

ORIGINAL ARTICLE

EFFECT OF VARIOUS FORMS OF NICOTINE CONSUMPTION ON GINGIVAL HEALTH OF DENTAL PATIENTS

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Background: Global market size of nicotine consumption has reached US\$22.45 billion that will increase more in future posing burden on both economy and health status of population. Objective of this study was to investigate effect of nicotine on gingival health. **Methods:** This study was conducted at School of Dentistry, Shaheed Zulfiqar Ali Bhutto Medical University, Islamabad from 3 Feb 2023 to 4 Mar 2024. Total 300 nicotine consumer dental patients were included, i.e., Smoke-Form (S-form), Electronic cigarette-Form (E-form), and Dual-Form (D-form) users whose Gingival Index (GI) was calculated occurrence of severe gingival issues in participants. GI 0.5–1.0 was labelled as light gingival inflammation, GI 1.1–2.0 as moderate gingival inflammation and GI>2.0 as severe gingival inflammation. Chi-square test checked association of mode of nicotine usage and development of GI, and $p \leq 0.05$ was considered significant. **Results:** One-hundred and fifty-seven (52.3%) patients aged 21–30 years were D-form users compared to 97 (32.3%) middle-aged (31–40 years) and 46 (15.3%) ultra-middle-aged (≥ 41) participants. Chi-square test revealed that 128 (98.5%) D-form users developed severe gingivitis after 3 months, 91 (95.8%) E-form users had severe gingivitis after 6 months, and 74 (98.7%) S-form users revealed severe gingival issues after 9 months ($p=0.012$). **Conclusion:** Dual usage of nicotine has more detrimental impact on gingival health, followed by E-form and S-form nicotine users. General awareness programs are necessary in order to educate people regarding hazardous effects of nicotine consumption in any form.

Keywords: Gingivitis, Inflammation, Nicotine, Periodontium, Smokers

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INTRODUCTION

The global market size of nicotine consumption has reached US\$22.45 billion in 2022, and shall grow @30.60% from 2023 to 2030 especially in Southeast Asian and Western countries¹ which is posing a huge burden on the economy as well as people's health worldwide. Non-contiguous diseases like malignancy, cardiovascular diseases, and diabetes occur due to nicotine consumption, either in the form of smoked cigarettes² or electronic cigarettes³, which is hazardous to the general and oral health of people worldwide⁴. Nicotine-oriented non-infectious diseases are at their peak in underprivileged nations because of their low socioeconomic status and destitution.⁵

A total of about 175 million females and 942 million males belonging to different age groups in these underdeveloped, low-income countries utilize nicotine regularly.⁶ WHO has reported the mortality status of about 7 million individuals globally because of nicotine consumption and its habituation, which is quite alarming.⁷ This predicament has unveiled a rise of about 80% in Asian countries, especially Pakistan.⁸ Nicotine consumption has been initiated in adolescence, either in Smoke-form or E-form, which then becomes a habit that might prevail throughout the life of any individual.⁹ Nicotine dependency is not only responsible for enhanced mortality and morbidity to a greater extent but

also for the economic, biomedical, geopolitical, cultural, and social downfall of a population.⁵

According to Food and Drug Administration (FDA), nicotine addiction is potentially injurious to oral health and its adjacent airway tissues.^{4,10} A possible justification could be biofilm formation on teeth, periodontium, and other adjacent oral tissues associated with nicotine consumption.^{4,11} There is a strong correlation between oral health and general well-being. Patients are enlightened about the impact of oral health on general welfare as compared to general population.¹² There is paucity of information in Pakistan regarding comparative impact of nicotine usage as Smoke form (S-form), Electronic form (E-form) and Dual form (D-form).

This study aimed to evaluate effects of nicotine on gingival health. Our findings will help Pakistani population in taking the initiative for cessation of nicotine consumption.

METHODOLOGY

This cross-sectional study was executed at the School of Dentistry, Shaheed Zulfiqar Ali Bhutto Medical University, Islamabad, from 3 Feb 2023, to 4 Mar 2024, after approval from Institutional Research Committee (SOD/ERB/2023/32-02). A total of 300 dental patients who were smokers and had gingivitis and visited School

of Dentistry were included in this study after taking their informed consent.

An analytical Gingival Index (GI) was used to investigate the association between smoking type and duration of getting severe gingivitis of these dental patients. The participants enrolled in the study were those who initiated the usage of S-form, E-form, and D-form not more than a month. Further details in the questionnaire were 1) Socio-demographic details including age, gender, and educational status, 2) Tobacco and E-cigarette usage including its frequency, and habits, 3) Oral health assessment including number of carious, missing and restored teeth, 4) Oral hygiene measures including frequency of brushing/flossing, type of toothpaste, dental visits, and 5) Symptoms of gingivitis due to smoking. These questions were taken from 'National Adult Tobacco Survey' and 'Centre for Diseases Control'.¹³

The participants were categorized into Smoke form (S-form), Electronic form (E-form), and Dual form (D-form) users whose GI was calculated to demonstrate the association between their smoking type and duration of developing severe gingivitis. The tobacco consumption related questions and the duration of the initiation of gingival effects were also answered by participants. The GI was used to calculate the severity of gingival inflammation among these participants where GI between 0.5–1.0 displayed Light gingival inflammation, GI between 1.1–2.0 revealed Moderate gingival inflammation and $GI \geq 2$ confirmed severe gingival inflammation.^{14–16}

Data were analysed on SPSS-26. Descriptive statistics as percentage and frequency were calculated as Mean $\pm$ SD and SE was calculated by one way ANOVA and multiple comparisons were conducted using post hoc Tukey test. The association between smoking type and duration for severe gingivitis was calculated with Chi-square test, and $p \leq 0.05$ was considered significant.

RESULTS

A total of 300 tobacco-consuming participants participated in this study, of whom 244 (81.3%) were male and 56 (18.7%) were female. Young participants developed gingivitis more quickly in comparison to middle- and ultra-middle-aged participants. The percentage of severe gingivitis was 68 (52.3%) young, 38 (29.2%) middle-aged and 24 (18.5%) ultra-middle-aged participants after 3 months. The inflamed gingival tissues appeared after 6 months in 38 (50.7%) young, 27 (36.0%) middle-aged and 10 (13.3%) ultra-middle-aged participants. On the other hand, severe gingivitis appeared after 9 months in 51 (53.7%) young, 32 (33.7%) middle-aged and 12 (12.6%) ultra-middle-aged participants. (Table-1 and Table-2).

Table-1: Gender stratification of dental patients for mode of nicotine usage and time for occurrence of severe gingivitis [n (%)]

Variables	Males	Females
S-form users	57 (76.0)	18 (24.0)
E-form users	77 (82.8)	16 (17.2)
D-form users	110 (83.3)	22 (16.7)
Duration of severe gingivitis occurrence		
After 3 months	108 (83.1)	22 (16.9)
After 6 months	58 (77.3)	17 (22.7)
After 9 months	78 (82.1)	17 (17.9)

Table-2: Age stratification of dental patients for mode of nicotine usage and time for occurrence of severe gingivitis [n (%)]

	Young (21–30 Yrs)	Middle aged (31–40 Yrs)	Ultra middle aged (≥ 41 Yrs)
S-form users	39 (52.0)	26 (34.7)	10 (13.3)
E-form users	48 (51.6)	33 (35.5)	12 (12.9)
D-form users	70 (53.0)	38 (28.8)	24 (18.2)
Duration of severe gingival inflammation			
After 3 months	68 (52.3)	38 (29.2)	24 (18.5)
After 6 months	38 (50.7)	27 (36.0)	10 (13.3)
After 9 months	51 (53.7)	32 (33.7)	12 (12.6)

The mean Gingival inflammation index (GI) in D-form users, E-form users and S-form users was calculated to be 2.51 ± 1.07 , 2.88 ± 1.11 and 3.06 ± 1.13 . This GI got severe in D-form user participants more quickly after 3 months, followed by E-form users. It became severe after 6 months compared to the S-form users that displayed its severity after 9 months ($p=0.001$). The mean GI was found to be moderate in D-form users, E-form users, and S-form users both at baseline $p=0.014$ and after one month $p=0.011$. The mean GI was calculated to be severe in D-form users but moderate in E-form users and S-form users after 3 months $p=0.017$. The mean GI got severe in E-form users also along with D-form users but remained moderate in S-form users after 6 months ($p=0.019$). The mean GI got severe in S-form users also after 9 months ($p=0.012$). Thus, it confirmed the quickest onset of severe gingival inflammation in D-form users after 3 months in comparison to E-form users and S-form users where this onset was observed after 6 months and 9 months respectively. (Table-3).

Table-3: Comparison of mean GI among different mode nicotine users during certain time duration

Duration	Mean gingival inflammation index			
	S-fom	E-form	D-form	<i>p</i>
Baseline	1.17	1.39	1.61	0.014
1 month	1.41	1.63	1.97	0.011
3 months	1.72	1.99	2.51	0.017
6 months	1.95	2.32	2.88	0.019
9 months	2.46	2.61	3.06	0.012

The Chi-square test revealed that 128 (98.5%) D-form users developed severe gingivitis after 3 months as compared to 91 (95.8%) E-form users who developed severe gingivitis after 6 months. On the other hand, 74

(98.7%) S-form users developed severe gingival issues after 9 months ($p=0.001$). (Table-4).

Table-4: Association of mode of nicotine usage and time for developing severe GI among dental patients

Association	Pearson χ^2 Value	Likelihood ratio	Linear-by-linear association	p
Mode of nicotine usage and time for developing severe GI	560.15	575.29	93.39	0.001

DISCUSSION

Tobacco intoxication is a malediction on mankind. It has preponderantly transfigured the modern era with its untoward consequences for oral and general well-being. Nicotine, an addictive substance, chiefly accredits tobacco dependency. Tobacco is strongly linked to oral malignancy, mucous lesions, gingival and periodontal diseases. *Porphyromonas gingivalis* is a potential pathogen associated with the initiation and propagation of gingival and periodontal diseases. It is chiefly found in higher proportions in smokers than non-smokers. Tobacco consumption is the leading cause of gingivitis in smokers.¹⁷ The key findings in the current study elaborated that young participants are more inclined towards nicotine habituation in comparison to middle-aged participants and ultra-middle-aged participants.

The results of the current study regarding the increased tobacco dependency in younger participants agree with the literature where a study¹⁸ reported the same upsurge in tobacco consumption among the younger population in several other countries. Tobacco use in middle-aged and ultra-middle-aged users was not evaluated in aforementioned research¹⁸ which became significant parameter investigated in current study.

Certain stresses arising due to cultural, social, political, geographical, and economical differences might be responsible for the escalating trends towards tobacco consumption and its habituation.⁵ D-form users reported development of gingivitis at the earliest just after 3 months followed by E-form users at a moderate rate after 6 months, and S-form users who displayed severe gingivitis at the slowest rate after 9 months. These results were not per other studies because the association between development of severe gingivitis and smoking type in participants was not scrutinized before this study. Previous studies reported evident correlation between gingivitis and socioeconomic demographics where low education, diabetes, increased plaque and old age were the main factors considered responsible for enhancing gingivitis.¹⁶

The GI index is considered authentic tool used to estimate the clinical implication and severity of inflammation in the gingival tissues where Light GI ranging between 0.5–1.0, Moderate GI between 1.1–2.0

and severe GI>2.0.¹⁹ The GI got severe in D-form users after 3 months, followed by E-form users where it became severe after 6 months compared to the S-form users who developed its severity after 9 months ($p=0.001$). That might have become possible because of the enhanced dual absorption and adsorption of the multiple toxic chemicals including nicotine in the oral mucosa of the D-form users as compared to the E-form and S-form users. According to WHO, nicotine habituation has a damaging effect on the health, environment, social and economic status of the global population.²⁰ Although tobacco smoke contains more than 700 dangerous toxins that might become cancerous²¹, a few components in E-cigarettes including acrolein, aldehyde and formaldehyde are more hazardous²². These chemicals might infiltrate the lungs, and in turn adversely affecting the health of the people using the various forms of nicotine.²³ These toxins could pose more disastrous effects in the oral cavity before hitting the airway passage and lungs.

The outcomes of the current study are not in collaboration with the prior studies because the effect of various forms of nicotine habituation on gingival tissues has not been addressed previously. However, the available literature has provided the association between smoking and other socioeconomic demographics especially in children.^{24,25} The strong association between tobacco consumption and oral diseases including periodontal diseases, gingivitis, dental caries, halitosis, soft tissue lesions, oral candidiasis and xerostomia has been discerned irrespective of the tobacco form and its type being consumed.^{4,11} Numerous other studies also reported the interrelationship between nicotine consumption and oral diseases such as dental caries²⁵, compromised oral health, general welfare, black hairy tongue, xerostomia^{4,11} and oral-mucous lesions^{4,19}. Still, nicotine consumption in E-form is more detrimental as compared to the S-cigarettes respectively. This is since a single E-form cigarette comprises high levels of nicotine that equals the amount present in 20 conventional S-form cigarettes.^{26,27}

Recently, it has been reported that tobacco consumption in Pakistan is at its peak²⁸ due to its handiness and accessibility without any impediment.²⁹ Therefore, influential awareness campaigns and strict implementation actions are required to preclude the easy accessibility of this fatal material.³⁰

CONCLUSION

Young participants are more indulged in nicotine consumption compared to middle-aged and ultra-middle-aged participants. Tobacco consumed in D-form is reported to precipitate severe gingivitis earlier than E-form and S-form. Dual usage of tobacco is more deleterious towards oral health.

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