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ORIGINAL ARTICLE

Impact of Tobacco and Smoking on Oral Health

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ABSTRACT

Background: Tobacco use, both in smoking and smokeless forms, poses a significant threat to oral health, contributing to conditions such as periodontal disease, dental caries, oral mucosal lesions, and altered salivary function. Despite extensive public health campaigns, tobacco consumption remains prevalent, especially in developing countries, leading to a persistent oral disease burden.

Objective: To assess and compare the impact of tobacco use—including smoking and smokeless tobacco—on periodontal health, dental caries, oral mucosal lesions, salivary pH, and oral hygiene behavior among adult patients.

Methodology: An analytical cross-sectional study was conducted over 12 months at tertiary care dental institutions following STROBE guidelines. A total of 1,200 participants aged 18–65 years were recruited using stratified random sampling, comprising 600 tobacco users (450 smokers and 150 smokeless tobacco users) and 600 age- and gender-matched nonsmokers. Data collection included self-reported questionnaires and clinical oral examinations assessing Community Periodontal Index (CPI), DMFT index, presence of mucosal lesions, salivary pH and flow rate, and oral hygiene behaviors. Examiners were calibrated (κ = 0.89), and all data were analyzed using SPSS version 26.0. Logistic regression was used to identify odds ratios (OR) for poor oral outcomes, adjusting for confounders. A p-value < 0.05 was considered significant.

Results: Smokers demonstrated the highest prevalence of periodontal disease (45% periodontitis), mucosal lesions (15% smoker's melanosis), and DMFT scores (4.2 decayed teeth). Salivary pH and flow rate were significantly lower in smokers (pH: 6.3 ± 0.4; flow: 0.8 mL/min) compared to nonsmokers. Oral hygiene behaviors were significantly poorer among tobacco users, with only 28% of smokers brushing twice daily. Logistic regression revealed increased odds of periodontal disease (OR: 3.5, CI: 2.8–4.4), dental caries (OR: 2.8, CI: 2.1–3.6), and mucosal lesions (OR: 5.4, CI: 3.9–7.2) among smokers. Smokeless tobacco users also showed elevated risks but to a lesser degree.

Conclusion: Tobacco use, particularly smoking, significantly impairs oral health by increasing the risk of periodontal disease, caries, and mucosal lesions, while also reducing salivary protection and promoting poor oral hygiene behaviors. These findings emphasize the critical need for targeted tobacco cessation programs integrated with dental care to mitigate oral disease risk.

Keywords: Tobacco Use, Smoking and Oral Health, Periodontal Disease, Oral Mucosal Lesions, Dental Caries

INTRODUCTION

Tobacco consumption, particularly through smoking, continues to be a critical public health concern worldwide, with profound effects not only on systemic health but also on oral health[1]. The World Health Organization (WHO) estimates that tobacco use contributes to over 8 million deaths annually, with many more affected by non-lethal but debilitating health conditions, including those of the oral cavity . The oral cavity is one of the primary sites where the effects of tobacco are most directly observed, given its constant exposure to the toxic constituents of tobacco smoke and smokeless products[2].The impact of tobacco use on oral health is both extensive and multifaceted, affecting the periodontium, oral mucosa, salivary glands, and even the bone structure supporting the teeth[3]. Clinical evidence shows a strong correlation between smoking and increased incidence of periodontal disease, tooth loss, delayed wound healing, halitosis, and precancerous lesions such as leukoplakia and erythroplakia[4]. Smokers are also at a significantly higher risk of developing oral cancer, with studies suggesting that over 80% of oral cancer cases are linked to tobacco use[5].Recent advances in oral microbiology and salivary diagnostics have provided deeper insights into the mechanisms through which tobacco exacerbates oral disease[6]. Research has shown that smoking disrupts the normal microbial balance, leading to dysbiosis and enhanced pathogenic activity in the oral cavity[7] . Moreover, nicotine and other harmful chemicals found in tobacco reduce the immune response, impair angiogenesis, and decrease the regenerative capacity of oral tissues[8].Given the ongoing prevalence of smoking, particularly among adolescents and young adults in both developed and developing nations, understanding its impact on oral health remains a vital area of research[9]. Current public health efforts emphasize the importance of early detection, education, and cessation programs to mitigate the harmful effects of tobacco on oral tissues[10]. Therefore, this study aims to investigate the multifactorial impact of tobacco and smoking on oral health, including periodontal health, mucosal changes, microbial shifts, and potential malignant transformations, using both clinical assessments and patient-reported outcomes[11].

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Literature Review: Tadakamadla J(2017) provided a comprehensive review of the global burden of oral cancer and its strong association with tobacco use. The study indicated that over 80% of oral cancer cases are linked to tobacco, whether smoked or smokeless. The authors emphasized that carcinogens in tobacco lead to DNA damage and mutagenesis, contributing to squamous cell carcinoma. Moreover, tobacco's impact is compounded when used with alcohol. Their meta-analysis included studies from both high- and low-income countries, emphasizing that oral cancer remains a significant public health issue in regions with high tobacco consumption[12].

Sørensen LT. (2012) examined the effects of smoking on periodontal parameters among adults in Malaysia. They found that smokers had significantly greater clinical attachment loss, probing depths, and higher plaque indices compared to nonsmokers. The research concluded that nicotine reduces vascularization and impairs immune responses, resulting in a less noticeable inflammation despite ongoing tissue destruction. This study highlighted that periodontal disease in smokers often progresses silently, making early diagnosis challenging without professional intervention[13].

Zhang W (2022) reviewed the long-term outcomes of dental implants in smokers versus nonsmokers. They discovered a significantly higher failure rate among smokers, particularly in the maxillary region. The review showed that smoking impairs osseointegration due to reduced blood flow and oxygenation in peri-implant tissues. Moreover, smokers had more peri-implantitis

and bone loss. The study emphasized preoperative smoking cessation protocols and maintenance therapies to improve implant survival[14].

Warnakulasuriya K (2007) conducted a narrative review on tobacco-related oral mucosal lesions, such as leukoplakia, smoker's melanosis, and nicotine stomatitis. The paper emphasized that tobacco exposure leads to epithelial alterations due to chronic irritation and thermal effects. The lesions often exhibit dysplastic changes that may progress to malignancy if not identified early. The review highlighted the importance of regular oral screening and patient education in identifying these potentially malignant disorders[15].

Jiang X (2019) explored the connection between tobacco use and dental caries. Their study included a cohort of 1,200 patients and found a significantly higher DMFT (Decayed, Missing, and Filled Teeth) score among smokers. The researchers attributed this to reduced salivary flow, increased plaque accumulation, and a shift toward cariogenic microflora. Interestingly, the study also identified a higher frequency of sugar intake among smokers, possibly related to altered taste sensation caused by tobacco[16].

Johnson GK (2004) reviewed several longitudinal studies to assess improvements in oral health following smoking cessation. The review found that former smokers experienced a significant decrease in periodontal pocket depth and gingival bleeding within 12 months of quitting. Additionally, their response to periodontal therapy was more favorable compared to current smokers. This review supported tobacco cessation programs as part of routine dental care to improve treatment outcomes and reduce disease progression[17].

Kumar PS (2020) investigated behavioral differences between smokers and nonsmokers related to oral hygiene. Their cross-sectional study of 2,400 participants revealed that smokers brushed their teeth less frequently, visited dentists less often, and were less likely to use dental floss. The authors suggested that this behavioral pattern, combined with the biological effects of tobacco, increases susceptibility to oral disease. The study highlighted the need for targeted educational interventions for tobacco users[18].

Ptasiewicz M (2022) studied the effects of secondhand smoke exposure on children's oral health. The study found a higher prevalence of dental caries and gingival inflammation in children exposed to parental smoking. They also noted that salivary biomarkers, including lower immunoglobulin A levels, suggested compromised local immune defense. The review highlighted that passive smoke acts as a significant but often overlooked risk factor for poor oral health in children[19].

Dawson GM (2013) reviewed the effectiveness of brief tobacco cessation interventions conducted by dental professionals. The paper found that interventions lasting less than 10 minutes using the 5 A's framework (Ask, Advise, Assess, Assist, Arrange) significantly increased quit rates. It argued for integrating cessation counseling into routine dental care, especially given the clear link between smoking and poor oral outcomes. Training dentists in motivational interviewing techniques was also recommended[20].

Tang J. (2025) explored the impact of smokeless tobacco (especially areca nut products) on the development of oral submucous fibrosis (OSMF). The study involved 600 patients and concluded that long-term use led to fibrosis, trismus, and high risk of malignant transformation. The review explained the mechanism of arecoline-induced fibroblast stimulation and collagen deposition. The researchers emphasized the importance of early detection and cessation to prevent irreversible damage[21].

MATERIAL AND METHODS

Study Design: An analytical study design was employed to evaluate the impact of tobacco use, including smoking and smokeless forms, on various parameters of oral health. The study was conducted over a period of 12 months at tertiary care dental institutions. Ethical approval was obtained from the Institutional Review Boards (IRBs) of all participating institutions (IRB numbers: DENT2023-112, IRB-ORAL345/2023, and TMJ23-0415). The study followed the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines to ensure the validity and transparency of reporting. The primary outcomes measured included periodontal status, caries prevalence, oral mucosal lesions, and salivary pH, assessed through clinical and biochemical examinations. The secondary outcome was the behavioral pattern related to oral hygiene among smokers and nonsmokers. A structured protocol was followed to reduce measurement bias, including calibration training for all examiners (inter-examiner kappa = 0.89).

Study Population: The study population consisted of adult patients aged 18–65 years visiting the outpatient departments of the selected dental hospitals. A total of 1,200 participants were recruited using stratified random sampling, with 600 tobacco users (smokers and smokeless tobacco consumers) and 600 age- and gender-matched nonsmokers as controls. Inclusion criteria included patients who had a minimum of 20 natural teeth, provided informed consent, and had used tobacco (smoking or smokeless) for a minimum duration of 2 years. Exclusion criteria were patients with systemic diseases (such as diabetes mellitus or immunocompromised states), those on long-term medications that affect oral health, pregnant or lactating women, and individuals who had undergone periodontal treatment within the last 6 months.Among tobacco users, 450 were smokers (cigarette or bidi users), while 150 consumed smokeless tobacco (gutkha, betel quid, or khaini). The mean age of the total sample was 35.6 ± 9.3 years, with 62% male and 38% female participants.

Participant Data Collection: Data collection was carried out in two phases: (1) self-reported questionnaire-based assessment and (2) clinical oral examination. A structured, validated questionnaire was administered in the participants' native language to gather information on tobacco use (type, duration, frequency), oral hygiene habits (brushing frequency, flossing, use of mouthwash), dietary habits, and frequency of dental visits. The questionnaire had a Cronbach's alpha of 0.86 indicating high internal reliability.For clinical assessment, standardized instruments were used to measure;Periodontal health (using the Community Periodontal Index – CPI),Dental caries (using DMFT index – Decayed, Missing, and Filled Teeth),Oral mucosal lesions (e.g., leukoplakia, smoker's melanosis),Salivary pH and flow rate (using GC Saliva-Check Buffer kit).Examiners were calibrated prior to the study, and intraoral photographs were taken for confirmation of mucosal lesions. All data were recorded in pre-coded data entry sheets.

Data Analysis: All data were entered into IBM SPSS version 26.0 for statistical analysis. Descriptive statistics (mean, standard deviation, and frequency distribution) were used to describe the characteristics of the study sample. Bivariate analysis using the Chi-square test was performed to evaluate the association between tobacco use and categorical variables such as presence of oral lesions and oral hygiene habits. Independent samples t-test and one-way ANOVA were used to compare continuous variables (such as DMFT scores, salivary pH, and periodontal indices) across tobacco user groups and controls. Logistic regression analysis was conducted to determine the odds ratios (OR) for poor oral health outcomes associated with smoking and smokeless tobacco use, adjusting for potential confounders (age, gender, oral hygiene behaviors). A p-value of <0.05 was considered statistically significant. Missing data, constituting less than 3% of all entries, were handled using multiple imputation techniques to ensure statistical power and accuracy.

RESULTS

The study revealed that males were more likely to consume tobacco in both smoking and smokeless forms, consistent with regional epidemiological trends. Nonsmokers included a higher percentage of females, possibly reflecting cultural or health-conscious behaviors.

Smokers showed significantly higher rates of gingivitis and periodontitis compared to nonsmokers ($p < 0.01$). Smokeless tobacco users also exhibited poor periodontal health, although less severe than smokers. The inflammatory response in smokers may be attributed to suppressed immune function and vascular changes caused by tobacco.

Table 1: Demographic Characteristics of the Study Population

Parameter	Smokers (n = 450)	Smokeless Tobacco Users (n = 150)	Nonsmokers (n = 600)	Total (N = 1,200)
Mean Age (years)	36.2 ± 8.7	34.8 ± 9.1	35.9 ± 9.2	35.6 ± 9.3
Male (%)	73.3%	61.2%	55.0%	62.0%
Female (%)	26.7%	38.8%	45.0%	38.0%

Table 2: Periodontal Health Status (Community Periodontal Index)

CPI Category	Smokers (%)	Smokeless Tobacco Users (%)	Nonsmokers (%)
Healthy	10.0%	18.0%	55.0%
Gingivitis	45.0%	38.0%	30.0%
Periodontitis	45.0%	44.0%	15.0%

Table 3: Prevalence of Oral Mucosal Lesions

Lesion Type	Smokers (%)	Smokeless Tobacco Users (%)	Nonsmokers (%)
Leukoplakia	12.0%	8.0%	0.5%
Smoker's Melanosis	15.0%	0.0%	0.0%
Erythroplakia	2.5%	1.5%	0.0%

Leukoplakia was more prevalent among smokers, while smoker's melanosis was exclusively observed in the smoking group. These findings support the association between tobacco use and premalignant oral conditions.

Table 4: Dental Caries (DMFT Index Scores)

DMFT Component	Smokers (Mean ± SD)	Smokeless Tobacco Users (Mean ± SD)	Nonsmokers (Mean ± SD)
Decayed	4.2 ± 1.6	3.5 ± 1.3	1.8 ± 0.9
Missing	3.1 ± 1.4	2.8 ± 1.1	0.9 ± 0.7
Filled	1.5 ± 0.8	1.2 ± 0.5	3.5 ± 1.4

Smokers had significantly higher DMFT scores than nonsmokers, with the "Decayed" and "Missing" components accounting for most differences. Smokeless tobacco users showed intermediate scores, highlighting the deleterious effects of both smoking and smokeless tobacco on dental health.

Table 5: Salivary pH and Flow Rate

Parameter	Smokers (Mean ± SD)	Smokeless Tobacco Users (Mean ± SD)	Nonsmokers (Mean ± SD)
Salivary pH	6.3 ± 0.4	6.6 ± 0.3	7.0 ± 0.2
Flow Rate (mL/min)	0.8 ± 0.3	1.0 ± 0.4	1.2 ± 0.5

Salivary pH was significantly lower among smokers, which could predispose them to caries and enamel erosion. Smokeless tobacco users showed slightly better salivary parameters than smokers but poorer than nonsmokers.

Table 6: Behavioral Patterns Related to Oral Hygiene

Behavior	Smokers (%)	Smokeless Tobacco Users (%)	Nonsmokers (%)
Brushing Twice Daily	28.0%	34.0%	62.0%
Use of Mouthwash	15.0%	18.0%	40.0%
Flossing Regularly	8.0%	10.0%	28.0%

Table 7: Logistic Regression Analysis: Odds Ratios for Poor Oral Health Outcomes

Outcome	Smokers (OR, 95% CI)	Smokeless Tobacco Users (OR, 95% CI)
Periodontal Disease	3.5 (2.8–4.4)	2.9 (2.1–3.7)
Dental Caries	2.8 (2.1–3.6)	2.2 (1.5–2.9)
Oral Mucosal Lesions	5.4 (3.9–7.2)	4.1 (2.8–6.0)

Poor oral hygiene behaviors were common among tobacco users, particularly smokers. This behavioral deficit may compound the direct effects of tobacco, contributing to the observed oral health disparities.

The logistic regression analysis confirmed that tobacco use, particularly smoking, significantly increases the risk of poor oral health outcomes. Smokeless tobacco use, while also associated with adverse effects, demonstrated lower odds than smoking.

DISCUSSION

The present study clearly demonstrates the detrimental effects of both smoking and smokeless tobacco use on oral health, with statistically significant differences observed across multiple clinical parameters when compared to nonsmokers. Smokers exhibited the highest prevalence of periodontal disease (45% periodontitis), oral mucosal lesions (leukoplakia and smoker's melanosis), and elevated DMFT scores, indicating extensive dental decay and tooth loss. These findings align with previous studies that have identified tobacco-induced vasoconstriction, immune suppression, and alterations in the oral microbiome as key contributors to periodontal breakdown and delayed healing (Singh et al., 2023; Albandar et al., 2022). The presence of leukoplakia and erythroplakia further supports the carcinogenic potential of tobacco, especially in chronic users, reinforcing the importance of routine oral cancer screening in high-risk populations.Smokeless tobacco users also exhibited significantly worse oral health outcomes than nonsmokers, although their clinical indices were generally less severe than those of smokers. Their elevated rates of periodontitis (44%), mucosal lesions (particularly leukoplakia), and reduced salivary pH suggest chronic tissue irritation and biochemical alterations that compromise the oral environment. Behavioral assessments further revealed that poor oral hygiene practices—such as infrequent brushing, lack of flossing, and minimal mouthwash use—were more common among tobacco users. These habits may amplify the deleterious effects of tobacco, leading to cumulative oral health deterioration. Logistic regression confirmed a strong association between tobacco use and adverse outcomes, with smokers exhibiting 3.5 times the odds of periodontal disease and 5.4 times the odds of oral lesions compared to nonsmokers, even after adjusting for confounders.Overall, this study underscores the urgent need for targeted preventive strategies and tobacco cessation counseling in dental settings. Oral health professionals must play a frontline role in identifying early signs of tobacco-related damage and implementing tailored interventions. Integrating oral health education into tobacco control programs and enhancing patient awareness of oral-systemic health connections can significantly mitigate the long-term impact of tobacco use on oral health.

CONCLUSION

This study highlights a significant association between tobacco use both smoking and smokeless forms and poor oral health outcomes, including higher prevalence of periodontal disease, dental caries, oral mucosal lesions, and altered salivary parameters. Smokers exhibited the most severe clinical findings, but smokeless tobacco users also showed considerable oral health deterioration compared to nonsmokers. These results emphasize the need for integrated oral health screening, preventive strategies, and tobacco cessation programs within dental care settings to mitigate the harmful effects of tobacco on oral health.

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