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The impact of social determinants on schoolchildren's oral health in Brazil

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Abstract: The aim of this study was to evaluate the impact of socioeconomic status, home environment, and self-perception of health conditions on schoolchildren's dental caries experience. A total of 515 twelve-year-old schoolchildren from Juiz de Fora, State of Minas Gerais, Brazil, were selected into a random multistage sample. The schoolchildren were examined for the presence of caries lesions using the decayed/missing/filled teeth (DMFT) index and categorized as caries-free (DMFT = 0) or with caries experience (DMFT > 0). The participants and their parents were asked to answer a questionnaire about socioeconomic status, home environment, and self-perception of their health conditions. The hierarchical multiple regression model was used to assess the associations, since a binary response variable was assumed. The bivariate analysis revealed that variables at four levels, such as type of school, monthly family income, parents' education, home ownership, number of people living in the household, household overcrowding, parents' perception of their children's oral health, and schoolchildren's self-perception of their oral health ($p < 0.05$), were significantly associated with children's worse dental caries conditions. The regression model results showed that type of school and monthly family income had a strong negative effect on schoolchildren's dental caries experience ($p < 0.05$) in the final statistical model, where all levels were included. It was observed that socioeconomic factors were considered a strong risk indicator of schoolchildren's caries experience among the investigated social determinants of oral health.

Keywords: Social Conditions; Oral Health; Healthcare Disparities; Dental Caries.

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Introduction

Oral health is considered an integral element of overall health and may impact the functional and psychosocial aspects of individuals.[1] Dental caries continues to be one of the most prevalent chronic diseases worldwide, and studies have confirmed the impact of socioeconomic status on the prevalence of this chronic disease. [2,3,4,5,6]

Therefore, studies evaluating the impact of social determinants of health have fundamental importance in helping public health planners to reduce inequalities in the population's oral health.[7,8]

According to the Ottawa Charter for Health Promotion "health is created and lived by people within the settings of their everyday life; where they

learn, work, play and love", which highlights the importance of healthy settings as an infrastructure for health production and maintenance, including schools, worksites, cities, local communities, and hospitals.[9]

In 2004, Christensen[10] proposed a theoretical model of the "health-promoting family" to encourage children's "capacity building for health". It is known that family plays a fundamental role in various aspects of children's development (biological, cultural, social) and is considered an important agent of their socialization. Parents are the most significant health role models, with impact on the oral health values and behavioral routines of their children. Therefore, the family setting is a valuable context for the creation and support of children's oral health.[5, 11]

Children's socioeconomic aspects such as family income, parents' education, and home ownership have a large influence on family function, and Locker [12] suggested the use of socioeconomic status as a control variable to reveal the associations between oral health and other factors. However, few studies have evaluated the integration of socioeconomic status, home environment, and self-perception of health conditions into a more complex model, in order to test the impacts of each one on dental caries in children. Hence, the use of a conceptual model, as proposed by the study of Fisher-Owens *et al.*,[6] may help researchers to consider a more holistic view of children's oral health. This model comprises the influences of "Child-Level", "Family-Level", and "Community-Level" on children's oral health. The child-level comprises health behaviors and practices, physical and gender attributes, biological endowment, *etc*. The Family-Level comprises socioeconomic status, family composition, health behaviors, and family culture, among other aspects. The Community-Level comprises physical environment, dental care system characteristics, social environment, social capital, culture, and physical safety, *etc*.

In addition, the use of conceptual models linked to hierarchical analysis, in order to define which social and environmental variables (proximal and/or distal) are associated with dental diseases, is a new and innovative approach in the literature.[13] Therefore, a more complex investigation, involving a hierarchical model, which includes socioeconomic, family and subjective factors, provides a more accurate evaluation of the joint action of these aspects upon schoolchildren's dental caries experience.

Much has been discussed about conceptual models of health promotion and social determinants, but it is important to combine this knowledge with epidemiological research in order to produce the best evidence so that health managers can develop appropriate oral health promotion interventions for children based on social determinants of health.[8]

Such oral health promotion actions must be planned, based on the complexity of factors that may directly or indirectly influence oral health. Thus, recognition of the impact of proximal and distal determinants allows defining a point of action for health policies, which would lead to greater efficacy in the prevention and control of oral diseases. This refers especially to dental caries, which continues to be a public health problem in Brazil. Furthermore, it is pointed out that public health decisions must be based on the results of investigations; that is, on practical evidence.[1,14]

Therefore, it is necessary to consolidate the existent theoretical and conceptual models, based on epidemiologic studies and statistical analyses that include different aspects, ranging in scope from clinical conditions to social determinants of health.[6]

The aim of this study was to evaluate the impact of social determinants of health on the dental caries experience of Brazilian schoolchildren.

Methodology

The research project was submitted to and approved by the Research Ethics Committee (Protocol 055/2009) of Piracicaba Dental School, University of Campinas - Unicamp. A written consent form was signed by the children or by their parents or guardians.

This cross-sectional study was carried out using a random multistage sample of 515 twelve-year-old schoolchildren from public and private schools. The study was conducted in Juiz de Fora, a town in the State of Minas Gerais, Brazil, with 570,000 inhabitants, among whom 98.91% have access to fluoridated water. The details of the sample and methods of data collection were published in a previous article.[15]

The independent variables used in this study were based on Fisher Owens *et al*.[6] The conceptual

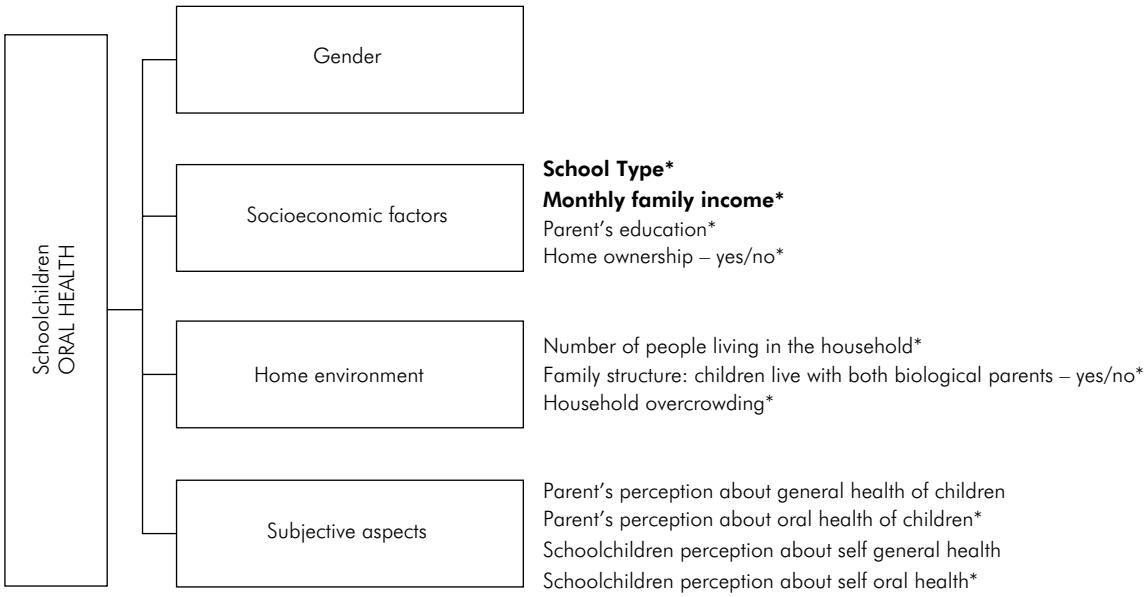
model of dental caries in schoolchildren and the hierarchical theoretical framework that guided the statistical analyses were based on the study of Lacerda *et al.*,[16] shown in Figure. The clinical data were based on the number of decayed, missing, and filled permanent teeth (DMFT index) in accordance with WHO recommendations. Good intra-examiner reproducibility was obtained (kappa > 0.91).

The schoolchildren answered a questionnaire concerning their self-perception of their general and oral health and of their home environment. The children's parents also answered a questionnaire, which contained questions about their children's general and oral health and about the family's socioeconomic status.[15]

The presence or absence of caries (DMFT = 0 or DMFT > 0) was selected as the dependent variable. The categorization of the DMFT index was based on the studies of Cinar *et al.*,[17] Delgado-Angulo *et al.*,[18] and Pereira *et al.*[2] Initially, descriptive and bivariate statistics were performed by the chi-square test, and the odds ratio and the respective confidence interval were estimated.

The hierarchical multiple regression analysis was performed by means of generalized linear mixed models, using the "PROC GLIMMIX" procedure, in order to evaluate the associations of the gender, socioeconomic, family, and perception variables with the DMFT index. Model 1 tested the (gender) variable gender; Model 2 included the socioeconomic variables; Model 3 assessed the family environment variables; and Model 4 analyzed those variables relevant to the perception of oral and general health. In order to select the variables within each block, which would be tested in the following model, a $p < 0.20$ was considered, and an analysis of the association between the independent variables was performed to evaluate multicollinearity. The model fit was assessed by -2 Res Log Likelihood (the lower the value, the better the model fit) and p-value (≤ 0.05).

The PROC GLIMMIX procedure was used because the modeling of oral health data is rather complex, since these data generally do not present a normal distribution. With the development of generalized linear models (an extension of linear models for not normally distributed data), this type



*p < 0.05 in bivariate analyses.
Bold highlighted the significant results in hierarchical multiple regression (p < 0.05).

Figure. Theoretical model adopted in the study.

of problem has been considerably reduced. However, on many practical occasions, binomial data present overdispersion. The application of generalized linear mixed models has been satisfactorily used in these cases. Hence, this statistical procedure (GLIMMIX) may adjust models to not normally distributed data, and this has been satisfactorily used in analyses with hierarchical effects. The analysis was performed using the SAS statistical software program, version 9.3.

Results

Table 1 presents the descriptive data and the bivariate analysis. The DMFT index was 1.09 (standard deviation of 1.70). Furthermore, 315 participants presented DMFT = 0, *i.e.*, 61.2% of them were caries-free and 200 (38.8%) presented DMFT > 0.

Considering the bivariate analysis according to the levels evaluated, the first level (gender) presented no association with worse dental caries experience ($p > 0.05$). At the second level (socioeconomic), all the evaluated variables were significantly associated with children's worse dental caries experience ($p < 0.05$), namely: type of school, monthly family income, parents' education, and home ownership. At the third level (home environment), the number of people living in the household and household overcrowding variables were associated with dental caries experience ($p < 0.05$). At the fourth level (subjective perceptions), parents' perception of their children's oral health and schoolchildren's self-perception of their oral health were significantly associated with children's worse dental caries experience ($p < 0.05$)

The results of the hierarchical multiple regression analysis using generalized linear mixed models with the PROC GLIMMIX procedures are shown in Table 2. In Model 1, the variable gender was associated with dental caries experience. In Model 2, with the inclusion of the socioeconomic level, type of school and monthly family income had a strong negative effect on schoolchildren's dental caries experience, while the variable gender made no contribution in Model 2. In Model 3, home environment was included and the negative effect of school type and monthly family income on schoolchildren's dental caries experience persisted. In Model 4, which included all levels, type of school and monthly family income were the only variables with a strong negative effect on schoolchildren's dental caries experience ($p < 0.05$).

Discussion

Studies assessing factors related to the social determinants of dental caries are considered the mainstream of the public oral health agenda and provide managers, who plan oral health promotion interventions, with very important information.

The analytical model proposed in this study, which incorporates three dimensions (socioeconomic status, home environment, and self-perception), represents an important methodological approach that allows investigating which proximal and distal variables are strong risk indicators of schoolchildren's caries experience.[6,13,14,16] As a result, structural determinants (family income and type of school) had a greater influence on disease prevalence than did individual determinants in this sample of Brazilian children.

In Brazil, dental caries is still considered a public health problem, particularly in some polarized groups living in worse socioeconomic conditions.[2,3,4,19,20] In the most recent national epidemiologic survey conducted in Brazil, in 2010, a DFMT index of 2.1 was observed at the age of 12 years.[20] Therefore, the participants in this study, who are representative of the 12 year-old schoolchildren in Juiz de Fora, presented a better dental caries status (DMFT index of 1.09) compared with that of the national survey. However, even in this sample with low prevalence and severity of the disease, differences in caries prevalence were observed between children living in higher-income and lower-income families.

In the hierarchical multiple regression model, children whose family income was lower than one minimum wage were 1.89 times more likely to have dental caries experience. This association is corroborated by various studies, highlighting that socioeconomic factors are important determinants of oral health inequalities in 12-year-old schoolchildren.[2,18,21] However, the present study innovates by having verified these associations by means of a hierarchical statistical model, including different levels of social determinants of health, and defining the contribution of each of the distal and proximal factors related to caries experience.[6,16]

Table 1. Bivariate analysis of the association of social determinants with caries disease.

Variable	DMFT > 0		DMFT = 0		Bivariate analysis		
	N	%	N	%	OR	95%CI	p-value
Level 1							
Gender							
Male	98	43.5	127	56.5	1.4223	0.9951-2.0327	0.0650
Female	102	35.2	188	64.8	Ref		
Level 2							
Type of school							
Public	171	47.1	192	52.9	3.7775	2.3989-5.9484	< 0.0001
Private	29	19.0	123	81.0	Ref		
Monthly family income*							
≤ 1 minimum wages	63	53.4	55	46.6	2.8636	1.7494-4.6876	< 0.0001
> 1 minimum wages	48	28.5	120	71.5	Ref		
Father's education							
≤ 8 years	60	48.4	64	51.6	2.6786	1.5360-4.6712	0.0007
> 8 years	28	25.9	80	74.1	Ref		
Mother's education							
≤ 8 years	64	45.4	77	54.6	0.5402	0.3322-0.8784	0.0177
> 8 years	98	69.0	44	31.0	Ref		
Home ownership							
No	59	45.4	71	54.6	1.6620	1.0288-2.6848	0.0499
Yes	52	33.3	104	66.7	Ref		
Level 3							
Number of people living in the household							
> 4 people	57	46.4	66	53.6	1.7433	1.0769-2.8219	0.0318
≤ 4 people	54	33.2	109	66.8	Ref		
Children live with both biological parents							
No	83	43.0	110	57.0	1.3221	0.9183-1.9033	0.1583
Yes	117	36.4	205	63.6	Ref		
Household overcrowding							
More than 1 person per room	41	54.0	35	46.0	2.0629	1.2622-3.2715	0.0051
≤ 1 person per room	159	36.2	280	63.8	Ref		
Level 4							
Parents' perception of their children's general health							
fair/poor	12	60.0	8	40.0	2.5303	0.9998-6.4036	0.0753
excellent/very good/ good	99	37.2	167	62.8	Ref		
Parents' perception of their children's oral health							
fair/poor	52	51.0	50	49.0	2.2034	1.3411-3.6202	0.0025
excellent/very good/ good	59	32.0	125	68.0	Ref		
Children's perception of their own general health							
fair/poor	24	42.8	32	57.2	1.2060	0.6877-2.1149	0.6108
excellent/very good/ good	176	38.4	283	61.6	Ref		
Children's perception of their own oral health							
fair/poor	77	46.4	89	53.6	1.5897	1.0916-2.3150	0.0199
excellent/very good/ good	123	35.2	226	64.8	Ref		

DMFT: Decayed, missing, and filled teeth in the permanent dentition; OR: Odds Ratio; CI: Confidence Intervals.
*Minimum wage at the time of data collection, approximately US$290,00.

Table 2. Hierarchical multiple regression models of social determinants associated with dental caries experience.

Variable	Model 1			Model 2			Model 3			Model 4		
	Estimate (EP)	OR	p-value	Estimate (EP)	OR	p-value	Estimate (EP)	OR	p-value	Estimate (EP)	OR	p-value
Level 1												
Gender												
Male	0.3485 (0.1883)	1.42	0.0559	0.3538 (0.2915)	1.42	0.2248	0.3561 (0.2942)	1.43	0.2260	0.3532 (0.2946)	1.42	0.2306
Female	Ref			Ref			Ref			Ref		
Level 2												
Type of school												
Public				0.9016 (0.4500)	2.46	0.0451	0.9746 (0.4797)	2.65	0.0423	0.9217 (0.3528)	2.51	0.0090
Private				Ref			Ref			Ref		
Monthly family income*												
≤ 1 minimum wages				0.7217 (0.3586)	2.06	0.0441	0.7916 (0.3854)	2.21	0.0400	0.6383 (0.2896)	1.89	0.0275
> 1 minimum wages				Ref			Ref			Ref		
Father's education												
≤ 8 years				0.3883 (0.3531)	1.47	0.2714	0.2623 (0.3679)	1.30	0.4779	0.2329 (0.3703)	1.26	0.5170
> 8 years				Ref			Ref			Ref		
Mother's education												
≤ 8 years				-0.3582 (0.3740)	0.70	0.3382	-0.4606	0.63	0.2274	-0.4844 (0.3779)	062	0.1999
> 8 years				Ref			Ref			Ref		
Home ownership												
No				0.2330 (0.3024)	1.26	0.4411	0.1858 (0.3100)	1.20	0.5491	0.1617 (0.3159)	1.18	0.6088
Yes				Ref			Ref			Ref		
Level 3												
Number of people living in the household												
> 4 people							0.1104 (0.3264)	1.12	0.7351	0.1124 (0.3292)	1.12	0.7328
≤ 4 people							Ref			Ref		
Children live with both biological parents												
No							0.6152 (0.3530)	1.85	0.0814	0.6504 (0.3556)	1.92	0.0674
Yes							Ref			Ref		
Household overcrowding												
More than 1 person per room							0.8479 (0.4610)	2.33	0.0659	0.7989 (0.4708)	2.22	0.0897
≤ 1 person per room							Ref			Ref		

Continue

Continuation

Level 4			
Parents' perception of their children's general health			
fair/poor	0.3934 (0.6070)	1.48	0.5169
excellent/very good/ good	Ref		
Parents' perception of their children's oral health			
fair/poor	0.0350 (0.4086)	1.04	0.9318
excellent/very good/ good	Ref		
Children's perception of their own general health			
fair/poor	0.1827 (0.4803)	1.20	0.7036
excellent/very good/ good	Ref		
Children's perception of their own oral health			
fair/poor	0.1804 (0.3684)	1.20	0.6243
excellent/very good/ good	Ref		

DMFT: decayed, missing, and filled teeth in the permanent dentition; OR: Odds Ratio; CI: Confidence Intervals.
*Minimum wage at the time of data collection, approximately US$290,00.

School environment could influence, facilitate, and support healthy choices by providing a physical and mental health setting.[22] Children from public schools had 3.8 more chance of having caries lesions than those from private schools. This association was also found in another study;[23] in addition, Piovesan *et al*.[21] stated that type of school could be used as an alternative indicator of children's socioeconomic status. In the study of Moreira *et al*.,[24] conducted in João Pessoa, in northeastern Brazil, with 12 to 15-year-olds from public and private schools, whose mean DMFT index was 1.91 (SD = 2.51), there was a higher caries prevalence among children from public schools (51.6%). Similarly, in the studies of Antunes *et al*.[25] and Lopes *et al*.,[26] type of school and its location were associated with higher prevalence of the disease in 12-year-old schoolchildren. Thus, it is noted that the results of the present study corroborate the literature findings, in addition to providing innovative information, *i.e*., that type of school continues to be associated with caries experience, even after having been included in the hierarchical model together with other levels of evaluation.

Furthermore, mothers of children from private schools had more years of education and consequently reported more oral health care and regular dental visits of their children in comparison with mothers with lower number years of formal education.[17] Moreover, Benazzi *et al*.[23] evaluated a sample of 724 twelve-year-old schoolchildren from public and private schools in Piracicaba, State of São Paulo, Brazil, and verified significant associations between the presence of caries, monthly family income, and dental visits.

In this sense, this study underscores that home environment is an important social determinant of children's dental caries. According to Shaw,[27] housing affects the health of its residents and represents one of the key social determinants of health, thus highlighting the need of intersectoral interventions to promote environmental changes in order to reduce inequalities in oral health. Antunes *et al*.[3] demonstrated that overcrowding was associated with an increased risk for dental caries because it has an inverse relationship with healthy eating habits and hygiene.

The association of socio-environmental aspects presented in this study showed it is important to recognize these determinants to evaluate caries experience and to plan the prevention and control of the disease within the broad context of oral health promotion.[1,4,7,19]

As dental caries is a significant public health problem, appropriate health promotion policies and actions should be directed to the social, economic, and environmental causes of dental disease at the primary, secondary, and tertiary health care levels using strategies at macro, meso and micro levels.[1,28] In view of the recurrent theoretical discussions about health promotion and social determinants of health, the results of this study provide important data about the contribution of social determinants (such as their different conceptual levels) to dental caries experience, and for the planning of oral health promotion actions in public health.[29,30]

Consequently, oral health promotion policies should include both upstream and downstream levels of intervention, such as policies of income distribution and other tools for eradicating poverty, placing oral health within the primary health care approach, abolishing taxes on oral health products, developing infrastructure for oral health services and population-based interventions, extending oral health care to vulnerable and poor population groups, carrying out intersectoral actions including social participation and empowerment of families and their children, establishing a common approach to risk factors, developing personal skills by means of health education, among others.[28]

Considering the importance of empowerment and knowledge about oral health promotion in the population and among health professionals, it is essential that research be discussed and disseminated, in order to reduce the causes of health inequalities. In particular, health professionals must be prepared to provide subsidies for health promotion in family settings - an essential strategy for promoting oral health among schoolchildren, as demonstrated in this research study. Moreover, the results of this study corroborate the need for multidisciplinary approaches to oral health promotion, as previously discussed in theoretical studies.[7,8,23,26]

Limitations of the study

Notwithstanding the limitations of the present study, the sample was representative of the population assessed. It is a cross-sectional study, and therefore, no causality between dental caries experience and socio-environmental aspects could be considered. Despite the important associations found between home environment and dental caries in this research, it would be interesting to include other individual and community factors, such as health behaviors and dental care system characteristics in future studies in this field of research, according to the conceptual model proposed by Fisher-Owens *et al*.[6]

Conclusion

Among the social determinants of oral health investigated in this study, socioeconomic factors were considered a strong risk indicator of schoolchildren's caries experience.

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