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Dental caries in smokers aged 20–40 years in Mosul City

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ABSTRACT

Background: *Numerous epidemiological studies reported a close relationship between smoking and the occurrence of dental caries.* ***Purpose:*** *To investigate the distribution of tooth decay, lost teeth, and fillings among adults of different smoking habits in Mosul City.* ***Methods:*** *A total of 400 people aged 20–40 years were randomly selected from 30 coffee shops in Mosul City and were divided into 8 groups of 50 participants each, as follows: male non-smokers; male cigarette smokers; male e-cigarette smokers; male hookah smokers; male cigarette + hookah smokers; male e-cigarette + hookah smokers; female hookah smokers; female non-smokers. Participants were examined using the decayed, missing, and filled teeth (DMFT) index.* ***Results:*** *The cigarette group had the greatest average decayed tooth value, followed by the e-cigarette and the hookah group, which had the least. The highest DMFT values were obtained in the cigarette group and the lowest in the hookah group. Missing teeth were highest in the cigarette + hookah group. Hookah-smoking women had significantly higher tooth decay than non-smoking groups. There was no significant difference in missing and filled teeth. Women had more decayed teeth on average than men when smoking hookah. Cigarette-smoking men had the highest percentage who answered "no" to brushing teeth, and the majority of men in each group answered "no" to the use of auxiliary aids. Women in the non-smoking group brushed their teeth on a more regular basis than women in the hookah group, with no difference regarding the usage of auxiliary aids.* ***Conclusion:*** *Smoking increased caries and DMFT values in both men and women.*

Keywords: *Cigarette; hookah; e-cigarette; smoking; decayed, missing, and filled teeth index*
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INTRODUCTION

Tobacco use is responsible for many preventable diseases and deaths. One report indicated that tobacco-related diseases killed >7 million people worldwide in 2016.[1] It has been termed a worldwide silent epidemic; cigarettes contain >7,000 chemical substances, 69 of which are implicated in the development of carcinoma.[2] Tobacco smoke disrupts the function of nearly every human organ system, causing deaths through cancer, heart disease, and noncancerous respiratory diseases. Smoking is also known to have negative effects on oral health, such as decreased sensitivity to the sense of taste, tooth and restoration material discoloration, palatal keratosis, oral candidiasis, melanosis, halitosis, excessive plaque accumulation and calculus, dental caries, and even oral cancer.[3] Risks extend not only to the person using tobacco but also to people involuntarily exposed to "secondhand smoke."[4] Men typically smoke due to a nicotine addiction, but women smoke because they are concerned with something specific, out of habit, or to improve their mood. One study conducted at Yale University in the United States indicated that the effect of smoking on body functions differs between men and women; the study recorded that nicotine stimulates the secretion of dopamine, which affects the right part of the brain in men, whereas in women it affects the back part of the brain. The production of this chemical produces a sense of joy and positivity.[5]

Tobacco can be consumed either in the smoking or smokeless form. Common forms of tobacco include several types of cigarettes (manufactured, hand-rolled, filtered, unfiltered, and flavored), cigars, and pipes. In addition, newer forms, such as hookah smoking and vaping, have emerged.[6] The last decade has also seen an expanding variety of new or emerging tobacco and/or nicotine products brought to market, most prominently electronic

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cigarettes (commonly called e-cigarettes).[7] Waterpipe smoking is becoming a more popular method of tobacco consumption and is associated with short- and long-term health effects. Waterpipe smoking is increasing worldwide, especially among university students.[8] This could be due to many people's mistaken perception that hookah is harmless and does not promote dependence, and because it is being advertised as a good alternative to cigarettes. However, several studies have found significant amounts of harmful chemicals in hookah smoke.[9] Aerosols emitted from hookah are a mixture of charcoal and tobacco smoke, exposing users to nicotine, carbon monoxide, polyaromatic hydrocarbons, volatile aldehydes, and tobacco-specific nitrosamines.[10]

Numerous epidemiological studies around the world have reported a close relationship between smoking and the occurrence of dental caries. They determined that the caries rate was high in smokers; they proposed that health education programs on smoking cessation should be arranged, and the use of tobacco products, such as hookah, should be banned.[11] Investigations showed that smokers tended to have bad eating habits, paid less attention to oral self-care, rarely sought professional medical treatment, and had poor compliance after treatment. All these behaviors could increase the incidence of caries.[12,13]

Smoking affects the oral environment's temperature and humidity and negatively affects the buffering capacity of saliva.[14] This altered environment disrupts the normal healthy balance of oral bacteria and causes caries bacteria to dominate.[15] This study aims to analyze the influence of smoking cigarettes, hookahs, and e-cigarettes and their combination on the decayed, missing, and filled teeth of adult men and women aged 20–40 years who frequent several cafes in Mosul City.

MATERIALS AND METHODS

The study was conducted in 2023 on a sample of 400 individuals who participated in this study. They were selected from 30 different coffee shops on both the right and left sides of Mosul City, Iraq, and were aged 20–40 years. Before the examination, the following demographic information was obtained for each person: name, age, gender, type of smoking (hookah, cigarette, e-cigarette), smoking one type or more than one type, teeth brushing, use of auxiliary aids, and dental visits in the past 12 months.

The samples were distributed as follows: group A – control group (non-smoking); group B – male smoking cigarettes; group C – male smoking hookah; group D – male smoking e-cigarettes; group E – male smoking cigarettes and hookah; group F – male smoking e-cigarettes and hookah; group G – female smoking hookah; group H – female non-smoking. Each group included 50 individuals. There were 300 men and 100 women. Pregnant women and anyone with a systemic disease or orthodontic treatment were excluded from the study.

Before beginning the examination, permission was acquired from the café owner. Each participant was given a document written in the Arabic language explaining the purpose of the research, and each person signed an agreement that they were willing to take part. Their information was kept with the researcher only, and they had the right to refuse or withdraw at any time. Ethical approval was obtained before starting the study from the College of Dentistry, University of Mosul, numbered 4 and dated January 29, 2023.

Each participant underwent a clinical examination under standardized conditions; the existence of obvious alterations in the color, shape, or appearance of pits, fissures, or smooth surfaces was typically used to diagnose dental caries. The participant was examined while seated in a portable chair in front of the examiner, utilizing probes and plane mirrors. Except for adding a score for initial caries (white or chalky spots) to the decaying tooth scoring, clinical criteria for the diagnosis of dental caries were based on the guidelines provided by the World Health Organization.[16] Before the examination, general data and questions were recorded on a unique form designed for data recording.

The decayed, missing, and filled teeth (DMFT) index was used to count the number of decayed teeth, filled teeth, and teeth lost due to decay. The sum of the decaying, missing, and filled teeth indices was computed and used to evaluate dental caries prevalence. Criteria: D – included decayed teeth, teeth with temporary filling, and filled teeth with decay; M – included missed teeth as a result of caries; F – included filled teeth with no decay. The D, M, and F teeth values were added to obtain the DMFT index for the person, and then all the DMFT values were added to obtain the DMFT for the group.

Inter-examiner calibration was conducted by examining five people and comparing the results with those obtained by an expert dentist, and intra-examiner calibration was performed by examining the same people on two separate periods of the same week. Clinical examination conducted included the DMFT. The findings indicated that there were no statistically significant differences at a significance level of $p > 0.05$ (Table 1).

Table 1. Inter- and intra-examiner calibration of DMFT

Variables	Calibration	Mean ± SD		*p*-value ($n = 5$)
		1st examination	2nd examination	
DMFT	Inter-examiner	5.51 ± 2.36	5.20 ± 3.63	0.845
DMFT	Intra-examiner	5.28 ± 2.77	5.11 ± 2.82	0.923

DMFT = decay, missing, and filled teeth index.

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The SPSS statistical program (IBM Corp., New York, USA) was used to conduct a one-way analysis of variance to determine the significance of variations in mean values between groups. Here, A, B, and C indicate significant differences at $p < 0.05$. The *t*-test was used for comparisons between two groups, while the Dunkin test was employed for comparisons between many groups.

RESULTS

The data in Table 2 represent the distribution of decayed (D), missing (M), and filled (F) teeth and DMFT values among different male groups categorized by smoking type. The mean DMFT values for the various groups were as follows: cigarette (6.96); e-cigarette (6.12); hookah (5.3), cigarette + hookah (6.24), e-cigarette + hookah (5.58), and male non-smoking (5.82). Different letters (A, B) are used to denote specific groupings with significant differences. Group A (cigarette, e-cigarette, cigarette + hookah) is distinct from group B (hookah, e-cigarette + hookah, male non-smoking).

Cigarette smokers had the greatest average decay tooth value, the e-cigarette had the second-highest average, and the non-smokers had the lowest value. The cigarette + hookah smokers had the greatest average number of missing teeth, and the e-cigarette smokers had the lowest number. Male non-smokers had the greatest average number of filled teeth, and the cigarette + hookah group had the lowest value.

Table 3 presents the data for the female hookah group and the female non-smoking group. For variable D, there was a statistically significant difference between the hookah group and the non-smoking group (the hookah group was higher). For variable M, the *p*-value was 1.000, showing no statistically significant difference between the groups (similar effects). For variable F, the *p*-value was 0.386, indicating no statistically significant difference between the groups; however, the non-smoking group had a higher average than the smoking hookah group. The female smoking hookah group had higher DMFT values than the non-smoking group, but with no significant difference.

As Table 4 shows, the mean number of decayed teeth was significantly different between the male hookah group (2.34) and the female hookah group (3.2), with a *p*-value of 0.006 (the female smoking hookah group was higher). There was no significant difference in the mean number of missing teeth between the male hookah group (0.2) and the female hookah group (0.44), with a *p*-value of 0.183. The mean number of filled teeth was not significantly different between the male hookah group (2.78) and the female hookah group (3.18), with a *p*-value of 0.193. The mean DMFT values for the male hookah group (5.3) and the female hookah group (6.84) were significantly different, with a *p*-value of 0.025 (the female smoking hookah was higher).

Table 2. Distribution of participants' decayed, missing, and filled teeth, observed for the male cigarette, e-cigarette, hookah, cigarette + hookah, e-cigarette + hookah, and non-smoking groups

Groups	D	SD	M	SD	F	SD	DMFT	SD
Cigarette	3.92 A	±1.78	0.30 A	±0.58	3.10 A	±1.46	6.96 A	±3.52
E-cigarette	3.34 AB	±2.19	0.18 A	±0.38	2.78 A	±1.40	6.12 AB	±2.02
Hookah	2.34 C	±1.42	0.20 A	±0.63	2.78 A	±1.29	5.30 B	±2.82
Cigarette + hookah	3.16 B	±1.92	0.38 A	±0.63	2.70 A	±1.47	6.24 AB	±3.01
E-cigarette + hookah	2.56 C	±1.41	0.26 A	±0.48	2.76 A	±1.15	5.58 B	±2.02
Male non-smoking	2.38 C	±1.45	0.20 A	±0.45	3.22 A	±1.37	5.82 B	±2.73
p-value	<0.001		0.411		0.292		0.049	

Different letters express a significant difference at $p \leq 0.05$; D = decayed teeth, M = missing teeth, F = filled teeth, DMFT = decay, missing, and filled teeth index.

Table 3. Distribution of participants' decayed, missing, and filled teeth observed for the female hookah and female non-smoking groups

Groups	D	SD	M	SD	F	SD	DMFT	SD
Female hookah group	3.2 B	± 1.65	0.44 A	±1.0	3.18 A	±1.72	6.84 A	±3.84
Female non-smoking group	2.36 B	± 1.71	0.44 A	±0.7	3.46 A	±1.48	6.2 A	±2.62
p-value	0.014		1.000		0.386		0.334	

Data express mean ± standard deviation ($n = 50$ in each group). Different letters express a significant difference at $p \leq 0.05$.

Table 4. Distribution of participants decayed, missing, and filled teeth observed for the male and female hookah groups

Groups	D	SD	M	SD	F	SD	DMFT	SD
Male hookah group	2.34 B	± 1.42	0.20 A	±0.63	2.78 A	±1.29	5.30 B	±2.82
Female hookah group	3.20 A	± 1.65	0.44 A	±1.09	3.18 A	±1.72	6.84 A	±3.84
p-value	0.006		0.183		0.193		0.025	

Data express mean ± standard deviation ($n = 50$ in each group). Different letters express a significant difference at $p \leq 0.05$.

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Table 5 displays the distribution of tooth-brushing habits for the male groups. The hookah group had the highest percentage of individuals, with 64% answering that they did brush their teeth, whereas the cigarette group had the lowest percentage, at 28%. In addition, the table shows the use of auxiliary aids habit distribution for male groups. The majority of men in each group answered "no" to the use of auxiliary aids, ranging from 94% to 100%.

Table 6 displays the distribution of tooth-brushing habits for the female group. The data show that a higher percentage of non-smoking women used to brush their teeth than the women smoking hookah (96% vs. 78%). In addition, the table displays the distribution of tooth-brushing habits between men and women; the data show that a higher percentage of women than men in the hookah group used to brush their teeth (78% vs. 64%), although there was no significant difference.

Table 7 shows the differences in the percentage of individuals reporting dental visits in the past 12 months. There was a variation in dental visits among different male groups. The e-cigarette + hookah group had the maximum value (50%) and was significantly different from the others.

Table 8 shows that there was a significant difference in tooth-brushing habits between the female hookah and non-smoking groups (p-value < 0.001). The non-smoking group had a higher percentage reporting regular teeth brushing than the female hookah group. There was no significant difference in the use of auxiliary aids between the female hookah and non-smoking groups (p-value = 0.676). Both groups had a low percentage reporting the use of auxiliary aids. There was no significant difference in dental visits in the past 12 months between the female hookah and non-smoking groups (p-value = 0.292), although there was a better value for the non-smoking group (48%).

DISCUSSION

Smoking is a harmful habit that affects overall health by causing brain alterations, lowering focus, increasing anxiety, and impairing memory. The current study found that smoking cigarettes and e-cigarettes is linked to tooth decay, possibly because the nicotine causes reduced saliva secretion, leading to increased fermentation, bacterial

Table 5. Teeth brushing and auxiliary aids habit distribution for the male groups

Criteria \ Groups		Cigarette	E-cigarette	Hookah	Cigarette + hookah	E-cigarette + hookah	Non-smoking
Teeth-brushing habit	Yes	14 (28%)	22 (44%)	32 (64%)	19 (38%)	24 (48%)	23 (46%)
	No	36 (72%)	28 (56%)	18 (36%)	31 (62%)	26 (52%)	27 (54%)
Auxiliary aids habit	Yes	2 (4%)	0 (0%)	2 (4%)	0 (0%)	1 (2%)	3 (6%)
	No	48 (96%)	50 (100%)	48 (96%)	50 (100%)	49 (98%)	47 (97%)

Table 6. Tooth-brushing habit distribution for the female hookah smoking, female non-smoking, and male hookah smoking groups

Criteria \ Groups		Female hookah group	Female non-smoking group	Male hookah group
Teeth brushing	Yes	39 (78%)	48 (96%)	32 (64%)
	No	11 (22%)	2 (4%)	18 (36%)

Table 7. Distribution of dental visits in the past 12 months for the male groups

Criteria \ Groups	Cigarette	E-cigarette	Hookah	Cigarette + hookah	E-cigarette + hookah	Non-smoking
Yes	13 (26%)	14 (28%)	23 (46%)	22 (44%)	25 (50%)	21 (42%)
No	18 (36%)	36 (72%)	27 (54%)	28 (56%)	25 (50%)	29 (48%)

Table 8. Distribution of teeth brushing, auxiliary aids habits, and dental visits in the past 12 months for female groups

Criteria \ Groups		Female	
		Hookah group	Non-smoking group
Tooth brushing	Yes	39 (78%)	48 (96%)
	No	11 (22%)	2 (4%)
Auxiliary aids	Yes	3 (6%)	2 (4%)
	No	47 (94%)	48 (96%)
Dental visits in past 12 months	Yes	19 (38%)	24 (48%)
	No	31 (62%)	26 (52%)

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proliferation, and subsequent decay. Additionally, smoking reduces mouth pH, allowing bacteria to grow, plaque to accumulate, and enamel to dissolve through additional acids.[17]

The current results show that male smokers of cigarettes and e-cigarettes had the greatest average decayed tooth value. This result agrees with previous research that showed that cigarette smoking causes decreased saliva secretion, which leads to caries.[18]

The current study also demonstrated that the rate of DMFT was higher in cigarette smokers than in hookah smokers. This suggests that smoking habits influence the occurrence and frequency of oral and dental diseases.[19] Cigarette smoking has been linked to a weakened immune system and gum inflammation. It also raises the risk of caries, which leads to tooth loss.[20]

The technique of smoking a hookah may differ from that of smoking cigarettes because the use of water in the hookah helps to cool the smoke, reducing the number of toxic compounds inhaled. This could explain the findings.

Another reason could be that cigarettes are available in many places throughout the day and are relatively cheap when compared with smoking hookah, which requires prior preparation and specific places of use, and has lower economic cost and limited availability.

A significant difference was also recorded in the DMFT index among male smokers of electronic cigarettes compared with the hookah group. This is because e-cigarettes are no less harmful than regular cigarettes, as they are easy to carry and use and relatively affordable. This leads to their widespread use among young people, despite the apparent harmful effects of the presence of nicotine in them. Plaque removal necessitates maintaining personal hygiene: brushing the teeth twice a day with a soft brush and fluoride toothpaste, and visiting the dentist regularly to thoroughly clean the teeth and examine them for any signs of oral and dental diseases to avoid future problems.[21] Dental floss removes plaque from between the teeth, where a toothbrush cannot reach. Antibacterial mouthwash helps to eliminate dangerous bacteria in the mouth.

The reason that smoking hookah in men has less effect than cigarettes and e-cigarettes may be that hookah smoking is more limited than regular and e-cigarettes; however, from a scientific standpoint, its health effects are no less harmful.[22] There were substantial variations in the prevalence of dental decay between women who smoked hookah and non-smokers, but no significant difference was seen in the number of lost or filled teeth. Caries is unavoidable as a result of hookah smoking; however, the patient must decide to consult a doctor to fill or remove the caries. As a result, female hookah smokers and non-smokers had close values. Personal oral and dental hygiene, as well as a lack of understanding about the importance of regular dental visits, may play a role in such cases.[18] The study found that women who consume hookah have more dental caries than female non-smokers. This agrees with Mittal et al.[23] and Shah et al.[24] This may be because hookah smoking poses oral health hazards, albeit possibly less harmful than cigarettes. In addition, the current results recorded that men were less likely than women to brush their teeth. The vast majority of people in each group said they did not use auxiliary aids.

The results clearly show that there is a link between the smoking of normal and e-cigarettes and the condition of decay, indicating that the type of smoking affects the nature of the pathological condition of the mouth and teeth.[25]

The study found that women are more susceptible than men to tooth decay when comparing women and men who smoke hookah, and this may be influenced by the physiological nature of women. Dietary habits, the quality of health care, and regular medical check-ups can all influence the severity of medical disorders,[26] which agrees with the study in prisons made by Yang et al.[27] In their study, female prisoners had a higher prevalence of oral, salivary gland, and jaw diseases than male prisoners. They found that early prevention and appropriate treatment were required, and that there is a need for gender-specific oral disease products, given the differences in the prevalence of oral disease among male and female prisoners.

Male hookah users have a lower rate of decaying, missing, or filled teeth than their female counterparts. This could be attributable to a variety of causes, including men's generally higher health and physical condition. One probable explanation is that female hormones contribute to the risk of dental decay in women. This agrees with Wulandari et al.,[28] who found that gender significantly influenced the occurrence and severity of oral diseases. Women are more prone to tooth decay because they have genes that produce less saliva or saliva with less fluoride. Women are more vulnerable to tooth decay due to differences in their immune system's response to the microorganisms that cause it.[29]

This study showed that men who smoke cigarettes are more susceptible to caries than non-smoking men; this agrees with Andayasari et al.,[30] who found that tobacco smoking was associated with dental caries in the Indonesian population. Further studies are needed to assess the oral health of smokers in other cities for comparison with the results in Mosul City. Additional studies are also needed to examine the effect of smoking type on tooth discoloration.

A positive correlation was observed between smoking and changes in oral health; an increase in DMFT scores was observed in men who smoke cigarettes and e-cigarettes compared with non-smoking men; and dental caries was higher in all smoking groups (except the hookah group) compared with the non-smoking group; women smoking hookah had higher DMFT scores than men smoking hookah; and women smoking hookah had higher DMFT scores than non-smoking women. The results indicate that the highest change in oral health occurs due to smoking cigarettes.

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