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Association of the DMFT Index to the Salivary pH Levels of Smoking and Non-Smoking Students of the Universidad Católica Santiago de Guayaquil

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Abstract

Introduction: Dental caries is a disease of multifactorial etiology; and saliva is the first biological fluid to be exposed to the harmful components of tobacco; therefore, its exposure will produce changes of the salivary pH level in the oral cavity. **Objective:** To analyze the association of the decayed, missed or filled teeth index (DMFT) with the oral pH levels in smoking and non-smoking students, in order to , to determine the relationship between smoking and the prevalence of

dental conditions. **Materials and methods:** A case-control study of simple random sampling, with young smokers and non-smokers from the UCSG Dentistry course, with good hygiene habits and without the presence of systemic diseases. The study groups underwent clinical inspections to determine the DMFT index and the unstimulated salivary pH level was measured with Macherey-Nagel® brand strips. **Results:** The study analyzed 237 individuals with good oral hygiene using the chi-square test, finding that smokers had a lower oral pH and slightly higher DMFT index compared to non-smokers. Although the association between the DMFT index and smoking habit was not statistically significant (p-value 0.07), a significant relationship between tobacco smoking and increased oral acidity was demonstrated (p-value < 0.001). These findings highlight the importance of considering the negative effects of smoking on oral health, particularly on oral acidity. **Conclusions:** The salivary pH levels of smokers is moderately more acidic. However, statistically, this acidity condition is not decisive to establish the correlation between smoking and an increase of the DMFT index.

Keywords: DMFT index, salivary pH index, smokers, tobacco

INTRODUCTION

There are several studies around the world addressing the harmful effects of tobacco use on the oral cavity and on health in general. However, in Ecuador, information is still very limited. In 2006, according to the National Institute of Statistics and Census (INEC), the smoking population represented 4.5% of the total population; and at the gender level, men represented the group with the highest consumption, with a prevalence of 85.5%; Guayaquil being the city with the highest frequency of consumption, with an average of seven cigarettes per day[1]. At the health level, tobacco smoking is the leading preventable cause of death worldwide; and in the dental field, the affections can be very diverse[2]. The main oral disorders are associated with pigmentation, halitosis, abrasion and, periodontal and peri-implant diseases[2, 3.] In addition, tobacco smoking prevents remission in periodontal surgery[2, 3].

Saliva is the first biological fluid exposed to the harmful components of tobacco and it has been shown that the salivary microbiome can vary according to lifestyle and diet[4]. Saliva is not considered a reservoir of putative oral pathogens in individuals with low caries and periodontitis[4]; yet, this fluid plays an important role in the homeostasis of the oral cavity and in the protection of teeth through its buffering capacity[5]. The buffering effect regulates salivary pH, neutralising acidity and decreasing cariogenic potential. Therefore, alteration of saliva, whether in quantity, composition or pH level, is a risk factor for the development of carious lesions[5-7].

Dental caries is the most prevalent pathology in the world, the origin of which is multifactorial and chronic, affecting both sexes from the beginning of their dentition, and is manifested as an imbalance in the remineralisation process of the tooth, leading to the progressive loss of its structures[8]. Internationally, there are studies that support the direct relationship between smoking and the generation of dental caries, using the index of decayed, missing and filled teeth (DMFT)[9]. Nonetheless, there are few studies on this topic in Ecuador. According to a study published in 2018, the DMFT index of smokers was 7.60 ± 0.36; against 4.80 ± 0.5 of non-smokers[9, 10]; and the salivary pH level obtained in smokers is slightly more acidic (6.57 ± 0.06) than that

of non-smokers (7.04 ± 0.07)[9, 11]. In comparison with non-smoking subjects, with regard to plaque accumulation and calculus deposits, the results indicated that no significant differences were found in smoking subjects[12].

The objective was to establish the relationship between DMFT index levels associated with oral pH levels in smoking and non-smoking students of the Dentistry course at the Universidad Católica Santiago de Guayaquil (UCSG).

MATERIALS AND METHODS

Epidemiological case-control study of simple random sampling, carried out in the period between October 2020 and February 2021, in the Dental Clinics of the Universidad Católica Santiago de Guayaquil (UCSG).

The study group consisted of students of both sexes, without systemic diseases, from the first to the ninth semester of the UCSG Bachelor's degree of Dentistry; whose universe was 688; from which a sample of 237 students was obtained, established through a confidence interval of 95% and with a margin of error of 0.05. The sample obtained was divided into a control group (non-smokers) and a group of cases corresponding to students who smoked (from occasional to severe, in terms of frequency of consumption). The inclusion criteria were: to be a registered student of the Dentistry course, to attend classes regularly and to have good oral hygiene; in addition to freely, consensually and explicitly agreeing to participate in the present study. Students who did not wish to participate and who at the time of the examination had systemic diseases (eight students) were excluded, so the final sample was 237 students.

Smoking prevalence was determined by means of a survey, and the DMFT index was obtained through an intraoral examination, according to World Health Organisation (WHO) criteria[13,14]. The intraoral assessment was carried out by a student in the last semester of the course, under the simultaneous supervision of the professor in charge of the clinic, using the dental chairs with LED light source and basic diagnostic instruments, such as oral mirror, explorer, use of triple syringe and a suction device.

Unstimulated saliva pH samples were collected periodically from 9:00 to 11:00 a.m., in order to avoid diurnal variations. Subjects were asked not to eat, drink or smoke for at least 60 minutes before and during sampling. For the measurement of the pH of unstimulated saliva, professional-grade strips of the brand Macherey-Nagel®, Ref. 92118, approved for the determination of saliva pH according to the *in vitro* Diagnostics Directive (IVD) 98/79/EC, were used. The strips have a pH measuring range from 2 to 9 and are graduated with visual scales of 0.5 in the reaction zones. According to the protocol established by the manufacturer, the strip was immersed in saliva under the tongue for 30 seconds; after removal, the salivary pH level was confirmed with the colour guide provided.

Within the pH classification levels, the samples obtained fell into the categories of slightly acidic (5.0-6.9), neutral (7.0) and slightly basic (7.1-8.9); no data were available for the other categories, while the DMFT index was grouped and analysed without categorisation. Simultaneously, the variables studied were analysed according to sex and smoking status.

For the present study, the analysis of association was applied with the Chi-square test and the data were collected in an Excel table and the variables were analysed using the IBM® SPSS Statistic programme.

RESULTS

A total of 237 persons participated in the study, with 63.29% (150) females and 36.71% (87) males. 20.25% (48 cases) of the sample were student smokers, with 11.39% males and 8.86% females. The control group accounted for 79.75% (189) considering both sexes. The mean age of the control group was 22.76 ± 0.19 years, while that of the smokers was 23.50 ± 0.34 years, with the age group 22 to 26 years being more common. The percentage of smokers aged 22 to 26 years was 71.43% (15/21) for females and 48.1% (13/27) for males (Table 1).

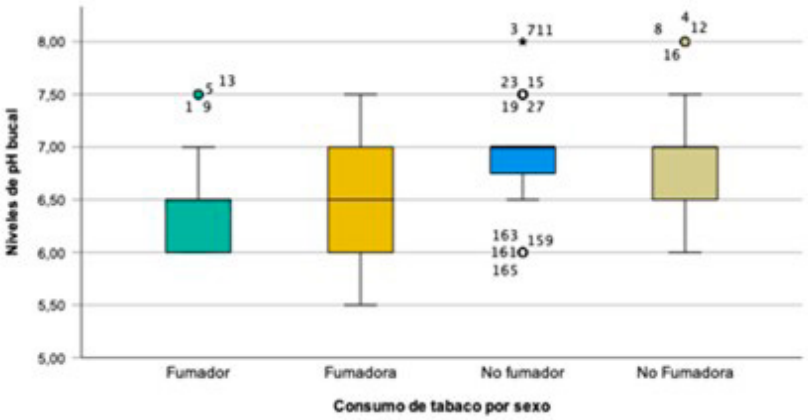
Table 1.
Frequency table of smokers and non-smokers according to sex and age

Age (years)	Male		Female	
	Smoker (%)	Non-Smoker (%)	Smoker (%)	Non-Smoker (%)
18-22	9 (4%)	27 (11%)	4 (2%)	72 (30%)
22-26	13 (5%)	28 (12%)	15 (6%)	47 (20%)
26-30	5 (2%)	5 (2%)	2 (1%)	8 (3%)
30-34	0 (0%)	0 (0%)	0 (0%)	2 (1%)
TOTAL	**27 (11%)**	**60 (25%)**	**21 (9%)**	**129 (54%)**

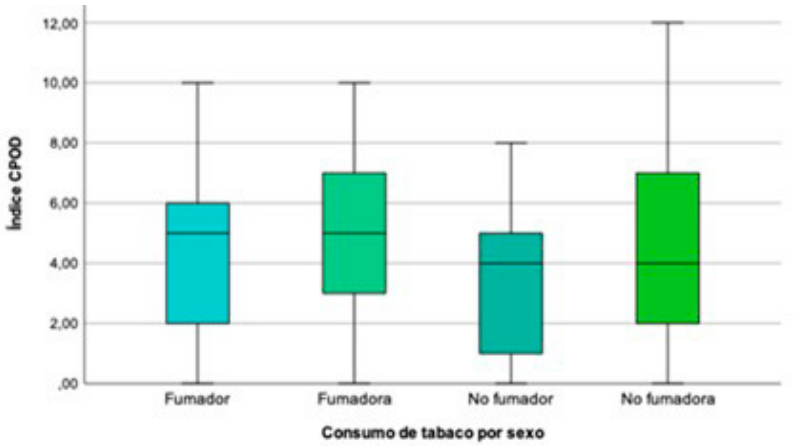
Source: database of surveys conducted in the period 2020-2021.

Regarding oral pH, the mean of the control group was 7.09 ± 0.03, slightly more neutral than the smokers' group, where the latter had a mean of 6.54 ± 0.07. The distribution of the median confirmed that smokers had an oral pH 0.5 units lower than non-smokers (Graphic 1).

Though, a moderately significant difference was found in the DMFT index between the two groups. The control group had a DMFT index of 4.14 ± 1.93 (moderate index), while the smoking group had a DMFT index of 4.70 ± 0.43 (high index). There was no significant difference between the sexes; but between smokers and non-smokers, the gap between these two categories was approximately one point around the mean (Graphic 2).



Graphic 1. Simple boxplot of oral pH levels by tobacco use and gender
Y-axis: Oral pH levels
X-axis: Tobacco use by sex



Graphic 2. Simple boxplot of CPOD index by tobacco use and by sex
Y-axis: DMFT index
X-axis: Tobacco use by sex
Categories: Male Smoker, Female Smoker, Male Non-smoker, Female Non-smoker

When categorising the DMFT index (from very low to high) and when analysed with the groups of tobacco smokers and non-smokers, the Chi-square test showed a value of 8.670, which indicates that there is some evidence of association, but its significance in terms of the p-value is 0.070, which is insufficient to statistically determine the relationship between tobacco smoking and the increase in the DMFT index; the Kappa value was 0.222, which determines a weak concordance between the variables (Table 2). As for oral pH, the Chi-square test statistic (Pearson) was 14.358, indicating a significant association; the associated p-value is less than 0.001, which determines the existence of a relationship between tobacco smoking and an increase in oral acidity; and inversely, mostly neutral and alkaline in non-smoking students (Table 3).

Table 2.
Chi-square test of DMFT index and tobacco use.

	DMFT index		**Very low**	**Low**	**Moderate**	**High**	**Very high**	**Total**
Tobacco use	Smoker	Observed	$10_{a, b, c, d}$	$2_{c, d}$	$8_{b, d}$	16_{a}	$12_{a, b, c, d}$	48
		% DMFT index	21.70%	6.90%	14.50%	32.00%	21.10%	20.30%
	Non-smoker	Observed	$36_{a, b, c, d}$	$27_{c, d}$	$47_{b, d}$	34_{a}	$45_{a, b, c, d}$	189
		% DMFT index	78.30%	93.10%	85.50%	68.00%	78.90%	79.70%

Chi-square test result Valid cases: 237		**Value**	**df**	**Asymptotic significance (bilateral)**	a. 0 cells (0.0%) have expected counts less than 5. The minimum expected count is 5.87.
	Pearson	8,670[a]	4	,070	
	Kappa	,022			

Each subscript letter denotes a subset of CPOD index categories whose column proportions do not differ significantly from each other at the .05 level.

Table 3.
Chi-square test of the oral pH index and tobacco use.

	pH index		Slightly acidic	Neutral	Slightly basic
Tobacco use	Smoker	Observed	34_a	8_b	$6_{a, b}$
		% DMFT index	30.40%	9.00%	16.70%
	Non-smoker	Observed	78a	81b	30a, b
		% DMFT index	69.60%	91.00%	83.30%
Total		Observed	112	89	36
		% DMFT index	100.00%	100.00%	100.00%
Chi-square test result Valid cases: 237		**Value**	**df**	**Asymptotic significance (bilateral)**	a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.87.
	Pearson	14,358[a]	2	< ,001	

Source: database of surveys conducted in 2020-2021, analysed using SPSS software.

DISCUSSION

The prevalence of smokers was relatively low (20, 25%); in relation to similar studies conducted within the UCSG[15]; as well as in Latin America[10] and the world[16]. In terms of oral pH, smokers were found to have a significantly more acidic oral pH compared to non-smokers. This difference in oral pH may be attributed to the effects of tobacco on the composition of saliva and its buffering capacity[17]. It has been shown that tobacco use can alter the amount and composition of saliva, affect the acid-base balance in the oral cavity and lead to the development of carious lesions.

In relation to the DMFT index, it was observed that smokers had a slightly higher DMFT index compared to non-smokers, although this difference was not statistically significant. Although other international studies have found a significant association between smoking and the development of dental caries, the results of this particular study do not support this relationship in the population studied. Still, it is important to keep in mind that the sample size was relatively small, which may have limited the detection of significant differences.

On the other hand, it is relevant to note that this study focused on dental students with good oral hygiene; therefore, it is possible that the student smokers in this study represent a sample of smokers who are more conscious and careful about their oral health compared to the general population. This could have influenced the results and the lack of significant association between smoking and the DMFT index.

These findings highlight the importance of further research into the effects of tobacco use on oral health and the need to promote prevention and risk awareness programmes.

CONCLUSIONS

Statistically the variables studied did not have a normal distribution and for the present study the variables were categorised according to the methodology described in this article to analyse their correlation.

The results of the study show that the salivary pH levels of smokers are moderately more acidic. Nevertheless, this acidic condition was not conclusive in generating higher DMFT indices than the control group.

Smoking individuals have a higher DMFT index than non-smokers by approximately 1 point difference; the index ranged from moderate to high. In contrast to other studies, which showed a statistically significant correlation between smoking and an increase in the DMFT index, statistical tests did not reveal a correlation between smoking and an increase in the DMFT index. In turn, it can be concluded that despite not establishing a causal relationship between smoking and the development of dental caries, tobacco smoking should be considered a risk factor for dental disease.

The results obtained confirm the decrease in pH levels in young smokers with good hygiene habits. Future research regarding smoking and its effects on cariogenic microorganisms and saliva can be derived from this study. We also recommend that other variables that may modify the occurrence of dental caries in relation to tobacco smoking be included in parallel.

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