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Research Article

Plaque Accumulation and Gingivitis Among (20-40) Years Old Adults Exposed to Different Smoking Methods in Mosul City

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Abstract

Aims: The present study aimed to investigate the effects of various smoking methods (cigarettes, electronic cigarettes, hookah and their combination) on plaque accumulation and gingivitis among (20-40) years old in males and females in Mosul city.

Material and Methods: To attain this purpose, 400 males and females aged 20-40 years participated in the study. The sample was divided into 8 groups of 50 participants each one, as follows: nonsmokers, cigarette smokers, electronic cigarette smokers, hookah smokers, cigarette smokers with hookah, electronic cigarette smokers with hookah, males, and a group who smoke hookah, and a group of nonsmoking females. (Silness and Loe, 1964) and (Silness and Loe, 1963) indices were recorded in the clinical examination.

Results: The findings revealed that the plaque index in males using cigarettes and electronic cigarettes was significantly higher from those using hookah alone and nonsmokers. The plaque index is significantly higher in female hookah smokers compared to nonsmoking females. The plaque index does not differ significantly between female and male hookah smokers. The effect on the gingival index was higher in male smokers of cigarettes and electronic cigarettes compared to non-smoking males. Gingival index was higher in females smoking hookah compared to non-smokers, and both males and females smoking hookah had similar readings. When comparing tooth brushing behavior among male smokers, cigarette smokers had the highest percentage of "no" responses.

Conclusion: The study found that smoking cigarettes and electronic cigarettes with or without hookah has a deleterious impact on the oral health of males and females, which is manifested by increasing plaque accumulation and associated gingivitis.

Keywords: Cigarette, Hookah, Electronic cigarette, Gingivitis, Plaque, Smoking.

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INTRODUCTION

Smoking is considered an addictive behavior. The World Health Organization in 2008 predicted that approximately 2.5 billion smokers worldwide, two-thirds, are in developing countries (1). Smoking is considered a preventable cause of mortality worldwide (2). Globally, as well as in the Middle East, cigarette smoking has attracted serious public health concerns. According to the WHO report on global tobacco use in 2019, the prevalence of active cigarette smoking among adults in the UAE was approximately 28% in men, but less in women (3). Alternative forms of tobacco smoking, such as hookah smoking, are also common in the Middle East and are spreading worldwide (4).

Smoking has been associated with the pathogenesis of periodontal disease and a significantly increased risk of periodontitis (5). Periodontal tissue consists of the gingiva, alveolar bone, periodontal ligament, and cementum. Gingivitis is a form of inflammation that is limited to the marginal gingival tissue, which is usually caused by the accumulation of plaque due to poor oral hygiene(6). The characteristics of gingivitis are the discoloration of the gingiva, redder than normal, swelling of the gingiva, and bleeding due to the inflammatory process (7). However, if it is properly treated, gingivitis is reversible without permanent damage (8). Gingival health status is determined by the severity of the measured gingival inflammation using the gingival index according to Löe and Silness. Clinical conditions are divided into normal gingiva, mild inflammation, moderate inflammation, and severe inflammation based on the gingival index (9).

Smokers may be exposed to additional risk factors as a result of smoking cigarettes or hookahs (10). The combination of smoking and a lack of attention to personal hygiene has repercussions on the teeth, as the combination of smoking, lack of brushing, and the accumulation of food residues in the teeth causes the formation of layers of irremovable bacterial plaque (11).

Direct exposure of inhaled cigarette smoke to periodontal tissues causes vasoconstriction of the periodontal microvasculature and gingival fibrosis, which is

often observed in smokers. Plaque accumulation and disease progression are exacerbated in smokers(12).

The current study aims to investigate the effect of different methods of smoking on plaque accumulation and gingivitis among (20-40) years old males and females and to compare the effect between both genders.

MATERIALS AND METHODS

Ethical consideration

Ethical approval was obtained before starting the study from the College of Dentistry/ University of Mosul, number **(4)**, date (29/1/2023), and permission was acquired from the café owner. A signed agreement was obtained from the person to be investigated, and gave him/her a paper written in the Arabic language explaining the purpose of the research. His/her information is kept confidential with the researcher only, and he/she has the right to refuse or withdraw at any time.

The samples

The study was conducted in 2023 on a sample of 400 individuals who participated in the present study; their age ranged between 20-40 years old, from 30 different coffee shops on both the right and left sides of Mosul City/ Iraq.

Demographic information

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 past 12 months' dental visits.

Samples distribution

- Group A: 50 control group non-smoking
- Group B: 50 males smoking cigarettes
- Group C: 50 males smoking hookah
- Group D: 50 males smoking e-cigarettes
- Group E: 50 males smoking cigarettes and hookah

- Group F: 50 males smoking e-cigarette and hookah
- Group G: 50 females smoking hookah
- Group H: 50 females non-smoking

Exclusion criteria

Any person with systemic disease, orthodontic treatment, or pregnant woman was excluded from this study.

Clinical examination

Each subject underwent a clinical examination under standard conditions, as recommended by WHO (13). The subject was evaluated with plane mouth mirrors and periodontal probes while sitting in a portable chair in front of the examiner. Prior to the examination, general information and questionnaires were recorded on a particular form.

Plaque Index (PI)

The plaque index by Silness and Loe (1964) (14) was used to evaluate dental plaque accumulation. The WHO periodontal probe was introduced from the oral side along both the proximal and buccal tooth surfaces, and then swept occlusally from a subgingival position. Six index teeth examined were: 16, 12, 24, 36, 32, and 44(15). Criteria for the plaque index:

0 No plaque.

1 A film of plaque adhering to the free gingival margin and the adjacent area of the tooth. The plaque can only be recognized by using a disclosing solution or by running a probe across the tooth surface.

2 Moderate accumulation of deposits within the gingival pocket, on the gingival margin, and/ or adjacent tooth surface, which can be seen with the naked eye.

3 Heavy accumulation of soft matter within the gingival pocket and/ or on the tooth and gingival margin.

Gingival Index (G.I.)

Gingival index by Loe and Silness (1963) (16) was used to measure gingivitis. The four surfaces of the tooth along the gingival margin were scored from "0" to "3". The

mean score for each tooth, individual, and group is determined. The six index teeth used were: 16, 12, 24, 36, 32, and 44(15). Criteria for the gingival index:

0 No inflammation.

1 Mild inflammation, slight change in color, slight edema, no bleeding on probing.

2 Moderate inflammation, moderate glazing, redness, bleeding on probing.

3 Severe inflammation, marked redness and hypertrophy, ulceration, and tendency to spontaneous bleeding.

Inter and Intra Examiner Calibration

Inter-examiner calibration was done by examining 5 persons and comparing the results with those made for the same 5 persons by an expert dentist, while intra-examiner calibration was done by examining the same 5 persons by examiner two separate periods of one week.

Statistical analysis

The SPSS statistical program was used to conduct a one-way analysis of variance (ANOVA) to determine the significance of variations in mean values between groups. A, B, and C indicate significant differences at $p < 0.05$. The t-test was used for comparisons between two groups, while Duncan's Multiple Range test was employed for comparisons between many groups.

RESULTS

Plaque Index (PI) Values

Table (1) outlines the distribution of Plaque Index (PI) values in various male smoking groups, including cigarette, e-cigarette, hookah, cigarette+ hookah, e-cigarette+ hookah, and non-smoking groups.

The mean PI values for different smoking groups are as follows: Cigarette: 1.38 (A), e-cigarette: 1.36 (A), Hookah: 0.94 (B), Cigarette+ Hookah: 1.07 (B), e-cigarette+ Hookah: 1.06 (B), Males non-smoking: 0.92 (B). The *p*-value of <0.001 indicates significant differences in PI values among the groups.

Table (1): Distribution of subjects' plaque index PI observed for cigarette, e-cigarette, Hookah, Cigarette+ Hookah, e-cigarette+ Hookah, and non-smoking group for males.

Groups	PI	Std.
Cigarette	1.38 A	±0.62
e-cigarette	1.36 A	±0.57
Hookah	0.94 B	±0.52
Cigarette+ Hookah	1.07 B	±0.48
e-cigarette+ Hookah	1.06 B	±0.45
Males non- smoking	0.92 B	±0.29
p-value	<0.001	

Data express mean ± Stand. Deviation (N=50 in each group).
Different letters express a significant difference at $p \leq 0.05$

Table (2) shows Plaque Index in females smoking hookah and non-Smoking groups. The mean PI values for the females in the smoking hookah group and the females in the non-smoking group are as follows:

Females smoking hookah group: 0.99 (A), females non-smoking group: 0.66 (B). The *p*-value of <0.001 indicates significant differences in PI values between females smoking hookah and the non-smoking groups.

Table (2): Distribution of the subject's plaque index observed for female's hookah and non-smoking groups

Groups	Plaque index PI	Std.
Females hookah group	0.99 A	±0.51
Females non- smoking group	0.66 B	±0.32
p-value	<0.001	

Data express mean ± Stand. Deviation (N=50 in each group). Different letters express a significant difference at $p \leq 0.05$.

Table (3) shows the Plaque Index in males and females in the hookah smoking groups. The mean PI values for male's hookah group (0.94) and females hookah group (0.99). The *p*-value of 0.042 indicates a significant difference in the mean of PI values between both male and female hookah smoking groups as females tended to have more plaque with a significant difference than males.

Table (3): Distribution of subjects' plaque index observed for females and males in smoking hookah groups.

Groups	Plaque index PI	Std.
Males hookah group	0.94 B	±0.52
Females hookah group	0.99 A	±0.51
p-value	0.042	

Data express mean ± Stand. Deviation (N=50 in each group). Different letters express a significant difference at $p \leq 0.05$

Gingival Index (GI) Values:

Table (4) outlines the distribution of Gingival Index (GI) values in various smoking groups, including male cigarette, e-cigarette, hookah, cigarette+ hookah, e-cigarette+ hookah, and non-smoking groups. The mean GI values for each group are as follows: The utilization of different letters (A, B, C) in the post-hoc test denotes specific groupings with significant differences in mean GI values.

Table (4): Distribution of subjects' gingival index GI observed for cigarette, e-cigarette, hookah, cigarette+ hookah, e-cigarette+ hookah and non-smoking group for males.

Groups	GI	Std.
Cigarette	1.82 A	±0.59
e-cigarette	1.63 A	±0.63
Hookah	0.94 C	±0.48
Cigarette+ hookah	1.18 B	±0.52
e-cigarette+ hookah	1.16 B	±0.42
Males non- smoking	0.9 C	±0.28
p-value	<0.001	

Data express mean ± Stand. Deviation (N=50 in each group). Different letters express a significant difference at $p \leq 0.05$

Table (5) shows the Gingival Index in females hookah and non-smoking groups. The mean GI values for females hookah group (1.1) and the non-smoking group (0.6). The *p*-value of <0.001 indicates significant differences in mean GI values between the two groups.

Table (5): Distribution of the subject's gingival index observed for females hookah and non-smoking groups.

Groups	Gingival index GI	Std.
Females hookah group	1.1 A	±0.63
Females non- smoking group	0.6 B	±0.04
p-value	<0.001	

Data express mean ± Stand. Deviation (N=50 in each group). Different letters express a significant difference at $p \leq 0.05$.

Table (6) shows the Gingival Index (GI) in females smoking hookah and the male smoking hookah groups. The mean GI value for males hookah group (0.94) and females hookah group (1.1) showed no statistically significant difference in mean GI values between the two gender groups.

Table (6): Distribution of the subject's plaque index observed for females Hookah and males in the smoking hookah groups

Groups	Gingival index GI	Std.
Males hookah group	0.94 A	±0.48
Females hookah group	1.1 A	±0.63
p-value	0.146	

Data express mean ± Stand. Deviation (N=50 in each group). Different letters express a significant difference at $p \leq 0.05$.

Table (7) shows the distribution of toothbrushing habits for male groups. The hookah group has the highest percentage of individuals 64% answering "Yes" to tooth brushing, while the cigarette group has the lowest percentage, 28%. Also, it shows the habit distribution for male groups. The majority of males in each group answered "No" to the use of auxiliary aids, ranging from 94% to 100%. The differences in the percentage of individuals reporting past-12 months' dental visits. There is a variation in dental visits among different male groups. Group e-cigarette + hookah had a maximum value 50% and was significantly different from others.

Table (7): Tooth brushing, Auxiliary aids, and Past 12 months' dental visits the habits distribution for male groups.

Criteria	Groups	Cigarette	E-cigarette	Hookah	Cigarette + Hookah	E-cigarette + Hookah	Non smoking
Tooth brushing	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	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%)
Past 12 months' dental visits	Yes	13 (26%)	14 (28%)	23 (46%)	22 (44%)	25 (50%)	21 (42%)
	No	37 (74%)	36 (72%)	27 (54%)	28 (56%)	25 (50%)	29 (48%)

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

Table (8): Tooth brushing, Auxiliary aids, and Past 12 months' dental visits habits distribution for females in the hookah group and the non-smoking group.

Criteria	Groups	Females 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%)
Past 12 months dental visits	Yes	19 (38%)	24 (48%)
	No	31 (62%)	26 (52%)

DISCUSSION

The acidic environment promotes the formation of plaque on teeth. Plaque, a sticky film of germs, builds when teeth are not cleaned on a regular basis, and it grows

stickier on smokers' teeth, making removal more difficult [17]. Plaque promotes gum irritation, resulting in redness, swelling, and bleeding. Periodontal diseases can affect the jawbone, resulting in tooth loss (18).

Plaque removal necessitates maintaining personal hygiene, brushing the teeth twice a day with a soft brush and fluoride toothpaste, and visiting the dentist on a regular basis to thoroughly clean the teeth and examine them for any signs of oral and dental diseases in order to avoid future problems (19). Dental floss removes plaque from between the teeth, where a toothbrush cannot reach. Antibacterial mouthwash helps to eliminate dangerous bacteria in the mouth (20).

According to the results of the current study, women who smoke hookah suffer from a significant increase in plaque compared to their non-smoking counterparts, while the percentage is equal between females and males who smoke hookah. This confirms that the hookah is the first offender in causing plaque for reasons related to the hookah or the materials included in its composition (21).

The present study found that the gingival index factor showed a significant difference in the percentage of hookah smokers with cigarette and electronic cigarettes compared to male non-smokers. This indicates the presence of a synergistic effect between cigarettes and hookahs on the gums, as it has been proven in a previous study that hot hookah smoke has a harmful effect on the gums (22). Both hookah and cigarettes and e-cigarettes include hazardous compounds, such as nicotine, which leads to addiction. In addition to tar and carbon monoxide, which restrict the quantity of oxygen that the body receives, it also contains heavy metals like lead and arsenic (23). When compared to nonsmokers, tobacco/cigarette smokers have more periodontal damage (24).

Hookah has a number of dangerous components that are not found in cigarettes, such as charcoal, which pollutes the air, and the flavors contain harmful chemicals, including benzene, which causes cancer and nervous system problems (25). These findings suggest that smoking behaviors have a deleterious impact on the emergence of gum disease and its associated bleeding and inflammation (26). While the lower

value in non-smokers confirms healthier gums in these people, smoking in all its forms causes an imbalance in blood circulation in the mouth, leading to the accumulation of toxic substances in the tissues, as well as affecting the pH of the blood as a result of smoke, and this leads to negative consequences in the accumulation of plaque and bacterial deposits on it, which subsequently leads to gingival infections with tooth decay and eventual tooth loss(27).

Also, the current study results showed that the gingival index differed between female hookah smokers and non-hookah smokers. While the gingival index in females was higher compared to males, indicating the importance of gender differences in the prevalence of gum lesions (28).

Conversely, the higher percentage of males not brushing their teeth in the smoking group may raise concerns about their oral hygiene and potential associated health risks. The difference in tooth brushing habits between smoking groups highlights the importance of tailored health interventions targeting specific demographic groups.

Addressing oral hygiene practices among hookah smokers, particularly males, could be crucial in reducing the risk of dental issues and promoting overall oral health. Public health campaigns targeting hookah smokers should incorporate gender-specific strategies to effectively promote oral hygiene practices and mitigate associated health risks.

Males' smokers' dental cleaning practices were shown to be typically negative and unsatisfactory when compared to nonsmokers. The percentage of females taking care of toothbrushes appeared high among female smokers and non-smokers, and the issue may be related to aesthetic and social reasons in women (29). Males smokers' use of auxiliary aids was shown to be lower than that of non-smoking guys. Male smokers of all types demonstrated a lack of commitment to visiting the dentist in the previous 12 months. This demonstrates that males are not interested in personal maintenance of the mouth and teeth. It was also discovered that neither female hookah smokers nor non-smokers visited the dentist on a regular or annual basis. Non-smoking females wash their teeth and visit the dentist more frequently than female hookah smokers.

CONCLUSIONS

Within the limitations of the current study, it is possible to conclude that:
Smoking, regardless of method, negatively impacts oral and dental health in males result in increased plaque and gingival index scores. Hookah use by females increases plaque and gingival index scores. Poor tooth brushing habits and little use of auxiliary cleaning aids among smokers further exacerbate the problem.

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Authors' Contribution

Ghanim LM and Gasgoos SS. completed the conceptualization, data curation, formal analysis, finding acquisition, investigation, resources, software, validation, visualization, writing- original draft, writing- review, and editing. Methodology, Project administration by Ghanim LM. Supervision, Visualization by Gasgoos SS.

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Ethical statement: Ethical approval was obtained before starting the study from the College of Dentistry/ University of Mosul, number (4), date (29/1/2023), and permission was acquired from the café owner. A signed agreement was obtained from the person to be investigated, and gave him/her a paper written in the Arabic language explaining the purpose of the research. His/her information is kept confidential with the researcher only, and he/she has the right to refuse or withdraw at any time.

Conflict of interest

The author declares that there are no conflicts of interest regarding the publication of this manuscript

Availability of data and materials: All data generated or analyzed during this study are included in this published article and its supplementary information files.

Declaration of Generative AI and AI-assisted technologies

During the preparation of this work, the authors used a grammar tool to improve the readability of the manuscript. The authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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تراكم البلاك والتهاب اللثة لدى البالغين الذين تتراوح أعمارهم بين 20 و40 عامًا والذين يتعرضون لأساليب تدخين مختلفة في مدينة الموصل

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الملخص

الأهداف: تهدف الدراسة الحالية الى مقارنة تأثير طرق التدخين المختلفة (السجائر والسجائر الإلكترونية والشيشة ومزيجها) على تراكم الصفيحات الجرثومية والتهاب اللثة لدى الأعمار (20-40) سنة لدى الذكور والإناث في مدينة الموصل. المواد وطرائق العمل: ولتحقيق هذا الهدف شارك في الدراسة 400 من الذكور والاناث الذين تتراوح أعمارهم بين (20-40) سنة. تم تقسيم العينات إلى 8 مجاميع تضم كل منها 50 مشاركاً، على النحو التالي: غير المدخنين ومدخني السجائر ومدخني السجائر الإلكترونية ومدخني الشيشة ومدخني السجائر مع الشيشة ومدخني السجائر الإلكترونية مع الشيشة من الذكور ومجموعة من النساء اللاتي يدخنن الشيشة ومجموعة من النساء غير المدخنات. تم استخدام مؤشري الصفيحات الجرثومية والتهاب اللثة للتسجيل في الفحص السريري. **النتائج**: أظهرت النتائج أن مؤشر الصفيحات الجرثومية لدى الذكور الذين يستخدمون السجائر والسجائر الإلكترونية كان أعلى بكثير من أولئك الذين يستخدمون الشيشة وحدها وغير المدخنين. وكان المؤشر أعلى بشكل ملحوظ لدى مدخنات الشيشة مقارنة بالإناث غير المدخنات. لا يختلف مؤشر الصفيحات الجرثومية بشكل كبير بين مدخني الشيشة من الذكور والإناث. وكان التأثير على مؤشر اللثة أعلى لدى الذكور المدخنين للسجائر والسجائر الإلكترونية مقارنة بالذكور غير المدخنين. كان مؤشر اللثة أعلى لدى الإناث المدخنات للشيشة مقارنة بغير المدخنات، كما أن كلا من الذكور والإناث الذين يدخنون الشيشة لديهم قراءات مماثلة. عند مقارنة سلوك تنظيف الأسنان بين المدخنين الذكور، كان لدى مدخني السجائر أعلى نسبة من الإجابات بـــ "لا". **الاستنتاجات**: وجدت الدراسة أن تدخين السجائر والسجائر الإلكترونية مع أو بدون الشيشة له تأثير ضار على صحة الفم لدى الذكور والإناث والذي يتجلى في زيادة تراكم الصفيحات الجرثومية والتهاب اللثة المصاحبة له..

الكلمات المفتاحية: السجائر، الشيشة، السجائر الإلكترونية، التهاب اللثة، البلاك، التدخين.