as Group I; the North, South, and East SD with intermediate indicators were grouped as Group II; and the Southwest, West, and Northwest SD with the worst indicators were included in Group III.

The Health Municipal Secretariat of the city conducted the three health programs at schools. The DAPS was created in 1986 with the aim of improving oral health conditions of 6- to 14-year-old schoolchildren attending the municipal system, through actions of educational, preventive, and curative characters. The MBP was created in 1992 and was developed among schoolchildren of municipal public institutions through daily brushing with fluoride toothpaste after meals at school. The FHS with OHT began in Goiânia, in 2004, including educational actions in the public schools and dentistry treatments to schoolchildren living in the strategy range.

## DATA ANALYSIS

Initially, the descriptive statistics analysis of the caries index (DMF) and its components was carried out. Contextual and individual variables were later described according to the DMF mean, considering the complex sample and sampling weights by school<sup>15</sup>.

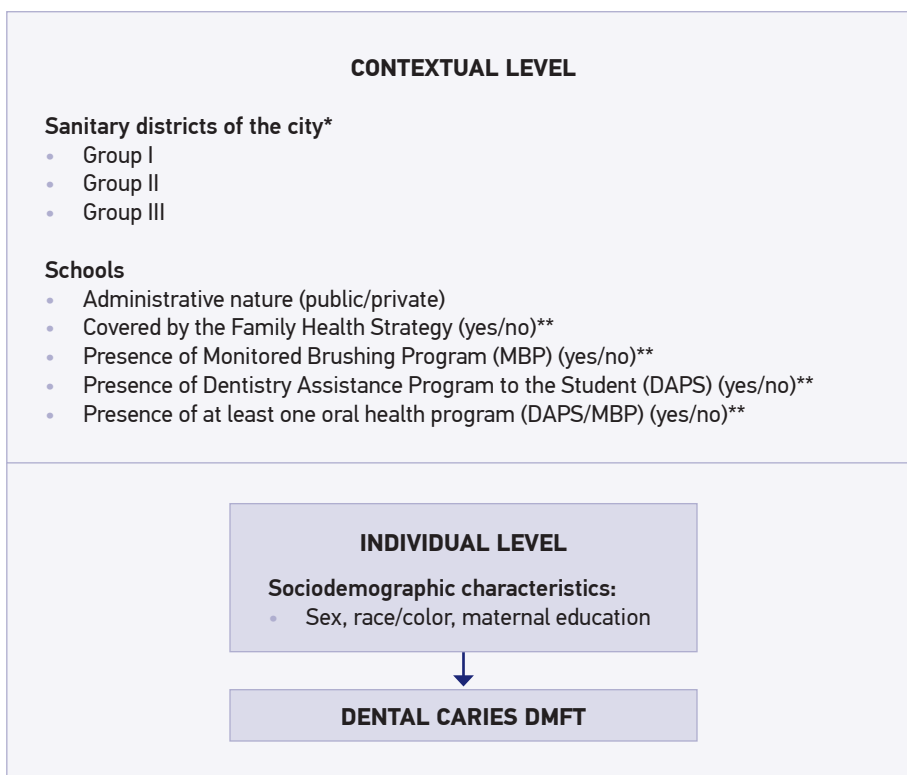
The multilevel analysis<sup>9</sup> was applied to later adjust individual and contextual determinants that can be associated with damage to the studied oral health, with collinearity control for the independent variables in each analysis level. Then, a negative binominal log-linear regression model of the proportion of means was used to calculate the effect measurements due to characteristics of the negative binomial distribution of the dependent variable (DMF) in the analyzed schoolchildren.

The exponential calculation applied to the regression coefficient generated an effect measure that can be interpreted as the mean ratio (MR). Epidemiological interpretation of this measure is similar to that of relative risk, where MR values higher or lower than 1, respectively, indicate risk or protection. This measure enables the comparison of the mean of a certain attribute of a group with the other. Estimations were given with the support of a statistical software called MLwiN, version 2.02<sup>16</sup>.

Influence of the studied factors on the DMFT index followed the hierarchical analysis methodology proposed by Victora et al.<sup>17</sup>. Considering the conceptual model presented in Figure 1 as a reference, first, simple analyses were performed in each model block. Inside each hierarchical level, variables with  $p < 0.20$  were tested in multiple models. At the end, variables with  $p < 0.05$  remained in the final model of each level and considered adjustment factors for the subsequent blocks.

## ETHICAL ISSUES

The Ethics Research Committee of *Universidade Federal de Goiás* approved the project. Only schools authorized by their principals and by the Education Secretariats and children whose parents signed the informed consent form could take part in the study.



\*Sanitary districts of the city: group I (with the best socioeconomic indicators); group II (with intermediate socioeconomic indicators); and group III (with the worst socioeconomic indicators).

\*\*Source of secondary data: *Secretaria Municipal de Saúde de Goiânia*.

Figure 1. Suggestion of a hierarchical theoretical model of the relationship between individual and contextual characteristics and dental caries among 12-year-old schoolchildren, Goiânia, GO, 2010.

## RESULTS

Of the 41 invited schools, 39 (24 public and 15 private institutions) were included in the research. A total of 2,075 schoolchildren were analyzed and presented a response rate of 70.05%. Reasons for not answering were lack of authorization from the tutors, especially in private schools; absence of schoolchildren on the examination day; refusals; and school evasion.

From the total of participants, 71.2% attended public schools and 28.8% private ones. More than half of them were male (50.9%). Most of the mothers had from 8 to 11 schooling years (51.2%), followed by < 8 years (27.5%) and > 11 years (21.3%). The *mulatto* color/race corresponded to 54.5% of the total, followed by white with 36.4%, black with 8.8%, yellow, 0.3%, and only 1 student with indigenous color/race.

The prevalence of caries was found to be 54% (95%CI 47.0 – 60.7). The DMFT index mean was 1.51 and there was predominance of the filled component (55.0%) (Table 1).

The DMFT and MR means were obtained based on independent variables from the simple model of negative binomial regression (Table 2). MR considers the variance present in each level and seems to be a corrected effect measure of the factors associated with the DMF. Regarding the contextual variables, the localization of the school by SD, the administrative nature of the school, and coverage by the FHS had statistically significant associations with dental caries. Individual variables, gender, color/race, and maternal education were not associated with caries.

After the adjustment of individual variables through the contextual ones, including those that were significant in the simple regression, only color/race of schoolchildren did not remain associated with the outcome (Table 3). In the final model, differences were seen in the geographic distribution of dental caries in Goiânia, Goiás, where students from schools located in the SD with the worst socioeconomic indicators (Group III) presented almost the double of the DMF index mean found in the SD with the best indicators (Group I;  $p < 0.001$ ). Inequalities were also found compared to other social variables. Public school students had DMFT mean

Table 1. Dental caries condition through the decayed, missing, filled teeth index (DMFT) in the permanent dentition (n = 2075) among 12-year-old schoolchildren in Goiânia, GO, 2010.

Dental caries (DMFT Index)	Mean	95%CI*	%*
Decayed	0.62	0.46 – 0.78	41.0
Missing	0.03	0.02 – 0.04	2.0
Filled/decayed	0.03	0.02 – 0.05	2.0
Filled	0.83	0.71 – 0.95	55.0
Total DMFT	1.51	1.28 – 1.75	100.0

\*Percentage regarding DMFT; DMF: decayed, missing, filled teeth; 95%CI: 95% confidence interval;

Table 2. Mean, 95% confidence interval, and mean ratio of decayed, missing, and filled teeth index (DMFT) according to the independent variables from the simple regression model in 12-year-old schoolchildren in Goiânia, GO, 2010.

Variables of the contextual level	Mean	95%CI	MR	95%CI	p-value
<b>Sanitary district of the city (Groups)</b>					
I – Central-Area/Campinas	0.91	0.67 – 1.14	1.00	–	–
II – East/North/South	1.23	0.95 – 1.50	1.25	0.94 – 1.67	0.117
III – Northwest/West/Southwest	2.02	1.82 – 2.22	2.10	1.59 – 2.77	< 0.001
<b>School</b>					
<b>Administrative nature</b>					
Private	0.85	0.63 – 1.07	1.00	–	–
Public	1.78	1.57 – 1.99	1.62	1.31 – 2.00	< 0.001
<b>Family Health Strategy (FHS) with Oral Health Team</b>					
No	1.34	1.12 – 1.57	1.00	–	–
Yes	2.28	2.08 – 2.48	1.36	1.05 – 1.77	0.004
<b>Programa de Escovação Supervisionada (PES)</b>					
No	1.40	1.09 – 1.72	1.00	–	–
Yes	1.77	1.54 – 1.99	1.18	0.93 – 1.45	0.167
<b>Programa de Atenção Odontológica ao Escolar (PAOE)</b>					
No	1.31	0.99 – 1.63	1.00	–	–
Yes	1.85	1.65 – 2.05	1.16	0.92 – 1.45	0.210
<b>PAOE ou PES</b>					
No	1.31	0.98 – 1.65	1.00	–	–
Yes	1.81	1.59 – 2.02	1.13	0.91 – 1.42	0.269
<b>Variables of the individual level</b>					
<b>Sex</b>					
Male	1.31	1.07 – 1.56	1.00	–	–
Female	1.72	1.46 – 1.98	1.30	1.16 – 1.45	< 0.001
<b>Race/Color</b>					
White	1.17	0.93 – 1.41	1.00	–	–
Nonwhite	1.71	1.46 – 1.96	1.18	1.02 – 1.35	0.021
<b>Maternal education (years of study)</b>					
> 11	0.82	0.60 – 1.04	1.00	–	–
8 – 11	1.55	1.34 – 1.76	1.55	1.30 – 1.85	< 0.001
< 8	1.98	1.75 – 2.22	1.72	1.40 – 2.12	< 0.001
Total	1.51	1.28 – 1.75	–	–	–

95%CI: 95% confidence interval; MR: mean ratio.



1.63 times higher than that of students from private schools ( $p < 0.001$ ). The index was also higher in institutions covered by the FHS, which was 1.37 times higher than in those without it ( $p < 0.01$ ). Through the analysis of individual variables, higher means of DMFT were found in female schoolchildren ( $p < 0.001$ ) and in those whose mothers had lower school education compared to the those with more schooling years ( $p < 0.05$ ).

Table 3. Results of the negative binomial regression multiple model of the association between dental caries and individual and contextual factors in 12-year-old schoolchildren. Goiânia, GO, 2010.

Variables of the contextual level	Regression coefficient	Standard error	MR*	95%CI	p-value
<b>Sanitary district level</b>					
Sanitary district of the city (Groups)					
I – Central-Area/Campinas	–	–	1.00	–	–
II – East/North/South	0.227	0.145	1.25	0.94 – 1.67	0.117
III – Northwest/West/Southwest	0.740	0.142	2.10	1.59 – 2.77	< 0.001
Variables of the contextual level	Regression coefficient	Standard error	MR†	95%CI	p-value
<b>School level</b>					
Administrative nature					
Private	–	–	1.00	–	–
Public	0.486	0.092	1.63	1.36 – 1.95	< 0.001
Family Health Strategy (FHS)					
No			1.00	–	–
Yes	0.315	0.098	1.37	1.13 – 1.66	0.001
Variables of the individual level	Regression coefficient	Standard error	MR‡	95%CI	p-value
<b>Sex</b>					
Male	–	–	1.00	–	–
Female	0.281	0.057	1.32	1.18 – 1.48	< 0.001
<b>Maternal education (years of study)</b>					
> 11	–	–	1.00	–	–
8 – 11	0.276	0.096	1.32	1.09 – 1.59	0.004
< 8	0.367	0.111	1.44	1.16 – 1.79	< 0.001
Variances of the residues	Variance	Standard error			p-value
First level (district)	0.112	0.069	–	–	0.103
Second level (school)	0.066	0.021	–	–	0.001

\*Adjusted by the variables of the contextual block of the sanitary district level; †adjusted by variables of contextual blocks in the sanitary district level and schools; ‡adjusted by variables of contextual blocks in the sanitary district level, schools, and individual block; MR: mean ratios; 95%CI: 95% confidence interval.

## DISCUSSION

In this study, inequalities in the distribution of caries among 12-year-old schoolchildren were seen in the researched city regarding contextual and individual factors. The more favorable situation among the highest socioeconomic groups confirms the influence of social determinants in the population's health pattern, which has been an object of growing interest in public health.

Availability of secondary data through local information systems enabled assessing the influence of contextual variables about the outcome. Besides considering the sampling design, the multilevel analysis enabled contemplating part of the complexity inherent to the health-disease process. The adopted hierarchical model considered aspects of contextual level as mediators of the entire individual determination network.

The log-linear negative binominal regression model is a favorable methodological instrument to analyze discrete quantitative dependent variables. Such variables do not have a normal distribution to be adjusted in the linear regression model or have a higher variance than the mean, harming therefore the use of Poisson's log-linear regression model due to the overdispersion phenomenon<sup>18</sup>.

The worst indicators of the disease were seen in children of schools located in the SD with the worst socioeconomic indicators. Other studies conducted in Brazilian cities presented similar results<sup>7,8</sup>. An association was also seen between the administrative nature of the school and the caries experience. These results were in agreement with those of the previous studies carried out among 12-year-old schoolchildren, based on the sample of the national survey about oral health in 2003<sup>10</sup> and in others conducted in Brazilian cities<sup>5,6,12</sup>. Thus, in the Brazilian environment, the administrative nature of the school seems to be a socioeconomic status indicator, together with individual variables, or when their achievement is not possible<sup>19</sup>.

In this study, findings regarding FHS coverage with OHT were noteworthy, which was associated with a bigger experience of caries among the investigated schoolchildren, regardless of the socioeconomic factors. This can be partially explained because areas with the worst social indicators are priorities for the implementation of FHS. In literature, evidence about the efficacy of oral health actions in FHS is rare and points out for difficulties in their structure, which result in minor or no advances at all in the support model and in the oral health condition of the population<sup>20-22</sup>.

The other contextual factors analyzed concerning the presence of oral health programs at school were not statistically associated with the dependent variable. Review studies showed that health education actions alone do not produce long-lasting behavioral changes, therefore they are relatively ineffective<sup>23,24</sup>. We should emphasize the cross-sectional design of the study, which does not allow establishing causality relations and does not evaluate the required time so that such programs can achieve the desired protective effect. Therefore, the present findings do not invalidate the assessed programs, but show that their probable effectiveness must be evaluated through other parameters as well, besides the health clinical condition of the assisted population.

Differences in the results from the female and male genders confirm the findings of other studies<sup>10,25</sup> and can be motivated through the variable commitment of the parents and society regarding the functional and aesthetical dimensions of oral health for girls and boys<sup>26</sup>.

As to the influence of maternal education, similar results were reported in studies performed in other Brazilian cities<sup>6,8,12,27</sup>. According to the National Commission on Health Social Determinants, education is strongly associated with the health of the populations<sup>28</sup>. Several mechanisms can explain the relationship between indicators of socioeconomic and health status. Furthermore, the causality of this relation is not unique, and there may be interaction between the factors.

Even though race/color has not been associated with the dependent variable, results of the bivariate analysis showed racial differences favoring white subjects, who presented lower prevalence of caries. Likewise, in the national survey performed in 2003, it was seen that black and *mulatto* adolescents of the Central-West Region had higher chances of presenting non-carious teeth<sup>29</sup>. The explanation for such an association is not clear and may include the influence of socioeconomic position, racial discrimination, health behaviors, among other factors that should be better explored in further studies.

Decreasing caries index of schoolchildren in the city since the 1980s has been shown<sup>30</sup> and follows the national tendency. The DMFT found in 2010 (1.51) may be classified as low according to the WHO scale for the age of 12 years old<sup>31</sup>. It was also lower than the mean found in Goiânia (DMFT = 1.76), in the Central-West Region (DMFT = 2.63), and in Brazil in its totality (DMFT = 2.07)<sup>13</sup>. These data show a less favorable situation in Goiânia, Goiás; however, they dissimulate inequalities found in the city. Hence, it is important to analyze the geographic distribution of local data. In addition, the high percentage of untreated dental caries in this study (41%) is a matter of concern and has caused some implications for the health public service.

Owing to the limited number of contextual and individual variables collected in the epidemiological survey, other analyses that could better elucidate the factors that influence caries prevalence among 12-year-old schoolchildren in the city were not performed. Despite this limitation, this is one of the first studies to have applied the multilevel analysis for a representative group of children, in which the analyzed individual and contextual factors were useful for identifying vulnerable groups. This kind of analysis enables the investigators to deal with the microlevel of subjects and the macrolevel of groups simultaneously, contributing for a more effective and contextualized local oral health planning.

## CONCLUSION

Finally, an association was observed between the prevalence of dental caries and individual and contextual factors among 12-year-old schoolchildren in the city of Goiânia, Goiás, in 2010. Monitoring the sociodemographic and geographic inequalities is relevant for scheduling the appropriate interventions, with emphasis on socially adequate actions to reduce the existing inequities.

## REFERENCES

1. Petersen PE, Bourgeois D, Ogawa H, Estupinan-Day S, Ndiaye C. The global burden of oral diseases and risks to oral health. *Bull World Health Organ* 2005; 83(9): 661-9.
2. Hobdell MH, Oliveira ER, Bautista R, Myburgh NG, Lallo R, Narendran S, et al. Oral disease and socioeconomic status (SES). *Br Dent J* 2003; 194(2): 91-6.
3. Petersen PE, Kwan S. Equity, social determinants and public health programmes: the case of oral health. *Community Dent Oral Epidemiol* 2011; 39(6): 481-7.
4. Pitts N, Amaechi B, Niederman R, Acevedo AM, Vianna R, Ganss C, et al. Global oral health inequalities: dental caries task-group research agenda. *Adv Dent Res* 2011; 23(2): 211-20.
5. Freire MCM, Reis SCGB, Gonçalves MM, Balbo PL, Leles CR. Condição de saúde bucal em escolares de 12 anos de escolas públicas e privadas de Goiânia, Brasil. *Rev Panam Salud Publica* 2010; 28(2): 86-91.
6. Cypriano S, Hugo FD, Sciamarelli MC, Törres LHN, Sousa MLR, Wada RS. Fatores associados à experiência de cárie em escolares de um município com baixa prevalência de cárie dentária. *Ciênc Saúde Coletiva* 2011; 16(10): 4095-5106.
7. Antunes JL, Frazão P, Narvai PC, Bispo CM, Pegoretti T. Spatial analysis to identify differentials in dental needs by area-based measures. *Community Dent Oral Epidemiol* 2002; 30(2): 133-42.
8. Moura C, Cavalcanti AL, Bezerra PKM. Dental caries prevalence in 12-year-old schoolchildren in the city of Campina Grande, Paraíba, Brazil: a socioeconomic approach. *Rev Odontol Ciênc* 2008; 23(3): 256-62.
9. Merlo J, Chaix B, Yang M, Lynch J, Rastam L. A brief conceptual tutorial of multilevel analysis in social epidemiology: linking the statistical concept of clustering to the idea of contextual phenomenon. *J Epidemiol Community Health* 2005; 59(6): 443-9.
10. Antunes JL, Peres MA, Mello TRC, Waldman EA. Multilevel assessment of determinants of dental caries experience in Brazil. *Community Dent Oral Epidemiol* 2006; 34(2): 146-52.
11. Moreira RS, Nico LS. Aspectos contextuais da ausência de cárie em escolares de 12 anos no Brasil, em três períodos históricos. *Rev Odontol UNESP* 2010; 39(5): 263-70.
12. Martins MT, Sardenberg F, Abreu MH, Vale MP, Paiva SM, Pordeus IA. Factors associated with dental caries in Brazilian children: a multilevel approach. *Community Dent Oral Epidemiol* 2014; 42(4): 289-99.
13. Brasil. Ministério da Saúde. Secretaria de Atenção à Saúde. Departamento da Atenção Básica. SB Brasil 2010: resultados principais. Brasília: Ministério da Saúde; 2011.
14. World Health Organization (WHO). Oral health surveys: basic methods. Geneva: WHO; 1997.
15. Szwarcwald CL, Damacena GN. Amostras complexas em inquéritos populacionais: planejamento e implicações na análise estatística dos dados. *Rev Bras Epidemiol* 2008; 11(Suppl 1): 38-45.
16. Rasbash J, Charlton C, Browne WJ, Healy M, Cameron B. MLwiN Version 2.02. Bristol: Centre for Multilevel Modeling; 2005.
17. Victora CG, Huttly SR, Fuchs SC, Olinto MT. The role of conceptual frameworks in epidemiological analysis: a hierarchical approach. *Int J Epidemiol* 1997; 26(1): 224-7.
18. Gschlößl S, Czado C. Modelling count data with overdispersion and spatial effects. *Stat Pap* 2008; 48: 531-52.
19. Piovesan C, Pádua MC, Ardenghi TM, Mendes FM, Bonini GC. Can type of school be used as an alternative indicator of socioeconomic status in dental caries studies? A cross-sectional study. *BMC Med Res Methodol*. 2011; 11: 37.
20. Pereira CRS, Roncalli AG, Cangussu MCT, Noro LRA, Patrício AAR, Lima KC. Impacto da Estratégia de Saúde da Família sobre os indicadores de saúde bucal: análise em municípios do Nordeste brasileiro com mais de 100 mil habitantes. *Cad Saúde Pública* 2012; 28(3): 449-62.
21. Soares FF, Figueiredo CRV, Borges NCM, Jordão RA, Freire MCM. Atuação da equipe de saúde bucal na estratégia saúde da família: análise dos estudos publicados no período 2001-2008. *Ciênc Saúde Coletiva* 2011; 16(7): 3169-80.
22. Souza TMS, Roncalli AG. Saúde bucal no Programa Saúde da Família: uma avaliação do modelo assistencial. *Cad Saúde Pública* 2007; 23(11): 2727-39.
23. Kay EJ, Locker D. A systematic review of the effectiveness of health promotion aimed at improving oral health. *Community Dent Health* 1998; 15(3): 132-44.
24. Pauleto ARC, Pereira MLT, Cyrino EG. Saúde bucal: uma revisão crítica sobre programações educativas para escolares. *Ciênc Saúde Coletiva* 2004; 9(1): 121-30.
25. Pereira SM, Tagliaferro EP, Ambrosano GM, Cortelazzi KL, Meneghim MC, Pereira AC. Dental caries in 12-year-old schoolchildren and its relationship with socioeconomic and behavioural variables. *Oral Health Prev Dent* 2007; 5(4): 299-306.

26. Grogan S, Richards H. Body image: focus groups with boys and men. *Men Masc* 2002; 4(3): 219-32.
27. Nicolau B, Marcenes W, Allison P, Sheiham A. The life course approach: explaining the association between height and dental caries in Brazilian adolescents. *Community Dent Oral Epidemiol* 2005; 33(2): 93-8.
28. Comissão Nacional sobre Determinantes Sociais de Saúde (CNDSS). As causas sociais das iniquidades em saúde no Brasil. Relatório final da Comissão Nacional sobre Determinantes Sociais da Saúde (CNDSS). CNDSS; 2008. Disponível em: [http://www.who.int/social\\_determinants/media/brazil\\_cndss\\_final\\_report\\_2008\\_pt.pdf](http://www.who.int/social_determinants/media/brazil_cndss_final_report_2008_pt.pdf) (Acessado em 10 de janeiro de 2014).
29. Bastos JL, Antunes JLF, Frias AC, Souza MLR, Peres KG, Peres MA. Color/race inequalities in oral health among Brazilian adolescents. *Rev Bras Epidemiol* 2009; 12(3): 313-24.
30. Oliveira LB, Reis SBG, Freire MCM. Cárie dentária em escolares de Goiânia no período de 1988 a 2010: tendência e desigualdades. *Rev Odontol Bras Central* 2013; 22(61): 94-9.
31. Petersen PE. The World Oral Health Report 2003: continuous improvement of oral health in the 21st century – the approach of the WHO Global Oral Health Programme. *Community Dent Oral Epidemiol* 2003; 31(Suppl 1): 3-23.

Received on: 05/26/2014

Final version presented on: 09/01/2014

Accepted on: 09/30/2014