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Does bullying due to oral conditions influence cigarette smoking in adolescents? A structural equation modeling

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Abstract: This study aimed to explore the pathways that can influence cigarette smoking among adolescents. This population-based cohort followed a random sample of 12-year-old adolescents from southern Brazil for 6 years. Regular cigarette smoking was assessed through a self-reported question, previously used in the Brazilian National Survey of Scholar Health. We also gathered data on bullying, dental caries at baseline, incidence of caries, sex, friend network, and Sense of Coherence (SOC). Socioeconomic and demographic characteristics were also collected. Structural equation modeling was used to evaluate the pathways. Of the 1,134 adolescents examined at baseline, 768 were re-evaluated (67.7% retention rate). The prevalence of smoking was 37.6%. This prevalence was directly affected by low SOC (SC: -0.14, $p < 0.01$), low household income (SC: -0.12, $p < 0.01$), and male sex (SC: 0.15, $p < 0.01$). Presence of dental caries at baseline indirectly influenced the occurrence of dental bullying at follow-up via the incidence of dental caries (SC: 0.01, $p < 0.05$). Dental bullying indirectly influenced cigarettes consumption via SOC (SC: 0.62, $p < 0.05$). Friend network also indirectly influenced the consumption of cigarettes via SOC (SC: 0.32, $p < 0.05$). Psychosocial factors influence adolescent cigarette consumption through its higher direct and indirect effects (via bullying). In addition, behavioral, sociodemographic, and clinical factors also influence the occurrence of smoking.

Keywords: Cigarette Smoking; Oral Health; Latent Class Analysis.

Introduction

Adolescence is a critical period for health, since there are biological, cognitive, emotional, and social changes that make individuals more susceptible to adopting new behaviors, including the use of harmful substances.[1] Cigarette smoking is recognized as one of the most harmful recurring practices in adolescence and is considered a public health problem around the world.[2] Smoking is responsible for a significant global morbidity and mortality rate, with negative impact on users' oral and general health, as well as contextual and financial losses to society.[2] In Brazil, the prevalence of this habit in adolescents varied from 2.4% to 22%, with an average of 9.3%.[3]

Among the available theoretical models identified as key theoretical pathways for explaining the consumption of harmful substances, the materialist, behavioral, and psychosocial theories are worth highlighting.[4-6] Materialism argues that the individual's behavior is determined by their natural needs based on socioeconomic status (SES).[6] Behaviorism establishes that the environment reinforces everyone's behavior. In this model, social acceptance is considered a major concern for young people, who adopt behaviors considered appropriate to belong to social groups.[4] Psychosocial theory argues that feelings of subordination or inferiority encourage the development of stress responses, which can promote consequences for physical and mental health, social marginalization, and risky behaviors.[5]

Oral health is directly related to the establishment of healthy behaviors. Individuals with certain oral injuries can have worse self-perception of oral health, and among adolescents with social interactions, this can lead to episodes of bullying.[7,8] A greater susceptibility to smoking among adolescents who have suffered bullying has been shown, since use of harmful substances is associated with coping with stress and seeking acceptance in social groups.[9] However, to our knowledge, no study has focused on bullying due to oral conditions and cigarette consumption and explored the different pathways that can lead to adolescent smoking. In addition, strategies to minimize adolescents' adoption of harmful behaviors, including cigarette consumption, are more effective when the pathways that lead to such attitude are identified.[10] Therefore, this study aimed to explore the pathways that can influence cigarette smoking among adolescents. We hypothesized that adolescents who suffered dental bullying are more likely to smoke.

Methodology

This study is reported according to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.[11]

Ethical issues

The study protocol was approved by the Ethics Committee for Research of the Federal University of Santa Maria (CAEE: 66553117.4.0000.5346). Only adolescents who consented and whose legal guardians signed the consent form were included in the study.

Study setting and sample

This 6-year cohort study began in 2012 (T1). A sample of 1,134 12-year-old schoolchildren from public schools in Santa Maria, a city in southern Brazil, was evaluated at baseline. In 2012, the city had an estimated population of 261,031 inhabitants, which included 3,817 12-year-old children, of whom 85% were enrolled in public schools.[12] The sample was obtained through a two-stage sampling procedure. The first stage consisted of selecting 20 of the 39 public schools in the city. Schools were selected in the 5 administrative regions of the city (center, north, south, east, and west) according to the weighted draw technique. The second stage consisted of selecting 12-year-old children regularly enrolled in the previously selected schools. Only individuals considered physically and intellectually able to answer the questionnaire were included in the study, while adolescents with cognitive problems or inability to understand Brazilian Portuguese were excluded from the analysis. Further details regarding the baseline methodological characteristics were published elsewhere.[13]

The sample size calculation considered a cigarette smoking prevalence of 10.3% in the non-exposed group (adolescents that were not bullied) and 27.6% in the exposed group (adolescents that were bully victims), confidence level of 95%, exposed/unexposed ratio 1:1, design effect of 1.6, and statistical power of 90%.[14] Considering possible losses, 30% was added to the sample size, resulting in a required minimum sample of 492 adolescents.

All participants evaluated in 2012 were invited to participate in the second follow-up phase, conducted after 6 years (T2). Some strategies were adopted to minimize nonresponse rate. Participants were contacted through telephone calls and were invited to attend the pediatric dentistry clinic of the university. Lists of students enrolled in public schools were obtained and data was assessed in a school setting. If the adolescents still could not be found, the researchers located the adolescents through home visits.

Data collection

The data collection in the two assessments of the study used standardized procedures. Data were collected through clinical examinations and structured questionnaires administered by five previously trained interviewers in face-to-face interviews. At baseline, legal guardians indicated the adolescent's sex and household income. At follow-up, the adolescents answered questions related to age, oral health measures, friend network, smoke, and psychosocial variables. The mean household income of all individuals living in the house in the last month was recorded in Brazilian reals (R$ - official currency; US$ 1.0 is equivalent to R$ 5.3).

Clinical examinations were conducted in both assessments through trained and calibrated examiners, according to criteria standardized by the World Health Organization (WHO).[15] The calibration process involved a theoretical class, a clinical-epidemiological exercise with 20 extracted teeth, and the calibration itself, in which 15 adolescents were evaluated by the same examiners twice, within an interval of 2 weeks. Agreement between T1 and T2 for dental caries using Kappa statistics (inter and intra-examiner) ranged from 0.77 to 0.82 and 0.79 to 0.85 at T1 and 0.79 to 0.95 and 0.71 to 0.88 at T2. Dental caries was measured through the Decayed, Missing, and Filled surfaces' index (DMFS), according to WHO criteria.[15] The variable "incidence of dental caries" was developed from the difference between baseline and follow-up DMFS values.

Regular cigarette consumption was measured using the following question "In the last month, on how many days did you smoke cigarettes?". This is a self-answered question present in the National School Health Survey (PeNSE), a widely applied survey carried out by the Brazilian Institute of Geography and Statistics (IBGE).[16] The consumption in the last 30 days are recognized as a standard measure for regular substance use.[17] The internal consistency of the questions related to the study outcome (cigarette smoking) was tested in 25 adolescents attending a dental clinic at UFSM. Although these adolescents did not belong to the study cohort, they had a similar socioeconomic background to the sample of this research. The Cronbach's α was 0.84. In the analysis, cigarette smoking was used as a quantitative variable.

Psychosocial variables were represented by SOC and dental bullying assessment. SOC is described as a global guideline that allows people to manage stress, identify their internal and external environments and find solutions for their health.[18] Adolescents answered the Brazilian version of SOC-13, a five-point Likert type scale, in which the final score is the sum of the items and ranges from 13 to 65.[19] Higher scores indicate a higher SOC, and a high SOC indicates a greater ability to deal with everyday adversity and stress in a healthy way. Verbal dental bullying was measured with a single question from the Child Perceptions Questionnaire for 11- to 14-year-old children (CPQ11–14).[20] They answered: "In the last month, how many times did other children made fun of you or called you nicknames because of your teeth or mouth?"[20] Response options ranged from 1 to 5 and corresponded to the following definitions: "1 – never"; "2 – 1 or 2 times"; "3 – sometimes"; "4 – often"; and "5 – every day or almost every day". Verbal dental bullying was considered absent ("No") when the adolescent answered option 1 and present ("Yes") when the answer was option 2, 3, 4 or 5. This question was previously used in the literature to assess dental bullying.[8] Friend network was measured through the following question: "Would you feel comfortable to borrow R$ 15 from your friends or classmates?",[21] and the answers were categorized as "Yes" and "No".

Statistical analysis

The STATA 14 software (StataCorp.2014 Stata Statistical Software, version 14.2 StataCorp LP, College Station, USA,) was used for all analysis conducted in this research. Descriptive analysis of baseline characteristics of the sample and for those who were measured in the follow-up were performed considering the sampling weight. Possible selection bias due to follow-up losses were evaluated by comparing the baseline and the followed-up samples with the Chi-square test (qualitative variables) and T-test (numeric variables).

Structural equation modeling (SEM) was performed to verify the pathways between demographic, socioeconomic, psychosocial, and oral health measures in the habit of smoking, using variables from T1 and T2 to predict cigarette smoking at T2. The model was

constructed based on the common risk approach model, the WHO conceptual framework, and considering variables related to cigarette smoking adoption found in previous studies.[9,14,22,23] The goodness-of-fit was measured using the Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), and the Standardized Root Mean Square Residual (SRMR). The RMSEA value < 0.05 and CFI and TLI > 0.90 indicate an adequate fit, respectively. The SRMR indicates an adequate fit when lower than 1.0.[24] Modification Indices (MI) were used to evaluate the quality of fit. MI values equal or above 0.40 were considered not significant and removed step by step.

Results

Of the 1,134 adolescents assessed at baseline, 768 were reevaluated at the 6-year follow-up (cohort retention rate of 67.7%). The reasons for loss of follow-up were inability to find the adolescent (n = 354), refusal (n = 11), and death (n = 1). There were no statistically significant differences between participants and drop-outs regarding demographic, socioeconomic, and oral health characteristics (p > 0.05).

Table 1 presents the characteristics of the 6-year follow-up sample at T1 and T2. Most of the individuals followed-up were girls (52.1%) and the mean age was 17.5 [standard error (SE) 0.05] years. The mean household income was R$ 1,406 (SE 39.67). Approximately 12.7% of adolescents reported experiencing dental bullying and 37.6% smoked. The incidence of dental caries from T1 to T2 was 1.52 (SE 0.14).

Figure shows the analysis of direct and indirect pathways of significant associations of variables with cigarette smoking in adolescents (parsimonious model). The habit of cigarette smoking at T2 was directly affected by low SOC [standardized coefficients (SC): -0.14, p < 0.01], low household income (SC: -0.12, p < 0.01), and male sex (SC: 0.15, p < 0.01). Caries incidence was directly affected by low household income (SC: -0.10, p < 0.01) and dental caries at T1 (SC: 0.13, p < 0.01). Dental bullying was directly influenced by male sex (SC: -0.07 (p < 0.05). Low overall SOC-13 score was directly influenced by the occurrence of dental bullying (SC: -0.20, p < 0.01) and weak friend network (SC: -0.14, p < 0.01). In addition, male sex was directly associated with high scores in SOC-13 (SC: 0.15, p < 0.01). Regarding indirect pathways, dental caries at T1 indirectly influenced the occurrence of dental bullying at T2 via incidence of dental caries (SC: 0.01, p < 0.05). Dental bullying indirectly influenced cigarette smoking via SOC (SC: 0.62, p < 0.05). In addition, friend network also indirectly influenced smoking via SOC (SC: 0.32, p < 0.05). This information is also shown in Table 2. The main indirect effects mentioned above were high and significant. The fit indices of the initial and final models are shown in Table 3. The parsimonious model presented a good fit since all criteria were met.

Discussion

This study explored the pathways that could influence cigarette smoking among adolescents, especially bullying due to dental caries. Lower SOC, lower household income, and male sex directly favored the adoption of cigarette smoking. Findings also suggest some indirect influences, such as dental

Table 1. Characteristics of the sample at baseline and at 6-year follow-up.

Variables	Follow-up (n = 768)
Baseline (T1)	
Sex [n (%)]	
Girls	427 (52.1)
Boys	341 (47.9)
Household income in R$ [mean (SE)]	1.406 (39.67)
Dental caries [mean (SE)]	1.69 (0.09)
Follow-up (T2)	
Friend network [n (%)]	
Yes	450 (59.2)
No	318 (40.8)
Dental bullying [n (%)]	
No	665 (87.3)
Yes	101 (12.7)
Cigarette smoking [mean (SE)]	2.43 (0.31)
SOC-13 score [mean (SE)]	46.66 (0.31)
Incidence of dental caries [mean (SE)]	1.52 (0.14)

Values lower than 768 due to missing data; T1: baseline; T2: 6-year follow-up; R$: Real (exchange rate was US$ 1 to R$4.28); SE: standard error.

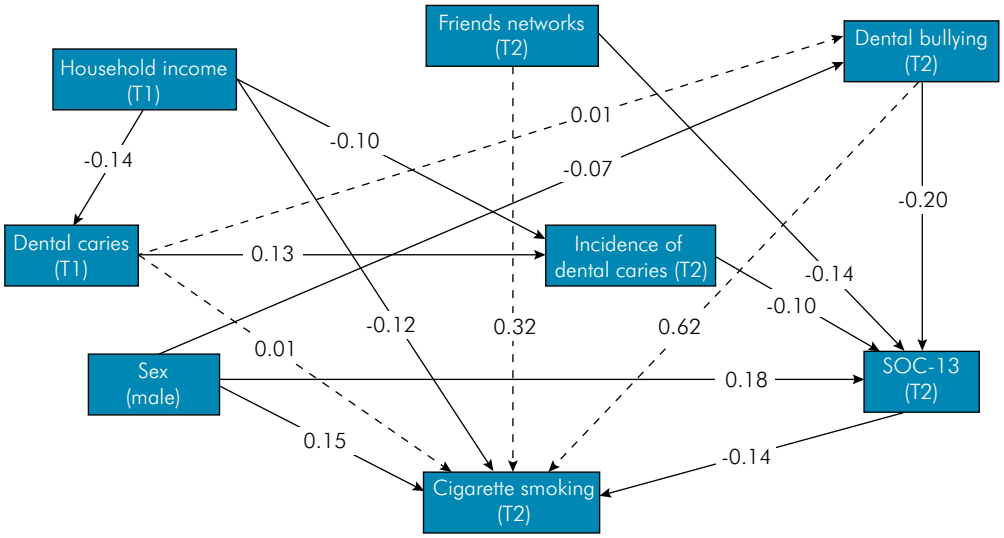

Figure. Significant associations of variables in cigarette smoking by adolescents. Direct effects are represented by solid lines and indirect effects are indicated by dashed lines.

Table 2. Standardized coefficients for direct, indirect, and total effects of oral health measures, psychosocial factors, and cigarette smoking.

Variables	Direct effects	Indirect effects	Total effects
From dental caries (T1) to cigarette smoking (T2)	-	-	-
Via incidence of dental caries (T2)	-	0.01*	-
From dental bullying to cigarette smoking (T2)	-	-	-
Via SOC-13 (T2)	-	0.62*	-
From friend network to cigarette smoking (T2)	0.52	0.32	0.84
Via SOC-13 (T2)	-	0.32*	-
Dental caries (T1) to dental bullying (T2)	-	-	-
Via incidence of dental caries (T2)	-	0.01*	-

T1: baseline; T2: 6-y follow-up; *p < 0.05.

caries, indirectly determined via incidence of dental caries and dental bullying, which indirectly influenced cigarette smoking, via SOC. These results confirmed the hypothesis that adolescents who suffered dental bullying are more likely to smoke.

Previous studies support our results indicating different pathways that could lead to smoking in adolescents and adults.[25,26] Those researches included different factors from psychosocial, behavioral, and materialistic theories in the analysis. It was observed that symptoms of depression and lower mental wellbeing (psychosocial aspects) were directly associated with an increased consumption of cigarettes.[25] Peer smoking behavior and delinquent behaviors also directly predicted adolescent smoking, indicating the problem behavior theory as a useful and multidimensional way of examining adolescent smoking.[26] Furthermore, socioeconomically disadvantaged individuals smoked more cigarettes daily, corroborating with the materialist theory.[25]

SOC showed an important role in this investigation. SOC is the central idea of the salutogenic theory, reflecting a global orientation for viewing life in a coherent, manageable, and meaningful way.[18] Since SOC has a determining role in behavioral outcomes among adolescents, our findings demonstrate that individuals with a lower SOC are more likely to smoke. It is believed that individuals with a high SOC have a greater ability to identify, mobilize, and use the necessary and available resources to face life's demands and challenges.[27] In addition, people with a stronger SOC tend to deal with stressful stimuli in

Table 3. Standardized estimated effects of indicators in initial and final structural model.

Pathway	Standardized coefficients	
	Initial model	Final model
Dental caries (T1)		
Household income (T1)	-0.14 ($p < 0.01$)	-0.14 ($p < 0.01$)
Sex (T1)	0.01 ($p = 0.93$)	-
Incidence of dental caries (T2)		
Dental caries (T1)	0.13 ($p < 0.01$)	0.13 ($p < 0.01$)
Household income (T1)	-0.10 ($p < 0.05$)	-0.10 ($p < 0.05$)
Friend network (T2)	-0.05 ($p = 0.33$)	-0.03 ($p = 0.32$)
Friend network (T2)		
Sex (T1)	-0.05 ($p = 0.13$)	-0.05 ($p = 0.11$)
Dental bullying (T2)		
Incidence of dental caries (T2)	0.01 ($p = 0.81$)	-
Friend network (T2)	0.04 ($p = 0.21$)	0.04 ($p = 0.20$)
Sex (T1)	-0.07 ($p < 0.05$)	-0.07 ($p < 0.05$)
SOC-13 (T2)		
Incidence of dental caries (T2)	-0.10 ($p < 0.01$)	-0.10 ($p < 0.01$)
Friend's network (T2)	-0.14 ($p < 0.01$)	-0.14 ($p < 0.01$)
Dental bullying (T2)	-0.20 ($p < 0.01$)	-0.20 ($p < 0.01$)
Sex (T1)	0.18 ($p < 0.01$)	0.18 ($p < 0.01$)
Cigarette smoking (T2)		
Dental caries (T1)	0.02 ($p = 0.48$)	-
Incidence of dental caries (T2)	0.01 ($p = 0.65$)	-
Friend network (T2)	0.03 ($p = 0.29$)	0.03 ($p = 0.31$)
Dental bullying (T2)	-0.03 ($p = 0.28$)	-
Household income (T1)	-0.11 ($p < 0.01$)	-0.12 ($p < 0.01$)
SOC-13 (T2)	-0.14 ($p < 0.01$)	-0.14 ($p < 0.01$)
Sex (T1)	0.14 ($p < 0.01$)	0.15 ($p < 0.01$)
Model Fit		
RMSEA (90% CI)	0.02 (0.01-0.05)	0.02 (0.01-0.04)
CFI	0.98	0.99
TLI	0.94	0.99
SRMR	0.02	0.02

T1: baseline; T2: 6-y follow-up; RMSEA: Root Mean Square Error of Approximation; CI: Confidence interval; CFI: Comparative Fit Index; TLI: Tucker-Lewis Index; SRMR: Standardized Root Mean Square Residual.

a more resistant way,[28] showing positive behaviors in health, such as better self-reported health and lower smoking rates.[29,30] This justifies that adolescents with low SOC adopt harmful behaviors due to lack of sufficient resources to deal with daily challenges.

Regarding the direct effect of friend network on the SOC and its indirect effect on cigarette smoking, via SOC, previous findings indicated that the strength of social support was associated with a high SOC.[28] Human connections provide mutual trust within the social network and influence the orientation and conduct of individuals.[28] Network connections can also diverge with respect to different outcomes. Resources exchanged within a group and social contagion can be used in a positive or negative way.[31] It is recognized that a network of friends is essential in the road to smoking, suggesting that behavior within this network can cause long-lasting associations with smoking.[32]

A relationship was observed between dental caries and bullying, via the incidence of dental caries. Schoolchildren with untreated dental caries had a higher prevalence of verbal bullying than children with treated or healthy teeth.[8] The clinical consequences of untreated dental caries can be observed by other children, promote unfavorable responses by peers, and change interpersonal relationships in a significant phase of socialization.[8] Bullying could be one result of this negative social relationship in adolescents, and it is related with smoking.[14] Thus, oral health indirectly favors cigarette smoking.

The connection between bullying, lower SOC, and a greater likelihood of smoking occurs through negative consequences in bullying victims, who tend to feel more depressed, lonely, and have low self-esteem.[33] These individuals have a greater predisposition to have difficulty in adopting coping strategies to manage these stressors, which may be associated with lower SOC. In addition, adolescents who have a weak SOC are associated with a growing and significant effect of bullying on physical and psychological symptoms, making them vulnerable to adopting unhealthy habits to face the challenges imposed on them as a coping strategy.[34]

Regular cigarette consumption was also directly affected by low household income and male sex, as previously observed.[35,36] It has been reported that the risk of using substances is greater in adolescents from poorer socio-economic backgrounds.[35] Socioeconomic barriers affect and limit access to knowledge and facilitate the adoption of health risk habits.[37] Regarding sex, some studies report higher cigarette consumption among female adolescents, and others find no difference between the sexes.[38] However, there is theoretical support for our finding, since

male adolescents are more likely to use substances as a coping strategy for bearing family costs and the need to prove their worth and self-image.[36]

This study had some limitations. Cigarette consumption was collected through self-report. This type of question can cause respondents to feel shame and concern about telling the truth and may underestimate the actual level of consumption. However, participants had privacy to answer this section of the questionnaire and informed that their responses would be kept confidential. Second, individuals may not remember exactly the actual consumption of cigarettes in the prior 30 days, which would cause a memory bias. Nonetheless, the consumption rates observed in this study are in accordance with previous results applied to a Brazilian sample, which contributes to the validity of our data.[3] Finally, we collected cigarette consumption by adolescents only at T2, so we do not have information about this consumption at baseline.

Despite these limitations, this study reports on a prospective cohort with a high retention rate after 6 years of follow-up. The use of SEM analysis makes it possible to separate several mutual relationships between the evaluated variables, which has a great advantage over conventional analyses that are tied to a unidirectional evaluation. This longitudinal assessment in a phase of behavioral vulnerability provides important information regarding the different pathways that can lead to smoking in adolescence and demonstrated in an unprecedented way the effect of dental bullying on this consumption. This knowledge has implications for professionals in the field of oral health by demonstrating the role of dental bullying in the adoption of risk behaviors in adolescence. Future studies should investigate this relationship through more complex methodologies to find results that allow an intervention in this age group.

In conclusion, the psychosocial pathway could be the strongest pathway to explain cigarette consumption. SOC was the strongest factor because of its higher direct effect and additional shared (indirect) effect (bullying). In addition, behavioral, sociodemographic, and clinical factors also influence adolescent smoking.

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