

Are Adolescents Aware of the Effects of Smoking on Oral Health? A School-Based Cross-Sectional Study in Midwest Brazil

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ABSTRACT

Objective: To assess the level of knowledge regarding the effects of smoking on oral health among Brazilian adolescent students and explore its associations with smoking and sociodemographic factors. **Materials and Methods:** A school-based cross-sectional study was conducted. Adolescents completed a 16-item questionnaire about the effects of smoking on oral health. The level of knowledge was estimated from the sum of the responses. Smoking status was categorized as "current and former smokers" or "never smoked". Covariates included sociodemographic variables: gender, age, colour or race, and parental education. Independent-samples t-test and multiple regression analysis using backward elimination were performed; statistical significance was set at 5%. **Results:** 219 students participated in the survey (98.2%); most had never smoked (77.6%). The statement "smoking is harmful to oral health" received the highest percentage of correct answers (85.4%). Most questions had low percentages of correct answers (below 50%). Smoking status was significantly associated with knowledge level. Current and former smokers showed higher knowledge scores regarding the effects of smoking on oral health than those who had never smoked ($p < 0.05$). **Conclusion:** Although most adolescents recognized that smoking is harmful to oral health, few were aware of its main effects on the mouth. Moreover, a lower level of knowledge was observed among those who had never smoked.

Keywords: Adolescent; Health Knowledge, Attitudes, Practice; Oral Health; Smoking.

■ Introduction

Smoking harms oral health (OH) [1-3]. Oral problems caused by or associated with smoking include oral cancer, leucoplakia, and an increased risk of periodontal problems, tooth decay, and tooth loss. Smoking causes stains on the gums (smoker's melanosis), bad breath (halitosis), and dry mouth (xerostomia). In addition, the habit can reduce the ability to taste and smell and contribute to staining teeth and dental fillings [1-4]. Exposure to cigarette smoke (secondhand smoking) is also associated with an increased risk of periodontal disease, as well as tooth decay and melanosis in children living with smokers [1,2,5-7].

Adolescents, mainly younger individuals, remain the primary target group for preventing smoking initiation [8]. In this period, they are vulnerable to several OH risk factors, including smoking [9,10]. It is estimated that one in five Brazilian adolescents has tried smoking at least once, while the prevalence of current smoking is around 7% [11]. A previous survey conducted in public schools in Midwest Brazil observed that approximately 2% of adolescent students were daily smokers (i.e., they had smoked every day for the past seven days) [12].

Changes in adolescents' smoking status, whether from nonsmoker to smoker or from smoker to ex-smoker, are behavioural transitions that involve the three basic elements of behaviour change, that is, motivation, opportunity and capability [13,14]. Motivation refers to an individual's desire, beliefs, and intention to smoke, while opportunity relates to external factors that enable or encourage the habit. Capability refers to one's physical and psychological aptitude, including knowledge of the health consequences of this behaviour. The presence or absence of such awareness may influence an individual's motivation to smoke, even to prevent initiation or stimulate cessation [13].

A previous study found that Brazilian adolescent students had low subjective knowledge about the risks of smoking on OH [15]. However, previous studies did not investigate the levels of knowledge among adolescents regarding the main effects of smoking on OH. Considering the importance that adolescents usually attach to OH and appearance, assessing their level of knowledge about the risks of smoking on OH may contribute to public policies and interventions. In this study, we aimed to assess the level of knowledge regarding the effects of smoking on OH among Brazilian adolescent students and explore its associations with smoking and sociodemographic factors.

■ Materials and Methods

Study Design and Sample

This cross-sectional study included adolescent students from a public federal school in the metropolitan region of Goiânia, Goiás, Midwest Brazil, in 2022. The inclusion criterion was age 14 to 19 years. The sample size was estimated using the online calculator Open Epi and the following parameters for calculating proportions: estimated population of students aged up to 19 years at the institution where the data were collected ($n = 250$); expected frequencies of 22.6% for prior experimentation with smoking and 6.8% for current cigarette use (in the last 30 days), based on a national survey [16]; sampling error of 2%; and a 95% confidence interval. The estimated minimum sample size was 178 students for the outcome "current smoking" and 218 for the outcome "ever smoking". To guarantee the sample size, we invited all students aged up to 19 years to participate. The statistical power of the sample for comparisons of knowledge means between the groups (former or current smokers and those who never smoked) was tested a posteriori using Open Epi (Power = 66.26%).

Data Collection

Data were collected using a self-administered questionnaire developed specifically for the present study. The instrument's questions were tested in previous studies with school adolescents at the same institution [13,15], except for the knowledge questions, which were developed for the present study. Three PhD researchers with expertise in questionnaire-based health research externally evaluated the instrument.

The level of knowledge regarding the impacts of smoking on OH was assessed using 16 correct statements about the main effects of smoking on OH, according to the World Health Organization [1,2]. Responses were recorded using a 5-point Likert-type scale of agreement and disagreement, ranging from 1 (full disagreement) to 5 (full agreement). In the descriptive analysis, 5 (full agreement) was considered the correct answer. The knowledge score was calculated by directly summing the 16 individual scores, so that a higher sum indicated a higher level of knowledge. Based on the analysis of data distribution, skewness and kurtosis, mean, standard deviation, median values, Q-Q plot, Boxplot, and the Kolmogorov-Smirnov test, we observed only small deviations from normality and an acceptable fit to the normal distribution. Therefore, this variable was analysed as numerical.

Independent variables were categorical and comprised the smoking status (current and former smokers or never smoked), smoking status of parents (smokers or nonsmokers), and sociodemographic factors: gender (male or female); age (< 16 or ≥ 16); self-reported colour or race (Black/Brown/Yellow or White); Mother's education level (low or high); and father's education level (low or high).

Data Analysis

Data were analysed using IBM SPSS (version 23, IBM SPSS, Chicago, IL, USA). Descriptive statistics were calculated, including absolute and relative frequencies. An independent-samples t-test was employed to test the bivariate association between variables. Multiple regression analysis using backward elimination was conducted to identify independent variables associated with the dependent variable ($\alpha = 0.05$). The cutoff point for including variables in the regression model was a p-value less than 0.20 in the previous bivariate analyses. Collinearity diagnostics showed that tolerance and variance inflation factor (VIF) values indicated multicollinearity would not be a problem in the regression model.

Ethical Clearance

The research ethics committee of the Federal Institute of Goiás approved this study (Approval 5342093). All participants were informed about the research and invited to participate voluntarily, with confidentiality and anonymity assured; those who agreed signed the informed consent form. The ethics committee exempted the research from obtaining parental or guardian consent for minors (Resolution CNS No. 510/2016, Art. 1) [17].

■ Results

A total of 219 students participated in the survey (Response rate = 98.2%). Table 1 describes their characteristics. Most were female (53.9%), aged 14 to 16 years (65.3%), and self-declared as brown (56.6%). Most mothers had a high level of education (61.2%), while most fathers had a low level (51.6%). Additionally, the majority had never smoked (77.6%).

Table 2 shows the frequencies of correct answers for the 16 statements about the main effects of smoking on OH. The statement "smoking is harmful to oral health" obtained the highest percentage of correct answers

(85.4%) among the students. Overall knowledge scores on the effects of smoking on oral health ranged from 49 to 80 points, with a mean of 65.8 (SD = 6.8).

Table 1. Characteristics of study participants

Variables	N	%
Gender		
Male	96	43.8
Female	118	53.9
Not informed	5	2.3
Age		
17-19 years	76	34.7
14-16 years	143	65.3
Colour/Race		
Brown	124	56.6
White	69	31.5
Black	21	9.6
Yellow	5	2.3
Mothers' Level of Education		
Low (< 9 years of study)	78	35.6
High (≥ 9 years of study)	134	61.2
Not informed	7	3.2
Father's Level of Education		
Low (< 9 years of study)	113	51.6
High (≥ 9 years of study)	84	38.4
Not informed	22	10.0
Smoking Status		
Current/Former smoker	48	21.9
Never smoked	170	77.6
Not informed	1	0.5
Parental Smoking		
Smokers	49	22.4
Nonsmokers	167	76.2
Not informed	3	1.4

Table 2. Frequency of correct answers regarding 16 statements about the effects of smoking on oral health among Brazilian adolescent students.

Items	Thematic Domains	Statements	Correct Answers	
			N	%
1	Oral health harms (overall)	Smoking is harmful to oral health.	187	85.4
2	Oral cancer	Smoking is one of the main causes of oral cancer.	78	35.6
3	Oral cancer	Smokers are more likely to develop oral cancer than nonsmokers.	112	51.1
4	Oral cancer	Smoking can cause leucoplakia, a precancerous condition in which thick white patches form on the gums and other areas of the mouth.	57	26.0
5	Periodontal diseases	Smokers are more likely to have periodontitis, a destructive inflammatory disease of the tissues that surround and support the teeth.	69	31.5
6	Periodontal diseases	After treatment for periodontal disease (diseases of the gums, ligaments, and bone that support the teeth in the mouth), smokers do not heal as well as nonsmokers.	52	23.7
7	Tooth decay and tooth loss	Smokers are more likely to have tooth decay.	82	37.4
8	Tooth decay and tooth loss	Smokers are more likely to lose their teeth compared to nonsmokers.	123	56.2
9	Aesthetics	Smoking contributes to brownish stains on the gums (smoker's melanosis).	80	36.5
10	Aesthetics	Smoking contributes to staining teeth and dental fillings.	115	52.5

11	Oral dysfunctions	Smoking is a common cause of bad breath and dry mouth.	117	53.4
12	Oral dysfunctions	Smoking can decrease the ability to taste and smell.	61	27.9
13	Dental implants and oral surgery	Smokers are more likely to experience dental implant failure.	54	24.7
14	Dental implants and oral surgery	Smokers who undergo oral surgery may have difficulty healing.	40	18.3
15	Passive smoking	Exposure to cigarette smoke (passive smoking) can increase the risk of periodontal disease (diseases of the gums, ligaments, and bone that support the teeth).	37	16.9
16	Passive smoking	Exposure to cigarette smoke (passive smoking) is associated with tooth decay and gum staining (melanosis) in children who live with smokers.	32	14.6

Table 3 shows the bivariate analyses. Age, colour or race, and smoking status were statistically associated with the level of knowledge of adolescents ($p < 0.05$). In addition, the regression analysis included gender and parental smoking. Lastly, Table 4 presents the results of the multiple regression analysis using backward elimination. Knowledge level remained associated with smoking status in the final adjusted model ($\beta = -0.146$; $p = 0.038$).

Table 3. Bivariate analysis of factors associated with Brazilian adolescents' knowledge about smoking effects on oral health.

Factors [#]	N	Mean (SD)	MD (95%CI)	p-value
Gender (N = 205)				
Male	91	64.98 (6.92)	-1.46 (-3.34 - 0.40)	0.124
Female	114	66.45 (6.63)		
Age (N = 210)				
17-19 years	73	67.23 (7.34)	2.15 (0.14 - 4.16)	0.028*
14-16 years	137	65.08 (6.33)		
Colour/Race (N = 210)				
Black, Brown or Yellow	143	65.15 (6.60)	-2.13 (-4.09 - -0.18)	0.033*
White	67	67.28 (6.92)		
Mothers' Level of Education (N = 203)				
Low (< 9 years of study)	75	65.99 (6.47)	0.20 (-1.72 - 2.137)	0.831
High (≥ 9 years of study)	128	65.78 (6.88)		
Father's Level of Education (N = 188)				
Low (< 9 years of study)	108	65.52 (6.94)	-1.20 (-3.19 - 0.78)	0.232
High (≥ 9 years of study)	80	66.73 (6.65)		
Smoking Status (N = 210)				
Current/Former smoker	44	68.09 (7.23)	2.86 (0.63 - 5.09)	0.012*
Never smoked	166	65.23 (6.53)		
Parental Smoking (N = 209)				
Smokers	47	67.45 (7.19)	2.06 (-0.27 - 4.26)	0.067
Nonsmokers	162	65.39 (6.59)		

M: Mean knowledge score; SD: Standard deviation; MD: Mean difference; CI: Confidence interval; *Statistically significant p-values ($p < 0.05$); [#]A smaller number of cases indicates missing data.

Table 4. Multiple regression analysis using backward elimination of factors associated with adolescents' level of knowledge about the effects of smoking on oral health.

Model	Unstandard. Coeff.		Stand. Coeff. Beta	t	p-value	95% CI for B	
	B	Std. Error				Lower Bound	Upper Bound
1 (Constant)	69.045	3.622		19.061	0.000	61.902	76.188
Age	-1.496	1.004	-0.105	-1.490	0.138	-3.475	0.484
Colour or race	1.790	1.020	0.123	1.756	0.081	-0.221	3.801
Smoking status	-1.675	1.203	-0.101	-1.392	0.165	-4.047	0.697
Gender	1.380	0.939	0.101	1.469	0.143	-0.472	3.232
Parental smoking	-1.276	1.163	-0.078	-1.097	0.274	-3.569	1.017
2 (Constant)	67.578	3.368		20.064	0.000	60.936	74.219

Age	-1.633	0.997	-0.115	-1.639	0.103	-3.598	0.332
Colour or race	1.668	1.014	0.115	1.645	0.102	-0.332	3.667
Smoking status	-1.945	1.178	-0.117	-1.650	0.100	-4.268	0.379
Gender	1.423	0.939	0.104	1.515	0.131	-0.429	3.274
3 (Constant)	69.889	3.013		23.199	0.000	63.948	75.830
Age	-1.548	0.998	-0.109	-1.551	0.122	-3.517	0.420
Colour or race	1.688	1.017	0.116	1.660	0.099	-0.318	3.694
Smoking status	-2.094	1.178	-0.126	-1.777	0.077	-4.416	0.229
4 (Constant)	67.763	2.692		25.168	0.000	62.454	73.072
Colour or race	1.818	1.017	0.125	1.787	0.075	-0.188	3.824
Smoking status	-2.427	1.162	-0.146	-2.088	0.038	-4.718	-0.135

*Standardized Coefficients; Unstandardized Coefficients; Variables removed at each step: Parental smoking (Model 2); Parental smoking/Gender (Model 3); Parental smoking/Gender/Age (Model 4).

Discussion

This study aimed to investigate the level of knowledge of adolescent students regarding the harmful effects of smoking on OH. Although most adolescents were aware that smoking is harmful to OH, few were familiar with its effects on the mouth. This finding supports a previous study whose authors assessed the subjective level of knowledge about the effects of smoking on OH among Brazilian adolescent students [15], who rated their level of knowledge mostly as low. These results highlight and reinforce that the awareness of the OH risks associated with smoking is limited among adolescent students.

A low level of knowledge about the effects of smoking on OH was associated with adolescents who had never smoked. Similarly, Rios and Freire [15] also found that adolescents who had never smoked presented a low level of subjective knowledge about the effects of smoking on OH. The authors noted that this finding may reflect the global shift away from mass media campaigns aimed at the entire population, which have been reduced in recent decades [18]. Warning strategies have mainly targeted those who have already acquired this habit (e.g., warning messages on packaging) [18]. Thus, the association between having smoked and greater knowledge in our study should be interpreted with caution. This does not imply a protective factor but may reflect prior exposure to anti-smoking messages.

Other studies have also observed a low level of knowledge among adolescents about the harms of smoking or secondhand smoke and its impact on general health [19-22]. Furthermore, a previous study noted poor oral cancer risk-related knowledge among adults, indicating that this problem persists into adulthood, and efforts to raise awareness at the population level are needed [23].

Regarding factors associated with knowledge of the effects of smoking on OH, the multiple regression analysis showed no statistical differences between sociodemographic groups (gender, colour or race, age, and parental education level). However, this finding does not rule out these associations. Rather, we did not observe them in this study.

The present study had some limitations. The cross-sectional design limits the ability to establish causal or temporal relationships because all variables were measured simultaneously. Furthermore, the findings should be interpreted with caution, as the sample was drawn from a public school and was a convenience sample. Another limitation is the lack of reliability tests for the knowledge questionnaire. However, the study is considered to have good internal validity, as precautions were taken to mitigate bias, such as double data entry, external evaluation of the instrument by health researchers, and a low non-response rate.

The low level of knowledge about the effects of smoking on OH highlights the potential for interventions aimed at addressing this issue. OH professionals should be routinely involved in educating patients

and the public about the risks of smoking and encourage the avoidance and cessation of all forms of tobacco [1,3]. Despite the global decline in smoking observed in recent years, the results are concerning because the prevalence of smoking has not declined among adolescent students [11]. Therefore, educational initiatives about smoking must be introduced as early as possible in the social lives of adolescents since they are most vulnerable to new experiences. Lastly, longitudinal studies must be conducted on causal relationships and experimental studies to monitor the changes and effects of interventions aimed at controlling adolescent smoking. For example, by testing how interventions affect changes in smoking behaviour.

The results of our study may have practical implications for public health interventions aimed at promoting smoking cessation and preventing the initiation of smoking among adolescent students. Through oral health education in the school environment, oral health services can develop interventions in partnership with high schools. Oral health professionals can benefit from the results of this study to develop interventions that reinforce and encourage awareness of oral health in the context of smoking.

■ Conclusion

While most adolescents recognize that smoking is harmful to oral health, many are unaware of the specific harmful effects it has on the mouth. Overall, students demonstrated greater awareness of the effects of smoking as a risk factor for oral cancer, tooth loss, and aesthetic or functional problems, and less awareness of the effects of passive smoking on oral health. The factor associated with the level of knowledge about the effects of smoking on oral health was the smoking status, meaning that a lower level of knowledge was observed among adolescents who had never smoked.

■ Authors' Contributions

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All authors declare that they contributed to the critical review of intellectual content and approval of the final version to be published.		

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■ Conflict of Interest

The authors declare no conflicts of interest.

■ Declaration of use of AI technologies

This study did not use generative artificial intelligence (AI).

■ Data Availability

The data supporting the findings of this study are available upon reasonable request to the corresponding author.

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