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Contextual and behavioral factors associated with dental caries experience in schoolchildren in southern of Brazil

Fatores contextuais e comportamentais associados à experiência de cárie dentária em escolares do sul do Brasil

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Resumo

Introdução: Além de fatores determinantes para o desenvolvimento da doença cárie dentária, como a dieta e a higiene bucal, o contexto em que os indivíduos vivem também tem mostrado reflexos no comportamento e nas condições de saúde bucal. **Objetivo:** O objetivo deste trabalho foi avaliar a associação de fatores contextuais e comportamentais com a experiência de cárie dentária em escolares de 12 anos em um município do sul do Brasil. **Materiais e métodos:** A pesquisa foi transversal e quantitativa, e os participantes eram estudantes de escolas públicas. Os dados foram coletados através de questionário e exame bucal, utilizando o índice CPOD para detecção de lesões de cárie dentária. O questionário avaliou aspectos relacionados à saúde bucal, como hábitos de higiene bucal e dieta. Cirurgiões-dentistas da rede municipal da atenção básica, previamente calibrados, realizaram o exame bucal dos estudantes, nas escolas. **Resultados:** Participaram do levantamento 712 estudantes. Destes, 656 realizaram o exame clínico. Os escolares que estudavam em escolas da área rural apresentaram 2,08 vezes maior prevalência de CPOD (95% intervalo de confiança [IC]: 1,43-3,03), bem como aqueles que não usavam escova de dentes, que tiveram 2,14 vezes maior prevalência (95% IC: 1,13-4,06) quando comparados às suas contrapartes. Ainda, quem possuía placa bacteriana visível em seus dentes apresentava 46% maior prevalência de CPOD (95% IC: 1,16-1,83) do que quem não possuía. **Conclusão:** Além dos fatores determinantes relacionados à cárie dentária, fatores contextuais apresentaram associação com experiência de cárie dentária, estimulando estratégias com potencial para minimizar as iniquidades em saúde bucal.

Palavras-chave: adolescente, cárie dentária, dieta cariogênica, higiene bucal, zona rural

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Abstract

Introduction: In addition to the factors that determine the development of dental caries, such as diet and oral hygiene, the context in which the individual lives is also reflected in behavior and oral health conditions. **Objective**: The objective of this study was to evaluate the association between contextual and behavioral factors and the occurrence of dental caries in 12-year-old schoolchildren from southern Brazil. **Materials and Methods**: This was a quantitative cross-sectional study. The participants were students from public schools. Data were collected using a questionnaire and an oral examination in which the DMFT index was used to detect dental caries lesions. The questionnaire evaluated aspects of oral health such as oral hygiene habits and diet. Dentists from the municipal primary care service, who had been previously calibrated, conducted the oral examination of the students in the schools. **Results**: 712 students participated in the survey and 656 were examined. Schoolchildren in rural areas had 2.08 times higher prevalence of DMFT (95% confidence interval [CI]: 1.43-3.03), as did those who didn't use a toothbrush, which had 2.14 times higher prevalence (95% CI: 1.13-4.06) compared to their counterparts. Also, those who had visible dental plaque had a 46% higher prevalence of DMFT (95% CI: 1.16-1.83) than those who didn't have plaque. **Conclusion**: In addition to the determinants of dental caries, contextual factors were also associated with the experience of dental caries, prompting strategies that have the potential to minimize oral health disparities.

Keywords: adolescent, dental caries, cariogenic diet, oral hygiene, rural areas

Introduction

Dental caries is the most prevalent of all diseases[1], and it's estimated that more than two billion people currently have permanent teeth with untreated carious lesions[2]. Caries occurs in childhood and continues through adolescence and adulthood, affecting individuals, communities, and society[3]. In Brazil, despite the decrease in 12-year-old schoolchildren from 96% to 56% in the 2003 and 2010 national surveys[4], caries is a public health problem that is still concentrated among the most disadvantaged populations[5].

Dental caries is considered a multifactorial disease, i.e., its development depends on several factors[6]. Frequent consumption of carbohydrates, poor oral hygiene, and inadequate exposure to fluorides are the main behavioral factors associated with the disease[7]. These aspects are also influenced by contextual factors. In the current literature, precarious living conditions, low education level, and cultural and environmental aspects have been associated with the disease[8,9]. In addition, commercial factors exert a strong influence on both dental caries incidence and other chronic non-communicable diseases (NCDs) and health behaviors[3]. Parental awareness of oral health and history of disease also play a central role in the management of dental caries[10] and this full range of factors needs to be considered in the formulation of future preventive interventions.

Because oral health is an inseparable part of overall health and well-being and plays a fundamental role in the ability to speak, smile, smell, taste, chew, and swallow without pain or discomfort[11], the conditions that may affect the integrity of oral health must be studied. Knowing the prevalence of dental caries in different age groups and the factors associated with it will allow us to develop prevention strategies. A multidimensional concept of oral health could then be a good starting point for new policies and social practices that address specific needs.

Therefore, the aim of this study was to investigate the relationship between contextual and behavioral factors and caries prevalence among 12-year-old schoolchildren in a municipality in southern Brazil.

Materials and Methods

Research design and sample

This was a quantitative cross-sectional study conducted according to standard guidelines for observational studies. This study is part of the "Epidemiological survey of 5- and 12-year-old schoolchildren in the city of Santa Cruz do Sul/RS", which provided for the evaluation of the oral health status of this population every three years. In 2018, in addition to dentists from the city's primary care network, professors and students from the dentistry program at the University of Santa Cruz do Sul (UNISC) contributed with the study.

The municipality of Santa Cruz do Sul is located in the central region of the state of Rio Grande do Sul, has 118,374 inhabitants, a school enrollment rate of 98.3% for ages 6 to 14, and a Human Development Index (HDI) of 0.773[12].

Inclusion and Exclusion Criteria

All students enrolled in public schools, municipal and state, in the municipality of Santa Cruz do Sul - RS - who were 12 years old on the day of data collection were considered eligible and invited to participate in the study. Students who weren't in school on the day of data collection, who didn't agree to participate in the examination or answer the questionnaire, or who were cognitively impaired were excluded.

The following parameters were considered when calculating the sample: caries prevalence in school children of 50%[13], confidence interval of 95%, standard error of 5%, effect size of 1.6, and an additional 30% for possible refusals. The minimum sample size to meet these requirements was estimated to be 190 participants. Because this study is part of a survey that also assessed other outcomes, a larger number of students were included.

Data collection

Data were collected between October and December 2018 in state and municipal public schools. Four calibrated examiners (dentists from the Municipal Health Network of Santa Cruz do Sul) and 11 trained interviewers (professors and students from the Dentistry program at the University of Santa Cruz do Sul) participated in this step.

A reference examiner participated in the training of the examiners, giving theoretical explanations and using images and dental mannequins. Oral examinations were performed for calibration and were repeated after one week. The calculated inter-examiner kappa coefficient ranged from 0.83 to 0.91 and intra-examiners from 0.76 to 0.90.

The contextual variables used in this study were school location (urban or rural) and Basic Education Development Index (IDEB). The school's IDEB was assessed on the portal of the National Institute for Educational Studies and Research Anísio Teixeira (INEP), recording whether or not the school achieved the target within the specified time.

Individual variables included gender (female or male), frequency of toothbrushing (categorized as 'twice or more a day' and 'less than twice a day'), use of a toothbrush (yes or no), use of fluoride toothpaste (yes or no), and flossing (yes or no). For foods, the frequency of eating fruit, cookies, cakes and pies, sticky foods, chewing gum with sugar, and sugary drinks was asked in the categories of ‘every day’, ‘a few times a week’, and ‘never or rarely’. Self-perception of gingival bleeding (yes or no) and the presence of visible plaque (yes or no) were also recorded.

The outcome of the study, caries experience in the permanent dentition, was assessed using the DMFT index (decayed, missing, and filled teeth) according to World Health Organization criteria (WHO)[14]. The examinations were performed in schools using a WHO probe

("ball point") and an oral mirror in natural light.

Data analysis

Data were analyzed with the statistical program STATA 14.0 (Stata Corporation, College Station, TX, USA). First, a descriptive analysis was performed with the distribution of absolute and relative frequencies of the variables and the mean and standard deviation (SD) of DMFT. In addition, an analysis of the association between the variables and the DMFT outcome was performed using unadjusted and adjusted multilevel Poisson regression models. The structure of the multilevel analysis considered individuals (level 1) nested within 38 schools (level 2). Multilevel models estimated the contextual effects of neighborhood-level variables by accounting for the spatial grouping of individuals within areas[15]. Variable selection followed Watt and Sheiham's conceptual theoretical model of hypothesized pathways between behaviors and oral health[16]. The multilevel model used the fixed effects and random intercept schema. Three models were described: Model 1 ("empty model") was an unconditional model, Model 2 included context-level variables, and Model 3 consisted of Model 2 and individual-level variables. Results are presented as prevalence ratio (PR) and 95% confidence interval (95% CI). Variables with a p value < 0.20 in the unadjusted analysis were included for the multivariate models. In all models, goodness of fit was measured by deviance (-2 log likelihood).

Ethics requirement

The research project was reviewed and approved by the UNISC Research Ethics Committee (statement 2.902.250), and all ethical requirements were met.

Results

A total of 712 students participated in the study, of which 656 underwent clinical examination to assess caries experience using the DMFT index, the outcome of this study. The mean DMFT was 0.87, with a standard deviation of 1.61 and minimum and maximum values of 0 and 13, respectively. Most of the students attended schools where the IDEB target was below expectations (63.7%) and were located in urban areas (84.1%). Regarding oral hygiene, most reported brushing their teeth twice or more a day (88.8%), using a toothbrush (98.3%), toothpaste (97.6%), and flossing (69.9%). In terms of diet, most students (59.8%) reported eating fruit a few times a week. Most also reported consuming cookies, cakes, and pies (63.7%), sticky foods (63.7%), sugared gum (55%), and packaged snacks (60.5%) a few times per week. Sixty-six percent of students reported consuming sugary drinks daily. Self-perception of gingival bleeding was reported by 49.6% of individuals and 35.9% had visible dental plaque (Table 1).

Table 1. Sample characteristics and mean Decayed, Missing and Filled Teeth (DMFT), Santa Cruz do Sul, Brazil (n=712).

Variables	n (%)	Mean (SD) DMFT
Contextual variables		
IDEB goal		
Above	198 (36.3)	1.08 (1.91)
Below	347 (63.7)	0.86 (1.54)
School zone		
Urban	598 (84.1)	0.69 (1.34)
Rural	113 (15.9)	1.71 (2.37)

Variables	n (%)	Mean (SD) DMFT
Individual variables		
Sex		
Female	350 (49.2)	0.84 (1.51)
Male	362 (50.8)	0.89 (1.70)
Toothbrushing frequency		
Twice or more a day	539 (88.8)	0.84 (1.50)
Less than twice a day	68 (11.2)	0.97 (1.90)
Use of toothbrush		
Yes	587 (98.3)	0.85 (1.53)
No	10 (1.7)	1.88 (2.80)
Use of toothpaste		
Yes	578 (97.6)	0.84 (1.53)
No	14 (2.4)	1.38 (2.18)
Flossing		
Yes	406 (69.9)	0.90 (1.52)
No	175 (30.1)	0.77 (1.70)
Fruit consumption		
Every day	200 (33.7)	0.96 (1.73)
A few times a week	355 (59.8)	0.80 (1.45)
Never or rarely	39 (6.6)	0.94 (1.65)
Consumption of cookies, cakes and pies		
Every day	73 (12.3)	0.98 (1.74)
A few times a week	415 (70.0)	0.83 (1.53)
Never or rarely	105 (17.7)	0.88 (1.53)
Consumption of sticky foods		
Every day	166 (28.6)	1.00 (1.84)
A few times a week	370 (63.7)	0.80 (1.44)
Never or rarely	45 (7.7)	0.55 (0.99)
Gum chewing		
Every day	120 (20.0)	1.15 (2.04)
A few times a week	331 (55.0)	0.74 (1.34)
Never or rarely	150 (25.0)	0.88 (1.53)
Consumption of packaged snacks		
Every day	115 (19.2)	0.84 (1.54)
A few times a week	361 (60.5)	0.85 (1.57)
Never or rarely	121 (20.3)	0.78 (1.36)
Consumption of sugary liquids		
Every day	392 (66.1)	0.86 (1.51)
A few times a week	181 (30.5)	0.81 (1.41)
Never or rarely	20 (3.4)	0.56 (1.25)
Perception of gingival bleeding		
No	287 (50.4)	0.79 (1.43)
Yes	282 (49.6)	0.91 (1.68)
Presence of visible plaque		
No	405 (64.1)	0.60 (1.11)
Yes	227 (35.9)	1.03 (1.64)

Values below 712 are due to missing data.
DMFT: decayed, missing and filled teeth; SD: standard deviation;
IDEB: Basic Education Development Index.

In the unadjusted analysis (Table 2), school zone, toothbrush use, consumption of sticky foods and sugared gum, self-perception of gingival bleeding and presence of visible plaque were associated with DMFT ($p< 0.05$).

Table 2. Unadjusted association of contextual and individual variables with number of decayed, missing, and filled (DMFT) teeth, determined using multilevel Poisson regression models.

Variables	PR (95% CI)	P value
Contextual variables		
IDEB goal		
Above	1	
Below	0.78 (0.48-1.27)	0.324
School zone		
Urban	1	
Rural	1.85 (1.24-2.75)	0.002
Individual variables		
Sex		
Female	1	
Male	1.04 (0.88-1.24)	0.610
Toothbrushing frequency		
Twice or more a day	1	
Less than twice a day	1.08 (0.81-1.45)	0.584
Use of toothbrush		
Yes	1	
No	1.82 (1.06-3.12)	0.029
Use of dentifrice		
Yes	1	
No	1.13 (0.68-1.88)	0.632
Flossing		
Yes	1	
No	0.90 (0.72-1.11)	0.314
Fruit consumption		
Every day	1	
A few times a week	0.97 (0.79-1.18)	0.751
Never or rarely	1.12 (0.77-1.64)	0.540
Consumption of biscuits, cakes and pies		
Every day	1	
A few times a week	0.79 (0.60-1.04)	0.097
Never or rarely	0.81 (0.58-1.12)	0.200
Consumption of sticky foods		
Every day	1	
A few times a week	0.80 (0.65-0.98)	0.030
Never or rarely	0.58 (0.37-0.90)	0.015
Consumption of gum with sugar		
Every day	1	
A few times a week	0.51 (0.41-0.65)	0.000
Never or rarely	0.62 (0.47-0.81)	0.000
Consumption of packaged snacks		
Every day	1	
A few times a week	0.84 (0.65-1.09)	0.188
Never or rarely	0.78 (0.56-1.07)	0.120
Consumption of sugary liquids		
Every day	1	
A few times a week	0.96 (0.78-1.18)	0.695
Never or rarely	0.62 (0.32-1.18)	0.146
Perception of gingival bleeding		
No	1	
Yes	1.22 (1.00-1.47)	0.045
Presence of visible plaque		
No	1	
Yes	1.54 (1.28-1.85)	0.000

PR: Prevalence Ratio;
95% CI: 95% Confidence Interval; IDEB: Basic Education Development Index.

Table 3 shows the adjusted models of the association between the variables and DMFT according to the multilevel Poisson regression models. In the adjusted analysis, the variables consumption of sticky foods and self-perception of gingival bleeding remained unrelated to the outcome. Students in rural areas had a 91% higher DMFT than students in urban areas (PR: 1.91; 95% CI: 1.17-3.10). Those who didn't use a toothbrush had a 2.08 times higher DMFT than those who did (PR: 2.08; 95% CI: 1.10-3.95). Regarding diet, those who chewed gum a few times per week had lower DMFT than those who chewed gum daily (PR: 0.63; 95% CI: 0.46-0.86). In addition, those who had visible plaque had a 47% higher DMFT than those who didn't (PR: 1.47; 95% CI: 1.17-1.84).

Table 3. Adjusted association of contextual and individual variables with the number of decayed, missing, and filled (DMFT) teeth, determined using multilevel Poisson regression models.

Variables	Model 1[a] PR (95% CI)	Model 2[b] PR (95% CI)	Model 3[c] PR (95% CI)
Fixed component			
Intercept	0.82 (0.66-1.01)	0.74 (0.50-1.10)	0.73 (0.48-1.10)
Contextual variables			
IDEB goal			
Above		1	-
Below		0.94 (0.60-1.47)	
School zone			
Urban		1	1
Rural		1.91 (1.17-3.10)*	2.08 (1.43-3.03)*
Individual variables			
Sex			
Female			-
Male			
Toothbrushing frequency			
Twice or more a day			-
Less than twice a day			
Use of toothbrush			
Yes			1
No			2.14 (1.13-4.06)*
Use of dentifrice			
Yes			-
No			
Flossing			
Yes			-
No			
Fruit consumption			
Every day			-
A few times a week			
Never or rarely			
Consumption of biscuits, cakes and pies			
Every day			1
A few times a week			0.87 (0.60-1.26)
Never or rarely			0.82 (0.52-1.28)
Consumption of sticky foods			
Every day			1
A few times a week			1.44 (0.53-1.96)
Never or rarely			1.04 (0.60-1.82)
Consumption of gum with sugar			
Every day			1
A few times a week			0.53 (0.37-0.75)*
Never or rarely			0.67 (0.45-1.01)

Variables	Model 1[a] PR (95% CI)	Model 2[b] PR (95% CI)	Model 3[c] PR (95% CI)
Consumption of packaged snacks			
Every day			1
A few times a week			0.96 (0.69-1.35)
Never or rarely			1.02 (0.66-1.57)
Consumption of sugary liquids			
Every day			1
A few times a week			0.93 (0.72-1.20)
Never or rarely			0.59 (0.26-1.31)
Perception of gingival bleeding			
No			1
Yes			1.01 (0.81-1.26)
Presence of visible plaque			
No			1
Yes			1.46 (1.16-1.83)*
Random component			
Deviance (-2 log likelihood)	1,893.47	1,463.35	1,145.80

*p<0.05
[a] Model 1: empty model, represents the unconditional model.
[b] Model 2: model adjusted by contextual variables.
[c] Model 3: model adjusted for contextual and individual variables.
PR: Prevalence Ratio;
95% CI: 95% Confidence Interval;
IDEB: Basic Education Development Index.

Discussion

This study found an association between contextual, socioeconomic, and behavioral factors and the incidence of dental caries. Schoolchildren who attended schools in rural areas, didn't use a toothbrush, and had visible dental plaque were more likely to experience dental caries than those who studied in urban areas, used a toothbrush, and didn't have visible plaque. In addition, chewing gum every day was associated with a higher risk of tooth decay. Similar data were found in previous studies in similar populations[17, 18].

The study population had a mean DMFT of 0.87. Compared to a previous study conducted in the same municipality, caries experience has decreased over the years, as in 2012 students had an average of 2.5 decayed, missing, or filled teeth[19]. The 2010 SB Brasil project also showed higher caries prevalence, with an average DMFT of 2.07 at age 12 in Brazil and 2.06 in the South Region[4]. The decrease in caries experience may be related to investments in oral health, such as increasing oral health teams, expanding access to dental services, and distributing toothbrush kits and fluoridated toothpaste[3]. In addition, it's possible that activities implemented in public schools, such as the Health in Schools Program (PSE), contributes in caries decrease by developing interventions to prevent disease and oral health problems and promote health, and linking schools with the health department[20].

This study showed that students from schools in rural areas had twice the DMFT index of students from urban areas. An earlier study conducted in the same municipality found that the prevalence of dental caries among school children in rural areas was about 25% higher than in urban areas[19]. According to the World Health Organization (WHO), people are unequally affected by disease, and residents of remote and rural areas tend to have a higher burden of chronic noncommunicable diseases (CNCDs) and oral diseases[1]. Similarly, national data show that medical and dental care is concentrated in urban areas and that rural residents use dental services less frequently than residents of urban areas[21].

These data may explain the findings of this study, as a greater concentration of professionals in urban areas[1] favors more frequent dental consultations, allowing for earlier diagnosis and less invasive interventions, as well as motivation for basic preventive care and appreciation of oral health.

In terms of diet, although only gum chewing had an association with the incidence of dental caries, free sugar is frequently consumed by most children, which is detrimental not only to oral health but also to general health and can lead to CNCD. Daily consumption of packaged snacks and gum was reported by 20% of students. Since an unhealthy diet is one of the most important risk factors for CNCDs, along with physical inactivity, tobacco use, and excessive alcohol consumption, the importance of taking steps to promote a healthy diet is emphasized. In this sense, Law 15.216/2018, of July 2018, which prohibits the sale of products that contribute to obesity, diabetes, and hypertension in canteens and similar establishments in public and private schools in the state of Rio Grande do Sul[22], may strengthen the role of schools as promoters of healthy habits. While approaches that focus on the individual, such as media campaigns, health education, and dietary guidelines, tend to increase health inequalities[23] and favor individuals with better socioeconomic conditions, public policies have the potential to minimize health inequalities[24]. In terms of oral health, there is thought to be little association between free sugar consumption and the incidence of dental caries, as students weren't asked when they consumed cariogenic foods and whether they practiced oral hygiene after consumption. However, the daily or repeated consumption of free sugars reported by most students may lead to dysbiosis in the oral microbiome[25].

In every age group, daily toothbrushing with fluoride toothpaste is one of the pillars of caries prevention, along with sugar control. In this study, most students reported brushing their teeth at least twice a day with toothbrush and toothpaste. However, 1.7% of adolescents didn't use a toothbrush and had a higher prevalence of dental caries. Toothbrushing at least twice a day is the recommendation for the prevention and control of dental caries[26], and 88.8% of students reported this brushing frequency. This rate is lower than that of Vettore et al. in which 95.2% of students reported brushing their teeth two or more times a day[27]. Inadequate oral hygiene leads to accumulation of dental biofilm, a crucial factor for the development of caries lesions[28].

In this study, schoolchildren with visible plaque had a 46% higher risk of developing dental caries, confirming the evidence linking the disease to poor oral hygiene. Other studies also showed an association between visible biofilm and increased caries risk[29,30]. At the same time, the quality of oral hygiene appears to be more important than its frequency, as most students reported brushing their teeth at least twice a day despite having visible plaque. In this sense, the role of schools in guiding and motivating students to adopt appropriate health behaviors and incorporating them into their routines is highlighted, which can have a positive impact throughout life.

This study has some limitations that need to be considered, such as its cross-sectional design and not recording the time of food intake and oral hygiene. However, it presents research data conducted with the involvement of professionals from the academic (professors and undergraduate dental students) and service (dentists of the municipal Primary Care network calibrated before data collection) fields, which qualifies the research and contributes to professional training. Another important aspect was the evaluation of food frequency before the adaptation of school cafeterias to the Rio Grande do Sul State Law, which prohibits the sale of cariogenic foods in these spaces, allowing a comparison of the impact on food frequency in future studies.

Considering that many surveys[4,20] only examine residents of urban areas, while an estimated 15% of the Brazilian population lives in rural areas, this study contributes by examining students from urban and rural areas.

Conclusion

In addition to caries determining factors, such as the presence of plaque, sugar consumption, and oral hygiene habits, school location, whether urban or rural, has also been associated with the incidence of dental caries among schoolchildren, underscoring the importance of public policies that target contextual factors to minimize oral health disparities. The burden of dental caries remains a global public health challenge, and reforms that target determinants are needed to effectively address the causes of such burden and reduce inequities.

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