Article:

Tomazoni, F., Vettore, M.V., Zanatta, F.B. et al. (3 more authors) (2016) The associations of socioeconomic status and social capital with gingival bleeding among schoolchildren. Journal of Public Health Dentistry. ISSN 0022-4006

https://doi.org/10.1111/jphd.12166

Title Page

The associations of socioeconomic status and social capital with gingival bleeding among schoolchildren

Fernanda Tomazoni[1]
Mario Vianna Vettore[2]
Fabricio Batistin Zanatta[1]
Simone Tuchtenhagen[3]
Carlos Heitor Cunha Moreira[1]
Thiago Machado Ardenghi[1]

1 Department of Stomatology, Federal University of Santa Maria, Santa Maria, Rio Grande do Sul, Brazil
2 Unit of Dental Public Health, School of Clinical Dentistry, University of Sheffield, Sheffield, UK
3 Department of Epidemiology, School of Public Health, University of Sao Paulo, Sao Paulo, Sao Paulo, Brazil

Abstract Page

The associations of socioeconomic status and social capital with gingival bleeding among schoolchildren

Abstract

Objective: The aim of this study was to assess the associations of gingival bleeding with individual and community social variables among schoolchildren.

Methods: This cross-sectional study evaluated a representative, multistage, random sample of 1134 12-year-old schoolchildren from Santa Maria, a city in southern Brazil. The participants were examined clinically, and full-mouth gingival bleeding was recorded according to the Community Periodontal Index criteria (scored as healthy or bleeding). The children's parents or guardians answered questions regarding their socioeconomic status and social capital, and an assessment of the associations was performed using multilevel Poisson regression models.

Results: The prevalence of gingival bleeding was 96.21%. The multilevel adjusted assessment revealed that socioeconomic, clinical, and social capital variables at the individual level were associated with higher levels of gingival bleeding. Children whose fathers had a low educational level, children who had dental plaque and dental crowding, and children who never/almost never attended religious meetings exhibited significantly higher levels of gingival bleeding than their counterparts. This social gradient remained significant even after adjusting for contextual-level covariates.

Conclusion: The results indicate that the socioeconomic status and features of social capital are associated with the levels of gingival bleeding among schoolchildren.

Key words: epidemiology, gingivitis, oral health, socioeconomic factors

Background

Gingivitis is a periodontal condition that is prevalent among children and adolescents, especially among socially disadvantaged populations (1, 2). Gingivitis is a local response to supragingival dental plaque that forms because of poor personal oral hygiene. In Brazil, data from the latest national oral health survey indicate that at least 27.1% of 12-year-old children had gingival bleeding, whereas 24% of these children had dental calculus (3). Gingivitis can contribute to the development of a wide range of clinical signs and symptoms in the periodontal tissues, including bleeding, bad breath, and gingival enlargement (4). In addition, severe periodontal diseases and high levels of gingivitis have been associated with worse oral health-related quality of life; moreover, signs of gingivitis might affect individual perception of oral health needs (5, 6).

Traditionally, studies addressing the possible determinants of gingivitis have focused on its biological risk factors, such as the biological interaction of dental plaque with local and host response factors (7). However, these biological factors may be influenced by the host's environmental and psychosocial conditions (8). Previous studies also reported a social gradient for the incidence of gingival (2, 9-12) and periodontal diseases among children and adolescents (7), with lower socioeconomic status being associated with increased disease severity.

Socioeconomic factors influence health outcomes across different groups, and they are also known to interact with other social characteristics (13). Recent studies also showed considerable attention on the concept of social capital and its potential application in health policy (14, 15). Social capital has been defined as the features of social organization, such as civic participation, norms of reciprocity, and trust in others, which indicate a willingness to cooperate for mutual benefit (16-18). Social capital resides in social structures such as communities or workplaces, being a resource that individuals access through their social networks. In this context, it has also been described as an attribute of individuals through the concepts of social support and social networks (15, 19), which involve features of social organization, helping participants to act together more effectively to trace shared objectives and mutual benefits (14).

The potential influence of social capital on oral health has been highlighted by a growing international literature. In adult populations, the association between social capital and oral health has been assessed by some studies, which reported social capital was associated with number of remaining teeth, edentulism, dental visits, and denture status (15, 20, 21), dental caries (14), self-rated oral health (22, 23), oral health-related quality of life (11), periodontal disease (24, 25), and dental pain (26). Features of religiosity, which is considered a type of social network linked by the reciprocal exchange of social support among members, have also been assessed as individual attributes that can affect oral health through the psychosocial and behavioral pathways (27, 28). Recent studies additionally reported that religiosity had a protective effect against periodontitis in the Jewish population of Jerusalem (28), indicating that the potential effects of sociopsychological factors on the etiology and management of periodontal diseases must be considered in future analyses. Nevertheless, there is limited and inconsistent evidence on the association between individual level measures of social capital and oral health among children and adolescents.

Moreover, it has been recognized that contextual socioenvironmental conditions can also influence the individual determinants and proximal causes of oral health problems (29). For instance, when assessing individual outcomes in schoolchildren, it is important to consider that there is variability among children from the same school, as well as interschool variability. Both of these sources of variability may affect a study’s conclusions if they are not correctly considered (30). In epidemiological studies, the possible effects of individual and contextual social capital on individuals' health have been evaluated via multilevel modeling approaches (15, 31). However, to the best of our knowledge, no studies have used multilevel analysis to evaluate the associations of adverse gingival conditions with socioeconomic factors, social capital, and contextual variables among schoolchildren.

Considering the lack of evidence using multilevel analysis to assess social determinants of gingival conditions in children and adolescents, this study aimed to assess the association of gingival bleeding with individual and community social variables among 12-year-old Brazilian schoolchildren. Enhancing our knowledge regarding the effects of social conditions on gingival disease would highlight the importance of upstream public health policies that aim to reduce broad social inequalities, thereby promoting gingival health.

Methods

Sample

We conducted a cross-sectional study of a representative sample of 12-year-old schoolchildren from Santa Maria, a city in southern Brazil. Santa Maria has an estimated population of 261,031, which includes 3817 12-year-old children. The sample size calculation was performed in consideration of the following parameters: prevalence of gingival bleeding in the exposed and unexposed groups of 27.81 and 18.99% (11), respectively, a ratio of exposed:unexposed of 1:1, a 95% confidence interval (CI), and a desired statistical power of 80%. We also increased the required sample size by 30% to account for persons who refused to participate. Based on these parameters, the minimum sample size was set at 1007 subjects.

A two-stage sampling procedure was adopted. The primary sampling units were all 39 public schools in Santa Maria (24). As the schools had different numbers of students, an equal probability selection method (probability proportional to the school size) was used to provide a representative sample from all schools (n = 20) (24). The secondary sampling units were all 12-year-old children who were enrolled in the 20 selected schools.

Data collection

Data were collected from dental examination records and structured interviews. Children were examined in their schools by four researchers (FT, GNR, JPF, and ST). These researchers were trained to assess gingival bleeding, dental plaque, and calculus. The data were also calibrated for the assessment of dental caries, dental trauma, and occlusal disorders (32). The training and calibration process lasted for 36 h. The process included theoretical activities with discussion regarding the diagnostic criteria for all conditions and the examination of 20 children. A benchmark dental examiner conducted the complete process (Marcos Britto Correa PhD).

For our examinations, we used the standardized international criteria provided by the World Health Organization (WHO) for oral health surveys (32). Children were examined in a room with natural light using periodontal probes (Community Periodontal Index [CPI]; “ball point”) and dental mirrors. Gingival bleeding was assessed according to the CPI criteria (32) and was scored as 0 (healthy) or 1 (bleeding). All six gingival sites were examined, and per-tooth scores were recorded. As recommended by the WHO, periodontal pockets were not recorded, as the survey population was younger than 15 years old (32). Various clinical conditions were also assessed, such as the prevalence of untreated caries (corresponding to a non-zero decay component in the decay, missing, and filled teeth index), dental plaque (Visible Plaque

Index), calculus (according to the CPI criteria), and dental crowding (according to the Dental Aesthetic Index criteria).

Socioeconomic and demographic characteristics were collected using a self-administered questionnaire that was given to the children's parents and guardians. The questionnaire evaluated information regarding gender, race (white or non-white), the parents' educational level, household income, household overcrowding, the parent's perception of the child's oral health, and religiosity. Race was classified according to the criteria established by the agency for demographic analysis, the Brazilian Institute of Geography and Statistics (33). According to these criteria, children were classified as "non-white" (black children of African and mixed descent) and "white" (children of European descendent). The parent's educational level was classified as the completion or failure to complete 8 years of formal instruction (i.e., primary school in Brazil). Monthly household income was measured in terms of the Brazilian minimum wage, which is standard for this type of assessment, and was dichotomized by the median income (approximately $450 USD at the time of the survey). Household overcrowding was assessed by calculating the ratio between the number of rooms in the home and the number of household residents. Data regarding the parents' perceptions of their children's oral health were measured using the following question: "Would you say that your child's oral health is: 1 – excellent, 2 – very good, 3 – good, 4 – fair, or 5 – poor?" Responses were categorized as excellent/good (codes 1, 2, and 3) or fair/poor (codes 4 and 5) oral health. Religious social networks were assessed according to the frequency of attending a church service by using the following question: "How often do you go to a church, temple, or another religious meeting?" The options for the answer were as follows: "a) More than once a week, b) Once a week, c) twice or three times a month, d) Sometimes a year, e) Once a year or less, f) Never." Responses were categorized as often (codes a, b, and c) or never/almost never (codes d, e, and f). The feasibility of the socioeconomic questionnaire was assessed before the study using a sample of 20 parents who were not included in the final analysis.

Contextual socioeconomic data for the children's schools were collected to assess the relationship between environmental characteristics and gingival condition. The related variables were obtained from official municipality publications, and they included the mean income of the neighborhood in which the school was located (dichotomized by the median) and the Basic School's Development Index (IDEB) of the school (dichotomized by the mean value of 5.1). The latter index has been used by the Brazilian government to rank public schools according to the quality of education they provide, and these data were obtained from the city of Santa Maria's official publications.

The study protocol was reviewed and approved by the Committee of Ethics in Research of the Federal University of Santa Maria. All children consented to participate, and their parents or guardians signed an informed consent form.

Data analysis

Data analysis was performed using STATA 12.0 software. Descriptive statistics were used to describe the demographic, clinical, and socioeconomic characteristics of the sample. The mean numbers of teeth with dental plaque, dental calculus, and gingival bleeding were also estimated. All descriptive analyses considered the sample weight using STATA's "svy" command for complex data samples. Unadjusted analyses were conducted to provide summary statistics and preliminary assessments of the associations between the predictor variables and the outcome (number of teeth with bleeding). Models were fitted using multilevel Poisson regression analysis to assess the association of gingival bleeding with the individual and contextual factors. The rate ratio (95% CI) was used to assess the predictors of gingival bleeding, and it corresponded to the ratio of the mean number of teeth with gingival bleeding between the exposed and unexposed groups.

In this study, children (the first level) were clustered in schools (the second level), and our multilevel analysis used the scheme of fixed effects/random intercept. Thus, it was possible to demonstrate the fixed effect of the association's estimates between the outcome and the first and second level variables, given the adjustment using the random intercept between the schools. In the first stage, an unconditional model ("empty model") estimated the proportion of variance for each level before the incremental introduction of the individual and contextual independent variables. The second model ("model 2") included only the first-level variables. In the final model ("model 3" or "full model"), the associations were adjusted by the individual and contextual level covariates. Only variables that generated a P-value ≤0.20 in the unadjusted analyses were considered for the model, and they were retained in the final models only if they had a P-value ≤0.05 after adjustment. In all models, the quality of the fit was measured using deviance (−2log likelihood), and significant changes in the fitting of the models were assessed using the likelihood ratio test.

Results

We assessed 1134 children (45.9% boys) with a response rate of 93%. Non-participation was typically attributable to the absence of children from school on the day of the examination or a failure of the children to return the signed consent form.

The prevalence of children with gingival bleeding was 96.21% (95% CI = 95.10–97.32), and ≥15% of the possible sites were positive for gingival bleeding in 26.28% (95% CI = 23.71–28.84) of the sample. Table 1 summarizes the clinical and sociodemographic characteristics of the sample. Most parents had at least 8 years of schooling and perceived their child’s oral health as “excellent/good.” Most participants attended schools that were located in neighborhoods with a mean income ≥1.19 multiplied by the Brazilian minimum wage, and nearly half of the sample attended schools with a high IDEB.

The mean numbers (and standard error) of teeth with dental plaque, dental calculus, and gingival bleeding were 8.40 (0.28), 0.98 (0.07), and 9.40 (0.38), respectively. In general, higher mean numbers of teeth with gingival bleeding and biofilm were observed among non-white children, children whose parents reported a poor perception of their children’s oral health, children with a low socioeconomic status, and children who had adverse clinical conditions (Table 2).

The unadjusted assessment of the covariates identified sociodemographic and social capital variables that were associated with the number of teeth with gingival bleeding (Table 3). Gingival bleeding was associated with race (non-white), low income, low parental education, fair or poor parental perception of the child’s oral health, and low religiosity. Adverse oral health conditions, including dental caries, dental plaque, and dental crowding, were also associated with gingival bleeding.

The results of the multilevel adjusted analysis of the individual and contextual covariates for gingival bleeding are shown in Table 4. Model 2 indicates the individual covariates for gingival bleeding. The model excluded the variable “mother’s level of education” from the analysis to prevent multicollinearity with the variable “father’s level of education.” In this model, children whose fathers had a low educational level and whose parents had a fair or poor parental perception of their oral health had a higher mean number of teeth with gingival bleeding. However, low religiosity, the presence of untreated dental caries, dental plaque, and overcrowding were also identified as individual covariates for gingival bleeding. The association between the socioeconomic factors, features of social capital and gingival bleeding remained statistically significant after the inclusion of contextual variables in Model 3.

Discussion

A socioeconomic influence was observed on the occurrence of higher levels of gingival bleeding, particularly among children with poor socioeconomic status and those reporting lower religiosity (a proxy for social capital). This information may help to prevent and control gingival conditions, which are possible proxies for health habits.

Previous studies investigated the factors that are associated with gingival and periodontal conditions among children and adolescents (1, 2, 7, 9-11), although few studies considered a multilevel approach to assess the possible determinants of gingival health. In our study, all associations were assessed while considering the multilevel effect of the contextual characteristics of the children's schools.

Concerning socioeconomic variables, our results indicate that the number of teeth with gingival bleeding is associated with parental education. Nevertheless, income did not remain associated with gingival bleeding in the adjusted models. Interestingly, the same pattern of association was reported in another study, which found that when adjusted by the educational level, the variable income loses its effect on periodontal disease (34). Education, a possible proxy for health behaviors, often mediates income inequalities in periodontal conditions. The effects of socioeconomic status on health have been described by different mechanisms (35). Therefore, theoretical explanations regarding the connection between socioeconomic status and oral health focus on the effects of material deprivation or psychosocial pathways on the individual's lifestyle decisions (14). Deprived individuals are more likely to engage in deleterious behaviors that could affect their oral health, given their lack of economic resources and empowerment to make healthy choices (36). On the contrary, the effect of low income on oral health may be explained in terms of psychosocial factors, including stress and coping styles across social groups (37).

Based on our results, the presence of dental plaque on more than 15% of the surfaces was significantly associated with a greater number of teeth with gingival bleeding, which corroborates the findings of other study (2). The literature clearly demonstrates that dental plaque, influenced by the host’s immunologic response, is the principal etiologic factor for periodontal diseases (38). Dental crowding was also associated with the number of teeth with gingival bleeding. More severe gingival conditions have also been reported among children with dentofacial anomalies (12). This result is likely attributable to the increased difficulty of performing self-care oral hygiene when the teeth are irregular, and longitudinal studies indicate that orthodontic correction contributes to more effective tooth brushing (39).

Low religious social support, as an aspect of individual-level social capital, was significantly associated with gingival bleeding. Social capital is implicitly present in the connections of a social network. This concept involves some elements, such as interaction between individuals (social network) and social cohesion, and it also can includes social support (15). The social network in which an individual is included provides social support that can influence his or her life (14). In this study, children whose parents’ reported never going to church exhibited higher levels of gingival bleeding than their more religious counterparts. Previous studies suggested that access to dental care and the adoption of oral health-related behavior are influenced by religiosity, thereby positively affecting the health of the individuals (27, 28). A recent Brazilian study also reported that adolescents’ preventive pattern of dental attendance and perceived importance of oral care were positively associated with the frequency of their attendance at religious services (40). Several plausible pathways link social capital (e.g., religious social network) to health outcomes. First, social capital may affect the individual's health by improving health-related behavior through the more rapid diffusion of health information and increased access to local services and amenities (15, 41). Thus, an individual who has a social network with greater social support may have better information and therefore may make healthier choices. This pathway appears to provide a plausible mechanism regarding the protective effect of religiosity on gingivitis. However, there are also associations between social capital and psychological distress (42), which is a risk indicator of periodontal disease. Therefore, religious social networks may buffer the individual's stressful situations, thereby improving their coping strategies (28, 41) and minimizing their susceptibility to gingivitis. Furthermore, social capital may exert a level of control over deviant health-related behavior, as religious participation increases the social support that originates from these networks (27, 28), which may lead to better oral health. We propose that as observed for chronic diseases in adults, religion may affect adolescents' gingival health through a behavioral pathway (27).

The contextual variables (neighborhood's mean income and IDEB) included in the model were not significantly associated with the outcome. It may have occurred because the considered variables do no explain the school variance. Notwithstanding, these variables were selected because the former represents a socioeconomic characteristic of the school and the second one is a way of considering different performances between schools. A Brazilian study found that children with worst oral health conditions had lower mean school performance than other children (43). Moreover, previous studies in developed countries have found that school performance results were significant predictors of the percentage of children requiring restorative dental treatment (44, 45). Therefore, the school variable “IDEB” could be an important contextual indicator of oral and gingival health among schoolchildren populations.

This study has several limitations. First, we used a cross-sectional design, which precludes the establishment of causality between the predictors and the outcome. However, we also believe that cross-sectional studies are important tools for identifying risk and protection indicators for inclusion in future longitudinal assessments. Second, although we sought to evaluate a representative sample of 12-year-old children living in Santa Maria, we were unable to include students who were enrolled in private schools. However, as only 15% of children in the city are enrolled in private schools, we believe that the lack of data from private schools did not affect the validity of our finding. Moreover, we could evaluate children from all social classes by using the public schools in Santa Maria. Chi-squared tests were conducted to compare the distribution of the subjects included in this study with the city population, and no differences were observed between the study population and city population for this age group in terms of gender, race, and household income (data provided by the Demographic Council of the City). Thus, we cautiously consider our findings to be generalizable for all 12-year-old schoolchildren living in the city.

Third, in our study, data on social capital were gathered on the basis of church attendance. It is important to acknowledge the limitations of using such very crude measure. However, there is a lack of clarity regarding the measurement of social capital, which has led to substantial criticism to the use of a wide range of different measures (46). It is possible that such indicator may not be relevant to reflect true differences in social capital, particularly in terms of individual social capital. Furthermore, while we looked at the role of church attendance as a proxy for social capital, we did not assess other relevant indicators such as level of social support and trust. Thus, our findings may not wholly capture the entire construct of social capital. Although no single indicator can embrace the complete spectrum of social capital, there are two main domains in the literature that can be associated with the concept, namely the cognitive (perceived interpersonal trust, norms, and reciprocity) and structural (civic participation, socializing, and networking) domains that act as resources for individuals and facilitate collective action toward effective social decisions and improved outcomes. Attendance at religious meetings can lead to these domains. Therefore, researchers have used different approaches to measure individual social capital using either a questionnaire or a set of questions. In our study, data on social capital was gathered on the basis of commonly used question in the social capital literature and also in previous studies (28, 40, 47). In this context, previous studies demonstrated that religious connections, as indicated by the frequency of attending religious meetings, can be considered a proxy of social capital because it is a mechanism for the provision of public goods and the transmission of information and shared values, which contribute to social support (27, 40). It has also been demonstrated that the frequency of contact with people, friends, or neighbors may reduce social isolation, which plays an important role in maintaining oral health (48). Finally, we considered the outcome (gingival bleeding) a count variable and a Poisson regression model was adjusted. However, there is no consensus in the literature regarding a suitable cutoff for this analysis.

In conclusion, our findings indicate that low socioeconomic status and the low frequency of families attending to religious meetings are significantly associated with the occurrence of gingival bleeding among Brazilian schoolchildren. The association may be important to develop appropriate oral health strategies that consider the socioeconomic and social capital factors experienced by children. This information suggests that individual social condition should be considered in the allocation of resources to public health.

Acknowledgments

The authors wish to thank all children, parents, and schools for their participation and collaboration in this study and the Municipal Education Authorities of Santa Maria, RS for their information and authorization to conduct this study. Finally, we thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq - process 477118/2013-5 and CNPq- process 308141/2012-1) for supporting this study.

The authors declare that they have no conflicts of interest.

References:

1. Jurgensen N, Petersen PE. Oral health and the impact of socio-behavioural factors in a cross sectional survey of 12-year old school children in Laos. BMC oral health. 2009;9:29.

2. Chiapinotto FA, Vargas-Ferreira F, Demarco FF, Correa FO, Masotti AS. Risk factors for gingivitis in a group of Brazilian schoolchildren. Journal of public health dentistry. 2013 Winter;73(1):9-17.

3. SB Brazil 2010: National Research on Oral Health: main results. Brasília: Ministry of Health; 2012.

4. Ramberg P, Axelsson P, Lindhe J. Plaque formation at healthy and inflamed gingival sites in young individuals. Journal of clinical periodontology. 1995 Jan;22(1):85-8.

5. Tomazoni F, Zanatta FB, Tuchtenhagen S, da Rosa GN, Del Fabro JP, Ardenghi TM. Association of gingivitis with child oral health-related quality of life. J Periodontol. 2014 Nov;85(11):1557-65.

6. Lopez R, Baelum V. Oral health impact of periodontal diseases in adolescents. J Dent Res. 2007 Nov;86(11):1105-9.

7. Lopez R, Fernandez O, Baelum V. Social gradients in periodontal diseases among adolescents. Community dentistry and oral epidemiology. 2006 Jun;34(3):184-96.

8. Jin LJ, Armitage GC, Klinge B, Lang NP, Tonetti M, Williams RC. Global oral health inequalities: task group--periodontal disease. Adv Dent Res. 2011 May;23(2):221-6.

9. Nicolau B, Marcenes W, Hardy R, Sheiham A. A life-course approach to assess the relationship between social and psychological circumstances and gingival status in adolescents. Journal of clinical periodontology. 2003 Dec;30(12):1038-45.

10. Cortellazzi KL, Pereira SM, Tagliaferro EP, Ambrosano GM, Zanin L, Meneghim Mde C, et al. Risk indicators of gingivitis in 5-year-old Brazilian children. Oral Health Prev Dent. 2008;6(2):131-7.

11. Antunes JL, Peres MA, Frias AC, Crosato EM, Biazevic MG. [Gingival health of adolescents and the utilization of dental services, state of Sao Paulo, Brazil]. Revista de saude publica. 2008 Apr;42(2):191-9.

12. Antunes JL, Peres MA, Jahn GM, Levy BB. The use of dental care facilities and oral health: a multilevel approach of schoolchildren in the Brazilian context. Oral Health Prev Dent. 2006;4(4):287-94.

13. Marmot M, Bell R. Social determinants and dental health. Adv Dent Res. 2011 May;23(2):201-6.

14. Pattussi MP, Marcenes W, Croucher R, Sheiham A. Social deprivation, income inequality, social cohesion and dental caries in Brazilian school children. Social science & medicine. 2001 Oct;53(7):915-25.

15. Aida J, Kuriyama S, Ohmori-Matsuda K, Hozawa A, Osaka K, Tsuji I. The association between neighborhood social capital and self-reported dentate status in elderly Japanese--the Ohsaki Cohort 2006 Study. Community dentistry and oral epidemiology. 2011 Jun;39(3):239-49.

16. Putnam R. Bowling Alone: The Collapse and Revivalof American Community. 1st ed. New York, NY: Touchstone Books by Simon & Schuster; 2001.

17. Coleman JS. Social capital in the creation of human capital. American Journal of Sociology. 1988;94:95-120.

18. Bordieu P. The forms of capital. In: Richardson JG, editor. Handbook of Theory and Research for theSociology of Education. New York, NY: GreenwoodPress; 1986.

19. Kawachi IT, S.; Subramanian, S.V. Global perspective on social capital and health. New York: Springler; 2013.

20. Hanson BS, Liedberg B, Owall B. Social network, social support and dental status in elderly Swedish men. Community dentistry and oral epidemiology. 1994 Oct;22(5 Pt 1):331-7.

21. McGrath C, Bedi R. Influences of social support on the oral health of older people in Britain. J Oral Rehabil. 2002 Oct;29(10):918-22.

22. Siriphant P, Drury TF. Healthy practices, social relationships and dental perceptions among US dentate adults. Journal of public health dentistry. 2005 Winter;65(1):36-42.

23. Tsakos G, Sabbah W, Chandola T, Newton T, Kawachi I, Aida J, et al. Social relationships and oral health among adults aged 60 years or older. Psychosomatic medicine. 2013 Feb;75(2):178-86.

24. Merchant AT, Pitiphat W, Ahmed B, Kawachi I, Joshipura K. A prospective study of social support, anger expression and risk of periodontitis in men. J Am Dent Assoc. 2003 Dec;134(12):1591-6.

25. Sabbah W, Tsakos G, Chandola T, Newton T, Kawachi I, Sheiham A, et al. The relationship between social network, social support and periodontal disease among older Americans. Journal of clinical periodontology. 2011 Jun;38(6):547-52.

26. Santiago BM, Valenca AM, Vettore MV. Social capital and dental pain in Brazilian northeast: a multilevel cross-sectional study. BMC oral health. 2013;13:2.

27. Zini A, Sgan-Cohen HD, Marcenes W. Religiosity, spirituality, social support, health behaviour and dental caries among 35- to 44-year-old Jerusalem adults: a proposed conceptual model. Caries research. 2012;46(4):368-75.

28. Zini A, Sgan-Cohen HD, Marcenes W. Is religiosity related to periodontal health among the adult Jewish population in Jerusalem? J Periodontal Res. 2012 Aug;47(4):418-25.

29. Aida J, Ando Y, Oosaka M, Niimi K, Morita M. Contributions of social context to inequality in dental caries: a multilevel analysis of Japanese 3-year-old children. Community dentistry and oral epidemiology. 2008 Apr;36(2):149-56.

30. Snijder TAB B, R.J. Multilevel analysis: an introduction to basic and advanced multilevel modeling. London; 2003.

31. Diez-Roux AV. Multilevel analysis in public health research. Annual review of public health. 2000;21:171-92.

32. World Health Organization WHO. Oral health surveys, basic methods. Geneva, 1997: 93.

33. IBGE.Instituto Brasileiro de Geografia e Estatística. 2010 [acessado em 13 de Janeiro 2015]. Disponível em: http://www.ibge.gov.br/home/estatistica/populacao/condicaodevida/indicadoresminimos/conceitos.shtm

34. Steele J, Shen J, Tsakos G, Fuller E, Morris S, Watt R, et al. The Interplay between socioeconomic inequalities and clinical oral health. J Dent Res. 2015 Jan;94(1):19-26.

35. Kawachi I, Kennedy BP. Income inequality and health: pathways and mechanisms. Health services research. 1999 Apr;34(1 Pt 2):215-27.

36. Braveman PA, Cubbin C, Egerter S, Chideya S, Marchi KS, Metzler M, et al. Socioeconomic status in health research: one size does not fit all. Jama. 2005 Dec 14;294(22):2879-88.

37. Celeste RK, Nadanovsky P. How much of the income inequality effect can be explained by public policy? Evidence from oral health in Brazil. Health policy. 2010 Oct;97(2-3):250-8.

38. Broadbent JM, Thomson WM, Boyens JV, Poulton R. Dental plaque and oral health during the first 32 years of life. J Am Dent Assoc. 2011 Apr;142(4):415-26.

39. Glans R, Larsson E, Ogaard B. Longitudinal changes in gingival condition in crowded and noncrowded dentitions subjected to fixed orthodontic treatment. American journal of orthodontics and dentofacial orthopedics : official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics. 2003 Dec;124(6):679-82.

40. Jordao LM, Saraiva LM, Sheiham A, Freire MC. Relationship between rates of attending religious services and oral health in Brazilian adolescents. Community dentistry and oral epidemiology. 2014 Oct;42(5):420-7.

41. Yeager DM, Glei DA, Au M, Lin HS, Sloan RP, Weinstein M. Religious involvement and health outcomes among older persons in Taiwan. Social science & medicine. 2006 Oct;63(8):2228-41.

42. Phongsavan P, Chey T, Bauman A, Brooks R, Silove D. Social capital, socio-economic status and psychological distress among Australian adults. Social science & medicine. 2006 Nov;63(10):2546-61.

43. Piovesan C, Antunes JL, Mendes FM, Guedes RS, Ardenghi TM. Influence of children's oral health-related quality of life on school performance and school absenteeism. Journal of public health dentistry. 2012 Spring;72(2):156-63.

44. Muirhead VE, Locker D. School performance indicators as proxy measures of school dental treatment needs: a feasibility study. Journal of public health dentistry. 2006 Fall;66(4):269-72.

45. Crowley E, O'Brien G, Marcenes W. School league tables: a new population based predictor of dental restorative treatment need. Community dental health. 2003 Jun;20(2):78-82.

46. Rouxel PL, Heilmann A, Aida J, Tsakos G, Watt RG. Social capital: theory, evidence, and implications for oral health. Community dentistry and oral epidemiology. 2015 Apr;43(2):97-105.

47. Mathur MR, Tsakos G, Parmar P, Millett CJ, Watt RG. Socioeconomic inequalities and determinants of oral hygiene status among Urban Indian adolescents. Community dentistry and oral epidemiology. 2016 Jan 14.

48. Guedes RS, Piovesan C, Antunes JL, Mendes FM, Ardenghi TM. Assessing individual and neighborhood social factors in child oral health-related quality of life: a multilevel analysis. Quality of life research : an international journal of quality of life aspects of treatment, care and rehabilitation. 2014 Nov;23(9):2521-30.

Table 1. Individual and Contextual level characteristics of the sample: 1,134 12-years-old children, Santa Maria – RS, Brazil.

Variables	n	%*
Individual level (child)		
Gender		
Female	611	54.12
Male	523	45.88
Race		
White	851	77.93
Non-white	254	22.07
Household income		
> 1.6 BMW†	487	47.78
≤ 1.6 BMW†	549	52.22
Mother's education		
≥ 8 years	702	65.55
< 8 years	382	34.45
Father's education		
≥ 8 years	628	61.44
< 8 years	406	38.56
Household overcrowding		
1 room or more/person	736	69.05
Less than 1 room/person	337	30.95
Parents health perception		
Excellent/good	719	65.47
Fair/poor	385	34.53
Untreated dental caries		
Without	654	57.67
With	480	42.33
Dental trauma		
Without	848	74.84
With	286	25.16
Dental plaque		
≤ 15% surfaces	801	70.63
> 15% surfaces	333	29.37
Dental Crowding		
Without	656	57.64
With	478	42.36
Religious social networks (Frequency of Going to the Church)		
Often	933	86.71
Never/almost never	146	13.29
Contextual Level (school)		
Neighborhood's mean income		
> 1.19 BMW†	893	79.68
≤ 1.19 BMW†	241	20.32
Basic School's Development Index (IDEB)		
High	507	48.06
Low	627	51.94

*Taking into account the sampling weight.

†BMW: Brazilian minimum wage (approximately U$ 450 during the data gathering).

Table 2. Mean (standard error) number of teeth with dental plaque, dental calculus and gingival bleeding by demographics, clinical and socioeconomic conditions: 1,134 12-years-old children, Santa Maria – RS, Brazil.

Variable	Dental Plaque Mean (SE)	Dental Calculus Mean (SE)	Gingival Bleeding Mean (SE)
Individual Level (child)			
Gender			
Female	7.76 (0.44)*	0.89 (0.09)	9.35 (0.43)
Male	9.09 (0.40)	1.10 (0.09)	9.45 (0.50)
Race			
White	7.99 (0.27)*	0.96 (0.07)	9.09 (0.46)*
Not White	9.63 (0.49)	1.10 (0.15)	10.15 (0.43)
Household Income			
> 1.6 BMW[†]	7.64 (0.27)*	0.97 (0.09)	8.77 (0.48)*
≤ 1.6 BMW[†]	9.23 (0.35)	0.95 (0.09)	9.92 (0.32)
Mother's education			
≥ 8 years	7.90 (0.25)*	1.00 (0.08)	8.86 (0.45)*
< 8 years	9.35 (0.43)	0.96 (0.12)	10.45 (0.50)
Father's education			
≥ 8 years	7.89 (0.29)*	1.01 (0.09)	8.80 (0.46)*
< 8 years	8.95 (0.31)	0.94 (0.12)	10.25 (0.45)
Household overcrowding			
1 room or more/person	8.10 (0.24)*	0.97 (0.07)	8.95 (0.47)*
Less than 1 room/person	9.06 (0.43)	1.05 (0.16)	10.15 (0.34)
Parents health perception			
Excellent/good	7.48 (0.26)*	0.92 (0.08)	8.69 (0.46)*
Fair/Poor	10.14 (0.29)	1.13 (0.12)	10.60 (0.36)
Untreated dental caries			
Without	7.43 (0.33)*	1.04 (0.09)	8.39 (0.51)*
With	9.32 (0.32)	0.93 (0.09)	10.40 (0.36)
Dental Crowding			
Without	7.63 (0.36)*	0.97 (0.10)	8.79 (0.45)*
With	9.50 (0.33)	1.00 (0.06)	10.30 (0.41)
Religious social networks (Frequency of Going to the Church)			
Often	8.37 (0.28)	1.01 (0.08)	9.26 (0.38)
Never/almost never	8.49 (0.53)	0.90 (0.13)	10.12 (0.69)
Contextual Level (school)			
Neighborhood's mean income			
> 1.19 BMW[†]	8.20 (0.29)*	0.10 (0.08)	9.19 (0.39)*
≤ 1.19 BMW[†]		0.95 (0.14)	10.20 (0.79)
Basic School's Development Index (IDEB)	9.05 (0.62)		
High		0.96 (0.07)	8.85 (0.54)*
Low	7.87 (0.19)*	1.01 (0.12)	9.90 (0.47)
	8.84 (0.44)		

*Mann-Whitney test ($p \leq 0.05$). [†]BMW: Brazilian minimum wage (approximately U$ 450 during the data gathering).

Table 3. Individual and contextual factors associated to the number of teeth with gingival bleeding. Unadjusted multilevel analysis: 1,134 12-years-old children, Santa Maria – RS, Brazil.

Variable	Number of teeth with gingival bleeding RR* (CI 95%)	P
Individual Level (child)		
Gender		0.893
Female	1	
Male	1.00 (0.96-1.04)	
Race		0.001
White	1	
Not White	1.08 (1.04-1.14)	
Household Income		<0.001
> 1.6 BMW†	1	
≤ 1.6 BMW†	1.11 (1.06-1.16)	
Mother's education		<0.001
≥ 8 years	1	
< 8 years	1.17 (1.12-1.22)	
Father's education		<0.001
≥ 8 years	1	
< 8 years	1.18 (1.13-1.23)	
Household overcrowding		<0.001
1 room or more/person	1	
Less than 1 room/person	1.09 (1.05-1.14)	
Parents health perception		<0.001
Excellent/good	1	
Fair/Poor	1.27 (1.18-1.28)	
Untreated dental caries		<0.001
Without	1	
With	1.24 (1.20-1.29)	
Dental plaque		<0.001
≤ 15% surfaces	1	
> 15% surfaces	1.42 (1.37-1.48)	
Dental Crowding		<0.001
Without	1	
With	1.21 (1.16-1.26)	
Religious social networks (Frequency of Going to the Church)		0.017
Often	1	
Never/almost never	1.07 (1.01-1.13)	
Contextual Level (school)		
Neighborhood's mean income		0.439
> 1.19 BMW†	1	
≤ 1.19 BMW†	1.07 (0.90-1.28)	
Basic School's Development Index (IDEB)		0.115
High	1	
Low	1.12 (0.97-1.28)	

*Rate ratio (ratio of arithmetic means) determined by Multilevel Poisson regression analysis.
†BMW: Brazilian minimum wage (approximately U$ 450 during the data gathering).

Table 4. Individual and contextual factors associated to the number of teeth with gingival bleeding. Adjusted Multilevel analysis: 1,134 12-years-old children, Santa Maria – RS, Brazil.

	Model 1 ("empty")*	Model 2* ("individual")	Model 3 ("full")*
Fixed Component	RR(CI95%)	RR(CI95%)	RR(CI95%)
Intercept	0.15 (0.11-0.22)	0.17 (0.12-0.24)	0.16 (0.12-0.23)
Individual Level (child)			
Race			
White		1	1
Not white		1.02 (0.97-1.08)	1.02 (0.97-1.08)
Household Income			
> 1.6 BMW†		1	1
≤ 1.6 BMW†		1.04 (0.99-1.09)	1.04 (0.99-1.09)
Father's Education			
≥ 8 years		1	1
< 8 years		1.12 (1.07-1.18)	1.12 (1.07-1.18)
Parents health perception			
Excellent/good		1	1
Fair/Poor		1.08 (1.03-1.13)	1.08 (1.03-1.13)
Untreated dental caries			
Without		1	1
With		1.18 (1.13-1.24)	1.18 (1.13-1.24)
Dental plaque			
≤ 15% surfaces		1	1
> 15% surfaces		1.32 (1.26-1.39)	1.32 (1.26-1.39)
Dental Crowding			
Without		1	1
With		1.06 (1.03-1.09)	1.06 (1.03-1.09)
Religious social networks ((Frequency of Going to the Church)			
Often		1	1
Never/almost		1.08 (1.01-1.14)	1.08 (1.01-1.14)
Contextual Level (school)			
Neighborhood's mean income			
> 1.19 BMW†			1
≤ 1.19 BMW†			1.01 (0.83-1.23)
Basic School's Development Index (IDEB)			
High			1
Low			1.05 (0.89-1.23)
Random Component			
Deviance (-2loglikelihood)	8976.75	6811.13	6810.78

*Model 1("empty"): represents unconditional model; Model 2: represents adjusted model by individual level variables; Model 3: represents adjusted model by individual and contextual level variables. †BMW: Brazilian minimum wage (approximately U$ 450 during the data gathering). ‡Gender was not included in the fitting of the models because it had p-value >0.20 in the unadjusted assessment.