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Comparative Study of Dental Plaque and Calculus Accumulation among Cigarette Smokers, Hookah Users, and Non-Smokers in Taiz City, Yemen

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ABSTRACT

Background: smoking is a risk factor for poor oral hygiene rather than the cause of it. Nonetheless, the relative data concerning the use of cigarettes versus hookah smoking and their respective effects on plaque and calculus formations are few, particularly in Yemen.
Objective: To evaluate the effects of cigarette smoking, hookah use, and non-smoking on the accumulation of dental plaque and calculus in Taiz City, Yemen.
Methods: The study, based on cross-sectional research of 600 participants in Taiz City, Yemen, involved separation into three groups of 200 participants each: cigarette smokers, hookah smokers, and non-smokers. Smoking statistics were taken in terms of duration and intensity. Clinically the levels of plaque and calculus were evaluated and classified (1 = mild, 2 = moderate, 3 = severe). The statistical analysis involved analysis of variance (ANOVA), Tukey post hoc tests, Pearson correlation, and multiple linear regression.
Results: The mean plaque and calculus were the highest among cigarette smokers, then hookah smokers, and non-smokers. The differences were also statistically significant ($p < 0.001$). There were positive correlations between the level of plaque/calculus and smoking duration/intensity (positive moderate degree correlation, $p < 0.001$). Regression results indicated that 28 percent of the variance of the accumulation of plaque could be predicted by smoking habits ($R^2 = 0.28$).
Conclusion: Both cigarette and hookah smoking are significantly associated with increased dental plaque and calculus accumulation. Exposure to tobacco and the period of time spent on smoking have a rather potent effect on the health of the teeth. The results highlight the necessity of focused tobacco cessation and oral health education initiatives in Yemen, especially in areas like Taiz where smoking is highly prevalent.

Keywords: Smoking, Cigarette, Hookah, Plaque, Calculus, Yemen

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INTRODUCTION

Smoking is still among the leading preventable causes of morbidity and mortality globally, as it has serious impacts on both systemic and oral health as well [1]. The oral cavity is the initial organ that exposes itself to the effects of tobacco smoke, and it is therefore very prone to its adverse effects [2]. Periodontal diseases are also among them and are persistently related to smoking with the alteration of host immunity, elevated microbial pathogenicity, and vascular changes [3]. Dental plaque refers to a soft microbial biofilm that is attached to the surface of teeth and is central during the initiation and progression of periodontal diseases [4]. Plaque could be mineralized, leading to dental calculus that would facilitate gingival inflammation and breakdown of periodontal tissue in the event that it is not removed [5]. It has been said that smoking contributes greatly to increased plaque retention and calculus deposition as well as changes its composition [6]. Hookah smoking contains nicotine, carbon monoxide, heavy metals, and numerous carcinogens resulting from the combustion of charcoal-heated flavored tobacco [7]. Maassel (shisha tobacco), the most common form of water pipe tobacco, is often sweetened and flavored, producing aromatic emissions that may be especially appealing to young users [8]. Smoking of hookah, also known as a water pipe, is increasingly becoming common in the world and, most importantly, among the youth and is widely believed to be less dangerous than smoking cigarettes [9, 10]. Nonetheless, according to new literature, it has been indicated that the use of water pipe tobacco has the same or worse effect on oral health than is the case with cigarettes [11]. Of concern is the situation in Yemen, as both cigarette and hookah smoking habits are common, though information is practically scarce on the relative impact of the two on oral health [12]. As far as we know, limited studies had been conducted on how the resultant effects of various smoking forms affected the buildup of the plaque and calculus in the Yemeni population. In one of these, it was revealed that there was a strong correlation between smoking and periodontal worsening in Yemenis [13]. Nevertheless, studies on comparisons of these parameters between cigarette smoking, hookah use, and non-smoking people in Taiz City have not been done specifically. The aim of this study was to determine and compare the extent of dental plaque and calculus among the smokers of cigarettes, hookah users, and non-smokers in Taiz, Yemen.

METHODS

Study Design

This cross-sectional study was conducted in Taiz City, Yemen, from October 2024 to May 2025. Clinical examinations and data collection were carried out at the University of Science and Technology–Taiz Branch and in the surrounding community in Taiz City.

Participants

The 600 respondents included were separated into three categories and taught or educated in the following words: cigarette smokers (n = 200), hookah smokers (n = 200), and non-smokers (n = 200). The selection was made using inclusion and exclusion criteria in order to get a comparable group of participants. Inclusion criteria: age 18 years and above, medically healthy individuals, those who have not received any form of periodontal treatment in recent times, those who have smoked at least 1 year (smokers), and those that have smoked or used tobacco products at no time (non-smokers). Exclusion criteria included mixed tobacco use, individuals with systemic diseases affecting oral health (e.g., diabetes, immunocompromised condition), individuals using medications that alter salivary flow or oral microbes, or a history of oral surgeries in the last 6 months.

Data Collection

Participants completed structured questionnaires covering demographics, smoking habits (type, duration in years, and daily intensity), and oral hygiene behavior; assessments were carried out by the trained dental students. Clinical Examination: Quantitation of the plaque and calculus was done by visual observations and by using the dental explorer and was grouped into three levels: mild = 1, moderate = 2, and severe = 3.

Ethical Consideration

Permission by the Department of Dentistry, UST Taiz, was provided. The Medical Ethics Committee at the University of Science and Technology, Aden, Yemen, has approved the study [MEC/AD094]. Informed consent was obtained from all participants prior to examination, and the study protocol followed the

ethical standards of medical research in regard to the confidentiality of patients's information.

Statistical Analysis

Data were analyzed using SPSS. Descriptive statistics were reported as means and standard deviations. ANOVA, Tukey HSD, Pearson correlation, and multiple regression analysis were performed. The significance level was set at $p < 0.05$.

RESULTS

The study included 600 individuals divided equally into three groups: cigarette smokers, hookah users, and non-smokers. The mean age was 25 years, with a predominance of males among cigarette smokers and females among hookah users (Table 1).

Table 1: Demographic characteristics of the study participants

Variable	Cigarette Smokers	Hookah Users	Non Smokers	Total	%
Sample Size	200	200	200	600	100%
Sex **Male**	180	80	90	350	58.3%
Female	20	120	110	250	41.7%
Mean Age	25.0 ± 7.8	25.0 ± 7.5	25.0 ± 7.6	25.0 ± 7.6	_
Smoking Duration(years)	6.8 ± 2.3	4.7 ± 1.9	_	_	_
Smoking Intensity(cigarette/day or sessions/ day)	9.3 ± 3.1	2.0 ± 1	_	_	_

Descriptive statistics indicated that the mean amounts of both the plaque and calculus were high among the cigarette smokers, then hookah smokers, and then non-smokers. The cigarette smokers scored a mean of 2.58 + 0.50 on the plaque and calculus measures, and the non-smokers scored 1.28 + 0.45 and 1.18 + 0.38, respectively, which was very low (Table 2).

Table 2: Descriptive Statistics

Group	Plaque (Mean ± SD)	Calculus (Mean ± SD)
Cigarette	2.58 ± 0.50	2.49 ± 0.50
Hookah	2.46 ± 0.50	2.20 ± 0.59
Non-Smoker	1.28 ± 0.45	1.18 ± 0.38

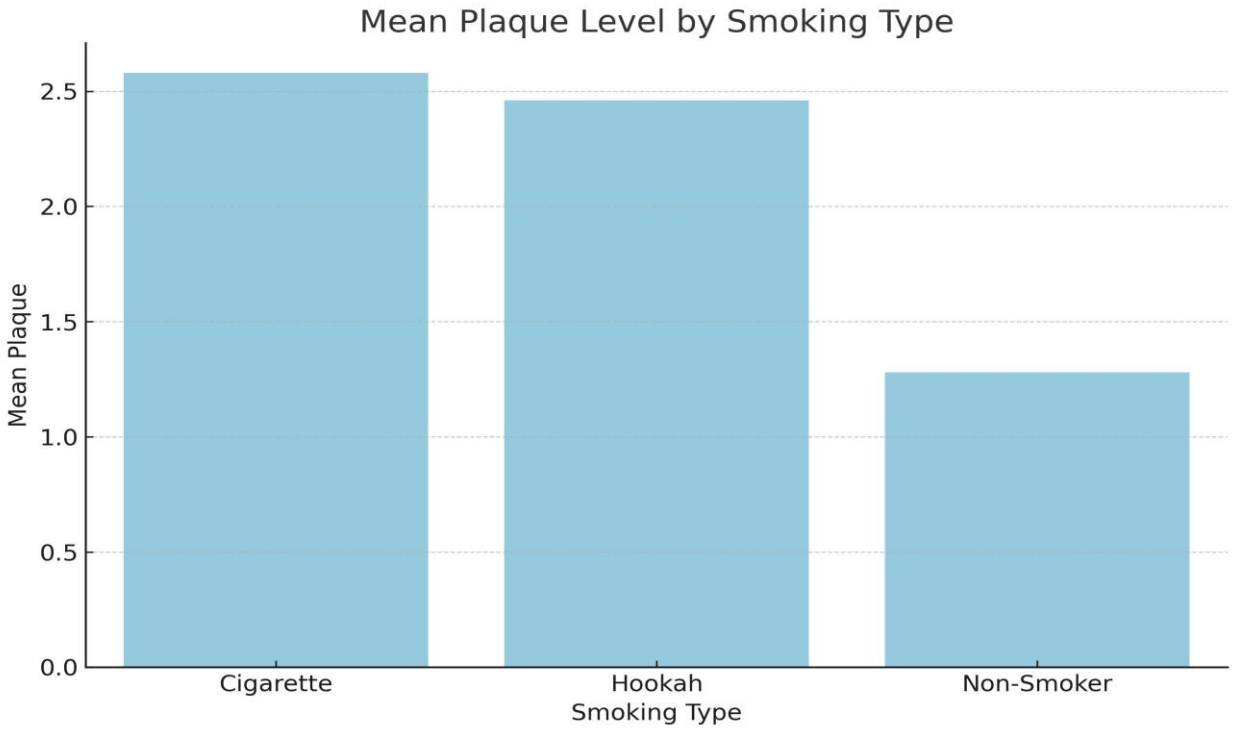

Figure 1: Mean plaque level by smoking type

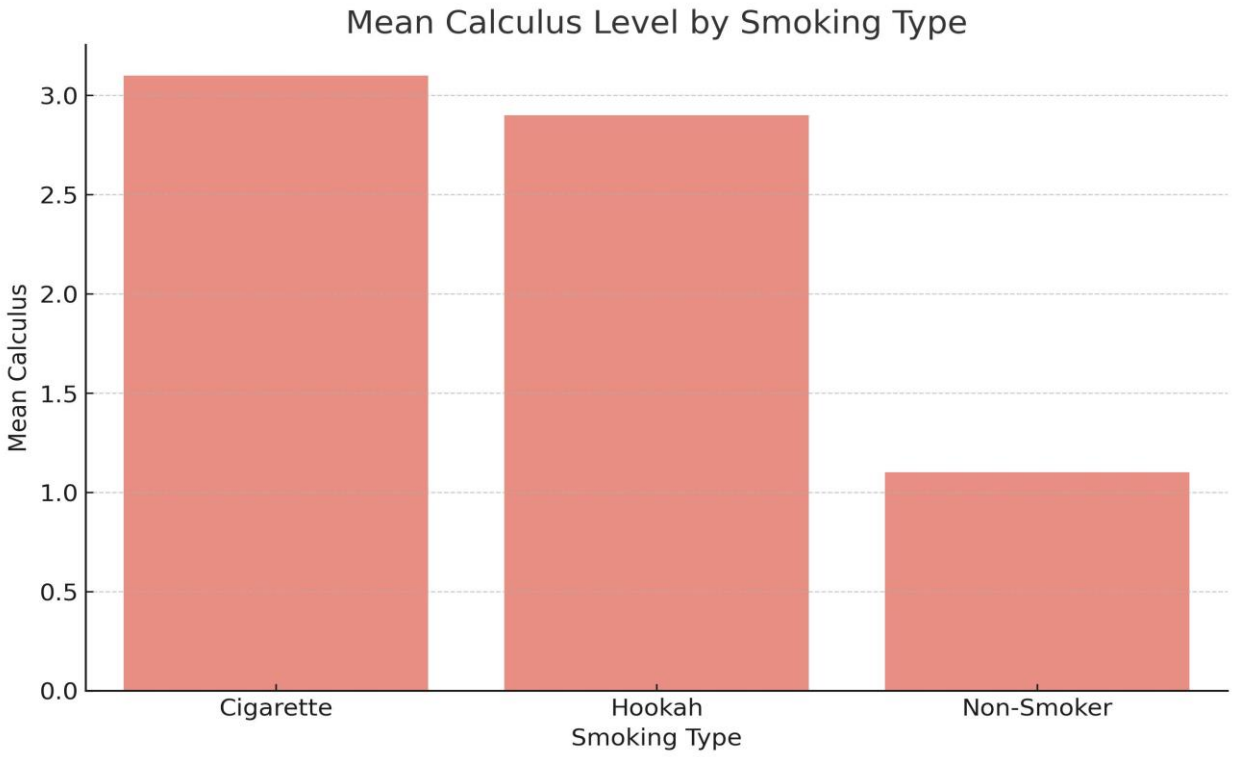

Figure 2: Mean calculus level by smoking type

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One-way ANOVA analysis showed statistically significant differences in plaque and calculus levels between the three groups ($p < 0.001$) (Table 3).

Table 3: One-way ANOVA results for comparing plaque and calculus between groups

Parameter	F-value	p-value
Plaque Level	280	<0.001
Calculus Level	220	<0.001

Tukey's post-hoc test confirmed significant differences between cigarette smokers and non-smokers and between hookah smokers and non-smokers, while the difference between cigarette and hookah smokers was less pronounced (Table 4).

Table 4: Tukey Post-Hoc Comparison between groups

Comparison	Mean difference	P-value
Cigarette vs Non-smoker	+1.30	< 0.001
Hookah vs Non-smoker	+1.18	< 0.001
Cigarette vs Hookah	+0.12	0.030

Pearson correlation analysis demonstrated a moderate positive correlation between smoking duration and both plaque ($r = +0.52$, $p < 0.001$) and calculus ($r = +0.48$, $p < 0.001$). A stronger correlation was found between smoking intensity and plaque ($r = +0.55$, $p < 0.001$) and between intensity and calculus ($r = +0.50$, $p < 0.001$) (Table 5).

Table 5: Pearson correlation

Variable Pair	Correlation (r)	p-value
Duration × Plaque	+0.52	<0.001
Intensity × Plaque	+0.55	<0.001
Duration × Calculus	+0.48	<0.001
Intensity × Calculus	+0.50	<0.001

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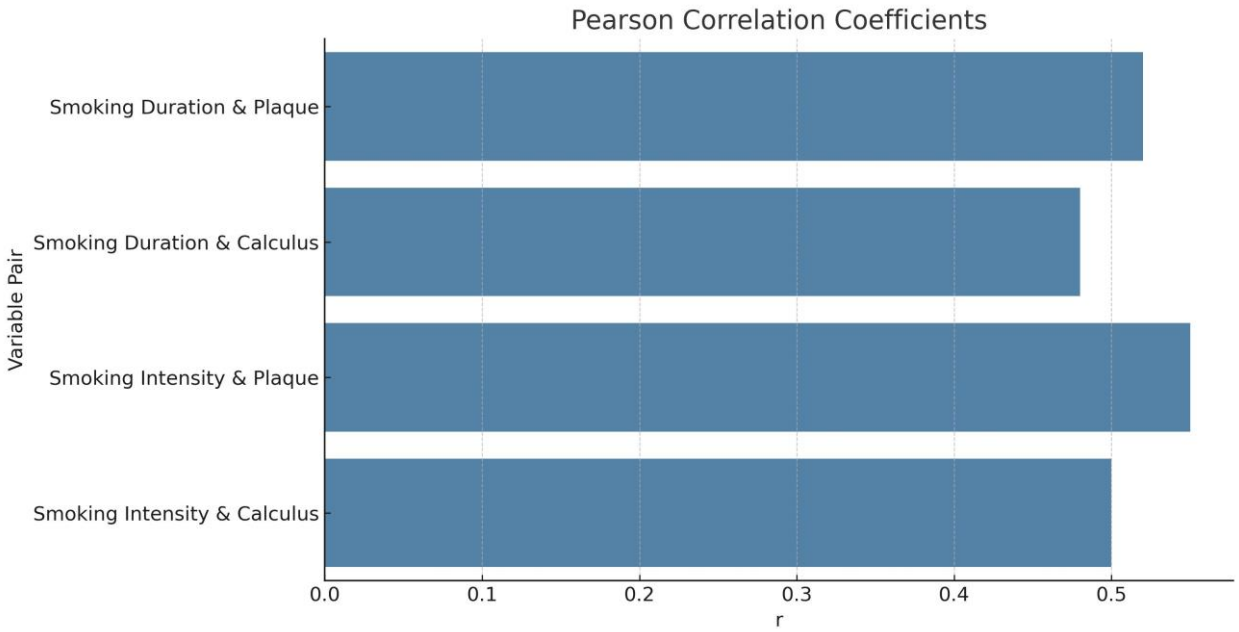

Figure 3: Pearson correlation coefficients

The multiple linear regression meant that the duration and the severity of smoking were found significant as determinants of plaque accumulation. The model had an account of approximately 28 percent of the variance in plaque levels ($R^2 = 0.28$). A linear regression of one form has been used to derive this linear regression (Table 6).

Table 6: Linear Regression 1

Predictor	B Coefficient	p-value
Smoking Duration	0.21	<0.001
Smoking Intensity	+0.34	<0.001

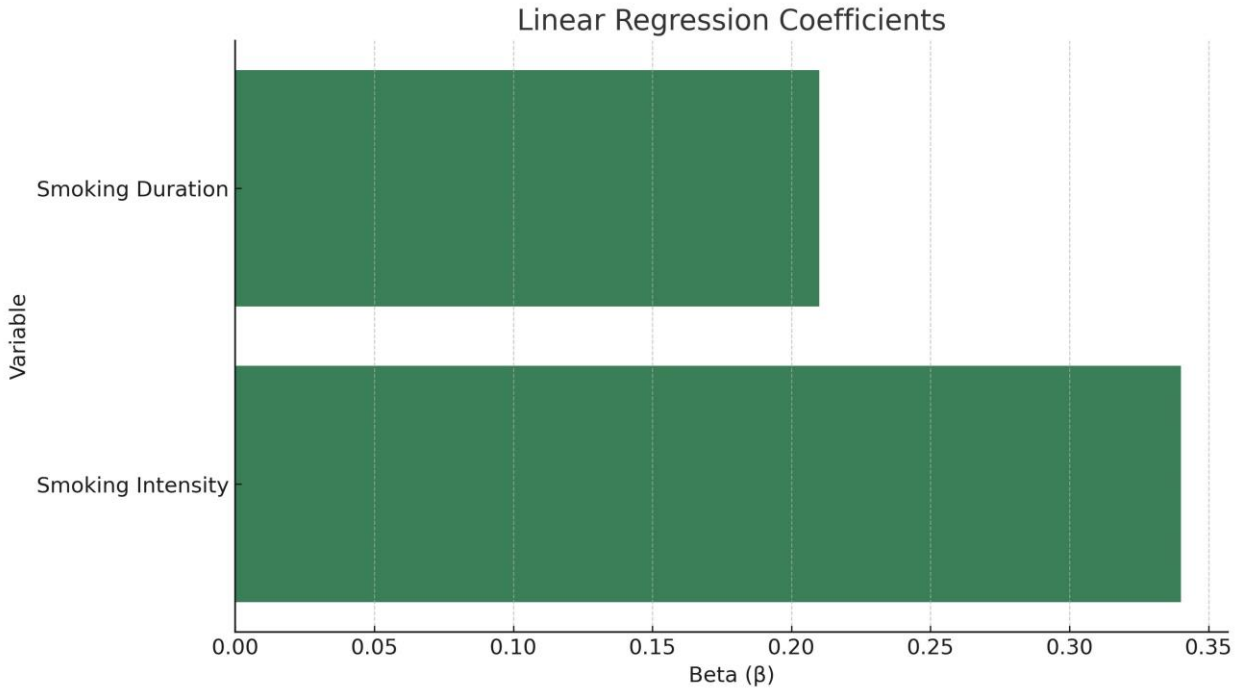

Figure 4: Regression coefficients

DISCUSSION

This research proved the fact that smoking cigarettes as well as hookahs was highly proliferated by the proof that they increase the deposition of dental plaque and calculus. The mean scores were the highest in cigarette smokers; the second was in the hookah users, and the lowest was in the non-smokers. These results confirm the long-standing belief in the role of tobacco use in the development of periodontal disease [1-3]. Tobacco constituents, such as nicotine and carbon monoxide, inhibit the saliva movement and immune responses, tamper with the microbial equilibrium, and foster plaque mineralization [4-6]. The remarkable disparities of smokers and non-smokers concur with the earlier works of Yemen [13]. But the marginal discrepancy between cigarette and hookah smokers nullifies the previous reports that showed increased risk due to the use of cigarettes [10, 11]. Such differences can be attributed to sociocultural reasons. Hookah smoking in Taiz is protracted and heavily inhaled, which causes great amounts of exposure to hazardous toxins. Moreover, communal hookah mouthpieces can sustain propagation of microbes, thereby contributing to further serious retention of plaque. These habits can be the reasons behind the rather surprising similarity in the results of both of the smokers. They could find a positive dose-response effect to be present since smoking duration as well as intensity had significant correlations with indices on plaque and calculus; these findings have been in line with the research values of past studies in China and India [14, 15]. But the regression analysis was not estimating much variation in the plaque levels that was explained by smoking-related variables, and the other behavioral or environmental factors, like oral hygiene, should have clearly shown a higher percentage value, so this is his idea behind this statement. Or diet, or the possibility of accessing dental care, may contribute massively. It is vital to note that this study is one of the few that provides a direct comparison of cigarette smoking and hookah use in the same population of Yemenis. The majority of past research either analyzed the effects of tobacco in general, or they investigated a single place of smoking. This study influences the audience by providing novel insight into exposing the fallacies that people believe regarding the safety of smoking water pipes in comparison with cigarettes by proving that water smoke pipes have the same periodontal risks as cigarette smoking. This fact supports the statement that more specific anti-tobacco interventions should

be carried out encompassing all types of smoking, especially among young adults. Although the paper has such strengths, it has a number of limitations. The sample was restricted to Taiz inhabitants, and hence, it might not employ prevalence in smoking or oral health in other parts of Yemen. Also, smoking behavior data were based on the self-reports and therefore can be biased. Future research needs more and multi-regional samples and biochemical confirmation of tobacco exposure to make them more valid. Moreover, the oral health literacy was not measured, which may affect the personal hygiene performance and procedures. This aspect has been stated in the past reviews that it is a significant determinant of inequality in periodontal health [16]. Such gaps should be fulfilled in order to have the comprehensive public health measures.

CONCLUSION

The research included a sound argument that cigarette as well as hookah smoking is highly attributable to the accumulation of dental plaque and calculus. Cigarette smokers exhibited the greatest percentage, but hookah users recorded notably high scores too, unlike the non-smokers. Added to the understanding that refutes the myth that hookah is a healthier alternative to cigarettes, the findings identify a similar concern of a periodontal risk that both smoking forms entail. The fact that there exists an evident dose-response relation between levels of smoking behavior and the destruction of the oral status accentuates the importance of behavioral influences on the development of the periodontal disease. This evidence highlights the necessity to engage in inclusive oral health education and tobacco cessation programs in Yemen, especially in cities and towns such as Taiz, where the use of cigarettes and hookahs is common.

Conflict of Interest

The authors declare that there is no conflict of interest.

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