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Community Dental Health

Factors associated with toothache in 12-year-old adolescents in a southeastern state of Brazil

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Abstract: This cross-sectional study evaluated factors associated with toothache in 12-year-old adolescents from the state of Minas Gerais in Brazil. Secondary data were collected from the SB Minas Gerais 2012 epidemiological survey. The dependent variable was toothache in the past 6 months. The independent variables were grouped into two levels: individual (sex, ethnic group, family income, periodontal condition, dental caries, dental treatment needs, and type of service used) and contextual (allocation factor, Human Development Index, Gini coefficient, gross domestic product, unemployment, illiteracy, basic sanitation, garbage collection, family income, half or a quarter of a minimum wage, primary healthcare coverage, primary oral healthcare team coverage, oral health technician, access to individual dental care, and supervised tooth brushing). A multilevel analysis was performed using the Hierarchical Linear and Nonlinear Modeling Software Program to assess the association of individual and contextual variables with toothache in the last 6 months. The prevalence of toothache in the last six months among the adolescents of this study was 19.1%. An association was found with family income ($p < 0.001$), dental caries ($p < 0.001$), primary oral healthcare team coverage ($p = 0.015$) and oral health technician ($p = 0.008$). Socioeconomic conditions and the most prevalent oral diseases, such as dental caries, as well as the use of public services, were related to toothache in adolescents aged 12 years. These findings reinforce the need to develop and implement public policies to address the oral health problems of this population.

Keywords: Toothache; Adolescent; Social Determinants of Health; Multilevel Analysis.

Introduction

Pain is defined as an unpleasant sensory and emotional experience associated with actual or potential tissue damage.[1] Pain can be characterized as acute when it appears suddenly, and disappears when the cause is eliminated. If left untreated, it can become chronic and cease to be felt.[2] Among the different types of pain that affect the population, toothache causes the greatest impact on people's lives. It originates from the teeth and their supporting structures, and can be caused by dental caries, periodontal disease, or dental trauma.[3] Caries is the main cause of toothache,

and also the major reason that public dental care is overburdening the primary healthcare system.[3,4] Depending on the intensity of the toothache, it can impact the daily lives of individuals and interfere with quality of life.[4]

The distribution of oral diseases is associated with unfavorable socioeconomic factors. Toothache affects the poorest and most marginalized groups in society, and is closely linked to socioeconomic status and broader social health determinants.[4-6] Toothache at age 12 has been associated with female adolescents, individuals of black, indigenous or mixed races, smoking/drinking, infrequent tooth brushing, high consumption of sugar, studying in state schools, low-income families, and parents with low educational backgrounds.[3,7,8] The age of 12 marks the transition from childhood to adulthood. This age was chosen for the global monitoring of caries for international comparisons and disease trends.[9] Thus, knowing the factors associated with toothache in this population can help outline strategies for the assessment and planning of health services. A multilevel approach allows factors to be analyzed in a hierarchy of different individual and contextual levels that interact with each other to produce more consistent results that aid in gaining a better understanding of the health-disease process.[7,8,10] For this reason, the objective of this study was to adopt a multilevel approach, using secondary data from a representative sample of the SB Minas Gerais epidemiological survey, to analyze the factors associated with toothache in 12-year-old adolescents from the state of Minas Gerais, Brazil.[9] The hypothesis was that individual and contextual factors are associated with the reports of toothache in 12-year-old individuals.

Methodology

This cross-sectional population-based study used secondary data from the SB Minas Gerais epidemiological survey conducted in 2012,[9] approved by the ethics committee of Pontifícia Universidade Católica de Minas Gerais (CAAE 01107412.4.0000.5137).

Minas Gerais is the second most populous state in Brazil, with an estimated population of 21,168,791 inhabitants.[11] Its total area is distributed into 853 municipalities, and it has great socioeconomic inequality, with a Human Development Index (HDI) ranging from 0.529 to 0.813.[11,12] In the national ranking, Minas Gerais ranks ninth, with an HDI of 0.731, which is close to the Brazilian average of 0.755.[11]

The SB state-based survey was representative of the state of Minas Gerais, and divided the state into three different domains: the state capital and two groups of outlying cities. The selection of individuals was based on a probabilistic sampling process made according to conglomerates, considering the age groups and the allocation factors of the cities. The outlying cities of Minas Gerais were allocated into 4 groups to compose the allocation factor, where Group 1 represented the outlying cites that had the least relative need for financial and health resources (less vulnerable), and Group 4 comprised those with the greatest need (more vulnerable). "Outlying Region I" comprised Groups 1 and 2, and "Outlying Region II" comprised Groups 3 and 4.[9]

The sample size for the capital was established according to the prevalence and severity of dental caries in 2003.[13] The process used to determine the outlying region was the same as that used in the SB Brazil 2010.[14] The sample size was based on the severity of dental caries, estimated by the DMFT index (number of decayed, missing and filled teeth), for Brazil's Southeast.[14] The caries prevalence and the DMFT average for each age group and domain were used as a reference to calculate a sample size associated with a preset margin of error. The coefficient of variation for age 12 was adopted to estimate the prevalence. After determining the minimum number of tests, it was decided that the estimated prevalence (P) should be greater than 10% of this number, and that the standard errors should not exceed 15%. This enabled the number of dental caries to be estimated for each domain of Minas Gerais, considering each age group. The degree of representativeness of other healthcare issues varied according to their estimated prevalence and severity. A sample was calculated according to a confidence level of 95% and power of 80% for the variables used in this study.[9]

Sixty cities from outlying regions of Minas Gerais were drawn, after examining 4,898 people across

the state, from the age groups of 5 and 12 years, as well as the ranges of 15 to 19, 35 to 44 and 65 to 74 years. A questionnaire was applied to the individuals examined, using a digital device for collecting data at home, with questions related to socioeconomic characterization, use of services, dental problems, self-reported oral morbidity, and self-perceived oral health. The questions were directed at all residents of the household. The oral exams were carried out by field teams, composed of a dental surgeon examiner and an annotator. A flat mouth mirror and probe were used to perform the oral examination, under natural light. The examiner and the person being examined were seated in a well-lit and ventilated location. Calibration took place using the "in lux" process with slides,[14] and in blocks of 5 participants at most. In cases where the exam was not specifically visual, such as that of periodontal disease assessed by the Community Periodontal Index and Loss of Periodontal Insertion, a discussion was undertaken of the codes and criteria of the indexes. A minimum agreement of 0.65 was established for the weighted kappa value.

Data from adolescents aged 12 years old (n = 1,217) were collected. This study used Petersen's theoretical framework[5], which proposed a conceptual toothache model, in which the toothache process can be influenced by factors other than just biological aspects. Individual conditions, and aspects of the social structure, health services, and socioeconomic and demographic conditions, also influence the outcome of tooth pain (Figure).

The dependent variable was 'Have you had a toothache in the last six months?" and was dichotomized into yes or no. The independent variables were structured on individual and

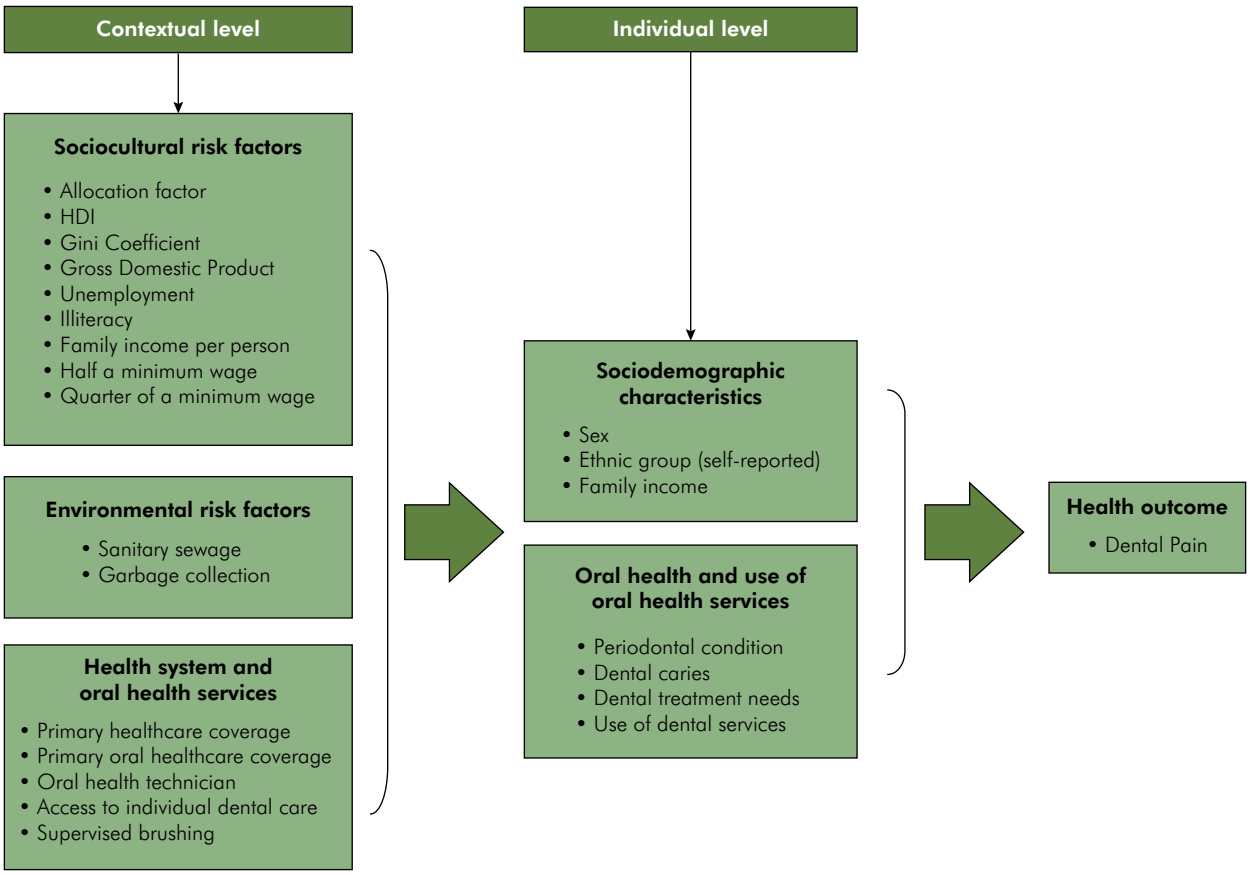

Figure. Conceptual model of risk factors for the toothache outcome. Adapted from Petersen's framework.[5]

contextual levels. The variables for the individual level were gathered from the SB Minas Gerais survey.[9] The variables for the contextual level were collected from the database of the National Information System of Brazil's Ministry of Health of Brazil (DATASUS),[15] IBGE,[11] and PNUD[12] (Table 1).

Table 1. Description of variables according to the levels analyzed - SB Minas Gerais Survey, Brazil, 2012

Level	Variable	Category
Individual level	Sex	Female
		Male
	Ethnic group (self-reported)	White
		Non-white
	Family income	More than 1500 BRL*
		Up to 1500 BRL*
	Periodontal condition	Healthy
		Bleeding or calculus
	Dental caries	No
		Yes
	Dental treatment needs	No
		Yes
	Type of service used	Other (private, insurance)
		Public service
Contextual level	Allocation factor	Outlying Region I
		Outlying Region II
		Capital
	HDI	Human Development Index
	Gini Coefficient	Income or wealth distribution
	Gross Domestic Product	Economic indicator of all goods and services produced by region, at a specific time period
	Unemployment	Percentage (%) of working-age residents who are not employed
	Illiteracy	Percentage (%) of residents who cannot read or write
	Family income per person	Average per capita family income by municipality
	Half a minimum wage	Percentage (%) of residents with monthly per capita revenues of up to half a minimum wage
	Quarter of a minimum wage	Percentage (%) of residents with monthly per capita revenues of up to a quarter of a minimum wage
	Sanitary sewage	Percentage (%) of residents with access to drinking water, sewage collection and treatment
	Garbage collection	Percentage of residents with access to garbage collection system
	Primary healthcare coverage	Percentage (%) of the population covered by primary healthcare teams
	Primary oral healthcare coverage	Percentage (%) of the population covered by a primary oral healthcare team
	Oral health technician	Percentage (%) of oral health teams with technical training in oral healthcare, and belonging to type II
	Access to individual dental care (admittance to the scheduled treatment program)	Percentage (%) of residents scheduled to have their first dental visit, designed to diagnose and develop a preventive / therapeutic plan to meet detected needs
	Supervised tooth brushing	Percentage (%) of the population who receive inspected brushing instruction through collective actions

*1 BRL = 0.5 USD (July 2012)

A descriptive analysis was performed using the IBM SPSS (Statistical Package for the Social Sciences) version 22.0. A multilevel analysis[10] was conducted using Hierarchical Linear and Nonlinear Modeling Software (HLM 6.08 statistical package) to assess the association of contextual and individual toothache-related variables in the last 6 months. The analyses involved 1,002 individuals (level 1) from 55 municipalities (level 2), and the nonlinear logit link function, which used the fixed effects/random intercept setup. Parameters were estimated using the restricted maximum likelihood method, and predictive quasi-likelihood estimation. A multilevel logistic regression model was constructed. In the first stage, a null model estimated the basic partition of data variability between the two levels, after which the individual and contextual characteristics were applied. The variance partition coefficient (VPC) was calculated to determine how much variance in the response variable stems from the between-group differences, and how much from the within-group differences. Initially, level 1 variables were incorporated into the model individually, before being tested together ($p < 0.05$). Afterwards, the contextual variables (level 2) were tested by incorporating them one by one, using the Student's t-test ($p < 0.05$). The multilevel model was constructed with the variables that achieved a $p < 0.25$. The odds ratio (OR), and the 95% confidence intervals (95%CI) were estimated in each analysis, taking into account the complex sample design. The reliability estimate was used to determine the adequacy of the final multilevel model. The final model included only variables with a p-value < 0.05.

Results

One adolescent was excluded from the sample for not meeting the dependent variable criteria, leaving 1216 adolescents in the survey. The prevalence of toothache in the last six months among the adolescents was 19.1% (95%CI: 16.2–22.4). The descriptive analysis of individual and contextual variables is shown in Table 2 and 3, respectively. The results of the variation component indicate that the toothache frequency is different between municipalities ($p < 0.001$) (Table 4). The VPC values show that 16.2% of the change in the response variable was due to differences between groups (from the contextual level).

The adjusted analysis showed an association with family income and dental caries experience. Adolescents with a family income of up to 1500 BRL had more than twice the chance of toothache (OR 2.30; 95%CI 1.50–3.54; $p < 0.001$), and the presence of dental caries increased the chance of toothache more than threefold (OR 3.35; 95%CI 2.18–5.15; $p < 0.001$). The coverage by the oral health team (OR 1.01; 95%CI 1.00–1.02; $p = 0.015$) and oral health technician (OR 1.01; 95%CI 1.00–1.02; $p = 0.008$) increased the chances of toothache by one point (Table 5).

Discussion

The study showed an association of toothache with low family income, dental caries, primary care coverage of the oral health team, and the oral health technician, over the past 6 months, in 12-year-old adolescents in the state of Minas Gerais. The prevalence of reported toothache was below the average for the southeastern region of Brazil, where the state of Minas is located (23.7%), and for the national average (24.6%).[14] It was also lower than the rate found in national[1,7,8] and international studies.[16-18] Studies that evaluated toothache in adolescents of this age group found prevalence rates that ranged between 11.9%[19] and 78%.[17] The high prevalence of toothache has been attributed to the low level of education and of family income of the mother,[8] low oral health conditions, low level of oral hygiene,[18] excessive sugar consumption,[16] difficulty accessing the dentist,[17,18,20] and few preventive actions by health services.[1] In studies that consider the prevalence of pain as satisfactory, factors such as higher HDI,[1,7] sugar consumption reduction, and implementation of public health programs for the effective use of fluoride[19] were pointed out as possible reasons.

Poorer people are more likely to adopt unhealthy habits, consume industrialized products with a high sugar index[4], face money-related difficulties in accessing health services,[20] and have inadequate oral hygiene habits that promote the inception of caries[6,18].

Table 2. Descriptive analysis of individual variables of adolescents (12 years old) from a southeastern state of Brazil, 2012

Variable	N	% (95%CI)*
Dependent		
Toothache in the past 6 months		
No	973	80.9 (77.6-83.8))
Yes	243	19.1 (16.2-22.4)
Independent (individual level)		
Sex		
Male	586	46.8 (43.4-50.2)
Female	630	53.2 (49.8-56.6)
Ethnic group (self-reported)		
White	486	39.2 (34.9-43.7)
Non-white	730	60.8 (56.3-65.1)
Family income		
Up to 1500 BRL**	827	63.7 (58.8-68.4)
More than 1500 BRL**	338	36.3 (31.6-41.2)
Dental caries		
No	737	63.1 (59.1-67.0)
Yes	479	36.9 (33.0-40.9)
Periodontal condition		
Healthy	849	69.7(64.4-74.5)
Bleeding or calculus	367	30.3 (25.5-35.6)
Treatment needs		
No	8	0.4 (0.2-1.1)
Yes	1208	99.6 (98.9-99.8)
Place of treatment of the last visit		
Other (private, insurance)	473	47.8 (42.5-53.1)
Public service	580	52.2 (46.9-57.5)

*sample design taken into account
**1 BRL = 0.5 USD (July 2012)

Other studies found an association between dental caries and toothache at age 12.[1,4,16-19] Untreated tooth decay progresses to inflammation of the pulp and causes pain. Toothache has a negative impact on the quality of life of adolescents, leading to impaired eating habits, inability to sleep, mood swings, absenteeism, and poor school performance.[1,4-6,18]

The Family Health Program, later called the Family Health Strategy (FHS), reorganized the national health services that focused on promoting health[21,22]. The FHS is formed by a multidisciplinary team, but its Oral Health Teams (OHTs) were added only in 2000.[22-25] This called for new guidelines for dental practices focusing on oral health promotion and preventive actions.[26]

Although the association of OHT coverage with toothaches may seem contradictory, it can be explained by the principle of equity in the Brazilian Unified Health System. The most vulnerable municipalities are also those with the greatest OHT coverage, and the population who lives there is more prone to toothache.[27] Often, the only way for the poorest population to obtain dental assistance is through public services. Although covered by OHT, they rarely seek public services for preventive consultations. They limit themselves to seeking public dental

Table 3. Descriptive analysis of contextual variables from municipalities in a southeastern state of Brazil, 2012

Variable	Mean	Standard deviation	P25%	P50%	P75%
Allocation factor	1.416	0.203	1.237	1.402	1.594
HDI	0.693	0.616	0.640	0.697	0.751
Gini Coefficient	0.499	0.468	0.473	0.495	0.525
Gross Domestic Product*	17600.8	12925.3	7131.7	13746,2	24215.7
Unemployment**	6.357	2.688	4.435	6.700	7.930
Illiteracy**	11.674	7.890	5.250	9.100	16.850
Family income per person*	563.287	241.543	350.040	551.230	723.130
Half a minimum wage**	38.922	17.459	21.985	35.780	55.210
Quarter of a minimum wage**	15.613	10.625	6.050	12.540	22.900
Sanitary sewage**	59.601	29.306	41.481	70.836	78.624
Garbage collection**	78.624	18.004	63.958	84.563	93.836
Primary healthcare coverage**	66,620	33,349	35.900	73.370	100.000
Primary oral healthcare coverage **	50,259	39.312	12.825	46.890	94.925
Oral health technician**	25.618	35.795	0.000	0.000	43.155
Access to individual dental care**	10.804	9.401	4.070	7.190	16.425
Supervised tooth brushing**	3.536	3.829	0.660	1.820	5.830

*1 BRL = 0.5 USD (July 2012)
**Percentage (%)

Table 4. Final estimation of variance components in the multilevel analysis (null-model; random effect).

Random effect	Standard deviation	Variance component	df	Chi-square	p-value
Intercept, U0	0.79887	0.63820	54	131.51612	< 0.001

services solely to remedy pain or discomfort, thus resorting to an immediate solution versus preferring preventive action.[18,20,24]

The expansion of OHTs in Brazil has contributed to increasing the use and access to dental services,[27] but there has been a drop in the use of dental services by young Brazilians.[20,25] The poor oral health conditions of low-income adolescents have been related to the fear of dentists.[20] In addition, adolescents often miss their dental appointments, because they must be accompanied by a responsible party, who is often too busy with other priorities.[28] Strategies are needed to expand access to oral health services for adolescents[8,20]. An interdisciplinary work process involving health teams and schools, health promotion actions and an active search for target adolescents is important.[20] Improving the health conditions of individuals goes beyond the issue of availability of services; what is needed most is guidance and the population's awareness of oral healthcare.

An OHT composed of a dental surgeon and an oral health assistant is classified as a type I team. Inclusion of an oral health technician classifies the team as type II, and enhances the team's contribution toward expanding the population's oral healthcare.[29,30] The association between oral health technicians and toothaches can be explained by the recent insertion of this team member in the OHT. There has been an increase in the number of type II teams since 2004, motivated by the National Oral Health Policy,[26,30] associated with an expansion in the OHT/FHS coverage of the population, and improvement in OHT productivity.[25,30] More important than the number of professionals is their work model, and the context in which the work takes place. It is

Table 5. Multilevel models (unadjusted and adjusted) for variables of individual (n =1,002) and contextual levels associated with the toothache of adolescents (12 years old), taken from a southeastern state of Brazil, 2012

Variable	Toothache (%)	Unadjusted OR*	95%CI	p-value	Adjusted OR*	95%CI	p-value	Reliability estimate
Individual level								0.515
Sex								
Female	22.4	1.00						
Male	16.2	0.63	(0.37-1.05)	0.076				
Ethnic group (self-reported)								
White	14.3	1.00						
Non-white	22.2	2.08	(1.36-3.18)	0.001				
Family income								
More than 1500 BRL	11.6	1.00			1.00			
Up to 1500 BRL	23.3	2.62	(1.67-4.11)	<0.001	2.30	(1.50-3.54)	<0.001	
Periodontal condition								
Healthy	14.7	1.00						
Bleeding or calculus	29.3	1.79	(1.02-3.14)	0.042				
Dental caries								
No	12.4	1.00			1.00			
Yes	30.7	3.69	2.50-5.45	<0.001	3.35	2.18-5.15	<0.001	
Treatment needs								
No	12.4	1.00						
Yes	30.7	2.16	0.29-16.10	0.451				
Place of treatment of last visit								
Other (private, insurance)	14.1	1.00						
Public services	21.9	2.16	1.17-2.26	0.005				
Contextual level								
Allocation factor		3.45	0.97-12.34	0.056				
HDI		0.01	0.01-1.59	0.074				
Gini coefficient		0.01	0.00-10.65	0.189				
Gross domestic product		1.00	1.00-1.00	0.453				
Unemployment		1.01	0.89-1.14	0.903				
Illiteracy		1.03	0.99-1.07	0.164				
Family income per person		1.00	1.00-1.00	0.099				
Half a minimum wage		1.01	0.99-1.03	0.179				
Quarter of a minimum wage		1.02	0.99-1.05	0.131				
Sanitary sewage		0.99	0.98-1.00	0.172				
Garbage collection		0.99	0.97-1.02	0.547				
Primary healthcare coverage		1.01	1.00-1.02	0.172				
Primary oral healthcare coverage		1.01	1.00-1.02	0.012	1.01	1.00-1.02	0.015	
Oral health technician		1.01	1.00-1.02	0.004	1.01	1.00-1.02	0.008	
Access to individual dental care		0.99	0.95-1.03	0.279				
Supervised tooth brushing		0.95	0.86-1.04	0.568				

essential to raise awareness among local managers toward the importance of this human resource to oral health.

The associations between oral health coverage and the inclusion of a technician highlight an interaction influenced by the polarization of caries disease, where many cases coalesce into a group of the most vulnerable individuals. The expansion of the FHS and the OHT made dental care access more equitable. However, there are low-income young people who have never used these services. Social inequalities can be so strong that even when people have access to a public and universal oral health system, their social differences are not eliminated.[31]

The demand for dental treatment in vulnerable regions is so significant that the increase in the number of dental surgeons in public services in Brazil has not been enough to reduce the inequities in the use of dental services.[32] Healthcare actions seem to be focused on disease and not health promotion.[33] Strategies are needed to address the social determinants of health, and promote an approach to reduce common risk factors for developing oral diseases.[31-33]

The present study has strengths, but also limitations. A multilevel analysis was performed, and both individual and contextual factors were adjusted to avoid the interaction of these factors and confusion. This study used a representative sample of 12-year-old adolescents, hence eliminating possible selection bias and loss of representativeness, and favored testing power and external validity. However, secondary data can contain information bias, and there was no way to determine cause and effect.

Conclusion

Toothache in 12-year-old adolescents was associated with low family income, dental caries, primary care coverage of the oral health team, and the presence/inclusion of an oral health technician in the OHT. Public policies to address the oral health problems of this population are important.

References

1. Guskuma RC, Lages VA, Hafner MB, Rando-Meirelles MP, Cypriano S, Sousa MD, et al. Factors associated with the prevalence and intensity of toothache in children in the municipalities of the Campinas region, São Paulo. Rev Paul Pediatr. 2017 Jul-Sep;35(3):322-30. https://doi.org/10.1590/1984-0462/;2017;35;3;00001
2. Swieboda P, Filip R, Prystupa A, Drozd M. Assessment of pain: types, mechanism and treatment. Ann Agric Environ Med. 2013;1(Spec no):2-7.
3. Freire MC, Leles CR, Sardinha LM, Paludetto Junior M, Malta DC, Peres MA. [Dental pain and associated factors in Brazilian adolescents: the National School-Based Health Survey (PeNSE), Brazil, 2009]. Cad Saude Publica. 2012;28 Suppl:s133-45. https://doi.org/10.1590/S0102-311X2012001300014
4. Peres MA, Macpherson LMD, Weyant RJ, Daly B, Venturelli R, Mathur MR, et al. Oral diseases: a global public health challenge. Lancet. 2019; 20;394(10194):249-260. https://doi.org/10.1016/S0140-6736(19)31146-8
5. Petersen PE. Sociobehavioural risk factors in dental caries: international perspectives. Community Dent Oral Epidemiol. 2005 Aug;33(4):274-9. https://doi.org/10.1111/j.1600-0528.2005.00235.x
6. Bastos TF, Medina LP, Sousa NF, Lima MG, Malta DC, Barros MB. Income inequalities in oral health and access to dental services in the Brazilian population: National Health Survey, 2013. Rev Bras Epidemiol. 2019 Oct;7(22 Suppl 02):E190015. https://doi.org/10.1590/1980-549720190015.supl.2
7. Peres MA, Peres KG, Frias AC, Antunes JL. Contextual and individual assessment of dental pain period prevalence in adolescents: a multilevel approach. BMC Oral Health. 2010 Aug;10(10):20. https://doi.org/10.1186/1472-6831-10-20
8. Freire MC, Nery NG, Jordão LM, Abreu MH. Individual and contextual determinants of dental pain in adolescents: evidence from a national survey. Oral Dis. 2019 Jul;25(5):1384-93. https://doi.org/10.1111/odi.13100
9. Minas Gerais. Secretaria de Estado da Saúde. SB Minas Gerais: pesquisa das condições de saúde bucal da população mineira: resultados principais. Belo Horizonte: Secretaria de Estado da Saúde; 2013. [cited 2020 Apr 9]. Available from: https://www.saude.mg.gov.br/images/documentos/SBMinas_Relatorio_Final.pdf
10. Snidjers TA, Bosker RJ. Multilevel analyses: An introduction to basic and advanced multilevel modeling. 2nd ed. London: Sage; 2012.

11. Instituto Brasileiro de Geografia e Estatística. Minas Gerais: índice de desenvolvimento humano. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística; 2019 [cited 2019 oct 10]. Available from: https://cidades.ibge.gov.br/brasil/mg/pesquisa/37/ 0?tipo=ranking
12. PNUD Brasil. Índice de Desenvolvimento Humano. IDHM Municípios 2010. 2021 [cited 2021 Feb 7]. Available from: https://www.br.undp.org/content/brazil/pt/home/idh0/rankings/idhm-municipios-2010.html
13. Ministério da Saúde (BR). Secretaria de Atenção à Saúde. Projeto SB Brasil 2003: condições de saúde bucal da população brasileira 2002-2003: resultados principais. Brasília, DF: Ministério da Saúde; 2004 [cited 2019 Sep 4]. Available from: http://bvsms.saude.gov.br/bvs/publicacoes/condicoes_saude_bucal.pdf
14. Ministério da Saúde (BR). Secretaria de Atenção à Saúde. SB BRASIL 2010: Pesquisa nacional de saúde bucal: resultados principais. Brasilia, DF: Ministério da Saúde; 2012 [cited 2019 Sep 4]. Available from: http://bvsms.saude.gov.br/bvs/publicacoes/pesquisa_nacional_saude_bucal.pdf
15. Ministério da Saúde (BR). DATASUS. Tabnet. Brasília, DF: Ministério da Saúde; 2019 [cited 2019 Sep 4]. Available from: https://datasus.saude.gov.br/informacoes-de-saude-tabnet/
16. Kumar S, Tadakamadla J, Duraiswamy P, Kulkarni S. Dental caries and its socio-behavioral predictors: an exploratory cross-sectional study. J Clin Pediatr Dent. 2016;40(3):186-92. https://doi.org/10.17796/1053-4628-40.3.186
17. Andegiorgish AK, Weldemariam BW, Kifle MM, Mebrahtu FG, Zewde HK, Tewelde MG, et al. Prevalence of dental caries and associated factors among 12 years old students in Eritrea. BMC Oral Health. 2017 Dec;17(1):169. https://doi.org/10.1186/s12903-017-0465-3
18. Escoffié-Ramirez M, Ávila-Burgos L, Baena-Santillan ES, Aguilar-Ayala F, Lara-Carrillo E, Minaya-Sánchez M, et al. Factors associated with toothache in Mexican schoolchildren aged 6 to 12 years. BioMed Res Int. 2017;2017:7431301. https://doi.org/10.1155/2017/7431301
19. Szöke J, Petersen PE. Changing levels of dental caries over 30 years among children in a country of central and eastern Europe: the case of Hungary. Oral Health Prev Dent. 2020;18(1):177-83. https://doi.org/10.3290/j.ohpd.a44322
20. Massoni AC, Porto E, Ferreira LR, Silva HP, Gomes MD, Perazzo MF, et al. Access to oral healthcare services of adolescents of a large-size municipality in northeastern Brazil. Braz. Oral Res. 2020; 27;34: e029. https://doi.org/10.1590/1807-3107bor-2020.vol34.0029
21. Pinto LF, Giovanella L. The Family Health Strategy: expanding access and reducinghospitalizations due to ambulatory care sensitive conditions (ACSC). Cien Saúde Colet. 2018 Jun;23(6):1903-14. https://doi.org/10.1590/1413-81232018236.05592018
22. Arantes LJ, Shimizu HE, Merchán-Hamann E. The benefits and challenges of the Family Health Strategy in Brazilian Primary Health care: a literature review. Cien Saúde Colet. 2016 May;21(5):1499-510. https://doi.org/10.1590/1413-81232015215.19602015
23. Scherer CI, Scherer MD. Advances and challenges in oral health after a decade of the "Smiling Brazil" Program. Rev Saúde Pública. 2015;49(0):98. https://doi.org/10.1590/S0034-8910.2015049005961
24. Costa RC, Ribeiro IL, Rodrigues LV. [Brazilian oral health coverage characteristics and the populational access to public]. REFACS. 2018;6(2):212-219. https://doi.org/10.18554/refacs.v6i2.2818
25. Corrêa GT, Celeste RK. [Association between coverage by oral health teams in the family health and the increase in dental care output in Brazilian municipalities, 1999 and 2011]. Cad Saúde Pública. 2015 Dec;31(12):2588-98. Portuguese. https://doi.org/10.1590/0102-311X00000915
26. Pucca Junior GA, Lucena EH, Cawahisa PT. Financing national policy on oral health in Brazil in the context of the Unified Health System. Braz Oral Res. 2010;24 (Suppl 1):26-32. https://doi.org/10.1590/S1806-83242010000500005
27. Andrade MV, Noronha K, Barbosa AC, Rocha TA, Silva NC, Calazans JA, et al. [Equity in coverage by the Family Health Strategy in Minas Gerais State, Brazil]. Cad Saúde Pública. 2015 Jun;31(6):1175-87. Portuguese. https://doi.org/10.1590/0102-311X00130414
28. Melo VB, Braga CC, Forte FS. [Accessibility to the oral health service in primary care: unveiling absenteeism in a family health unit in João Pessoa-PB]. Rev Bras Cienc Saúde (Porto Alegre). 2011;5(3):309-18. Portuguese. https://doi.org/10.4034/RBCS.2011.15.03.06
29. Sanglard-Oliveira CA, Werneck MA, Lucas SD, Abreu MH. [Responsibilities of oral health technician in the family health strategy in Minas Gerais, Brazil]. Cien Saúde Colet. 2013 Aug;18(8):2453-60. Portuguese. https://doi.org/10.1590/S1413-81232013000800030
30. Cruz AC, Lucas SD, Zina LG, Pinto RD, Senna MI. Factors associated with the inclusion of oral health technicians into the public health service in Brazil. Hum Resour Health. 2019 May;17(1):35. https://doi.org/10.1186/s12960-019-0371-7
31. Narvai PC, Frazão P, Roncalli AG, Antunes JL. [Dental caries in Brazil: decline, polarization, inequality and social exclusion]. Rev Panam Salud Publica. 2006 Jun;19(6):385-93. https://doi.org/10.1590/S1020-49892006000600004
32. Ely HC, Abegg C, Celeste RK, Pattussi MP. [Impact of oral health teams of the Family Health Strategy on the oral health of adolescents in the south of Brazil]. Cien Saúde Colet. 2016 May;21(5):1607-16. Portuguese. https://doi.org/10.1590/1413-81232015215.07822015
33. Lourenço EC, Silva AC, Meneghin MC, Pereira AC. [The insertion of oral health services in the Family Health Program at Minas Gerais State, Brazil]. Cienc Saúde Colet 2009;14(Suppl 1):1367-7. Portuguese. https://doi.org/10.1590/S1413-81232009000800009