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Prevalence And Factor Associated With Cancer And Pre-Cancerous Condition In India: A Hospital-Based Study**Ribhav Kumar Terry, Rashi Bahl, Ajay Kumar, Ashima B. Behl, Ramandeep Grewal, Harveen Kaur**

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Keywords*Oral cancer, precancerous lesions, tobacco, betel nut, socioeconomic factors, Malwa belt, India, retrospective study***ABSTRACT**

Background: Oral cancer poses a significant public health challenge in India, ranking as the second most common cancer among males and the fourth among females. Despite advancements in diagnostics and increased public awareness, incidence rates continue to rise, particularly in high-risk regions such as the Malwa belt of Punjab. While lifestyle-related habits like tobacco use, betel nut chewing, and alcohol consumption are well-established risk factors, emerging evidence highlights the role of socioeconomic status and genetic predisposition in disease progression.

Aim: To evaluate the prevalence, associated risk factors, and treatment outcomes of oral cancer and precancerous lesions over a ten-year period in a hospital-based population.

Methodology: A retrospective observational study was conducted at BJS Dental College and Hospital, Punjab, from 2014 to 2024. A total of 1,503 patient records with clinically evident oral lesions were analyzed. Data collected included lesion type, stage at presentation, risk factors, and treatment modalities. Of these, 1,424 patients presented with early-stage lesions and 79 with late-stage conditions. Variables such as tobacco use, betel nut chewing, alcohol consumption, socioeconomic status, denture fit, and family history of malignancy were evaluated.

Results: Early-stage lesions accounted for 94.7% of cases, while 5.3% were diagnosed at a late stage. Tobacco use was the most significant risk factor, followed by betel nut chewing and alcohol consumption. A higher prevalence was observed among patients from lower socioeconomic backgrounds. Poor denture fit and family history of cancer were linked to several advanced cases. Conservative treatment effectively managed early-stage lesions, while late-stage cases required biopsy and referral to tertiary cancer centers. The Malwa region of Punjab emerged as a high-incidence area.

Conclusion: The study highlights the growing burden of oral cancer in India and underscores the importance of early diagnosis, public awareness, and preventive strategies, particularly in high-risk regions.

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INTRODUCTION:

Oral cancer remains a major public health concern in India and other developing nations, ranking as the second most common cancer among males and the fourth among females. As of 2022, approximately 1.4 million cancer cases were reported in India, with projections indicating a 12.8% increase by 2025 compared to 2020 estimates. Over 90% of oral cancer cases are histopathologically identified as squamous cell carcinoma.^{1,2}

Tobacco use, betel quid chewing, and regular alcohol consumption are the most prominent and well-documented risk factors associated with the development of oral precancerous and cancerous lesions. Additionally, infection with high-risk genotypes of human papillomavirus (HPV) and diets low in fresh fruits and vegetables have also been implicated in the etiopathogenesis of oral cancer.^{3,4}

Despite increased awareness efforts, the disease continues to rise, particularly in the Malwa region of Punjab, which includes districts like Bathinda, Mansa, Muktsar, Patiala, and Sangrur. This area has been termed “India’s Cancer Belt” due to heavy pesticide usage in agriculture, contributing to a higher cancer incidence.⁵ Notably, breast cancer is more prevalent among women in the region, while cancers of the colon, esophagus, and tongue are more common among men.

In Indian culture, the areca (betel) nut holds significant religious and social importance and is widely consumed during rituals and ceremonies.^[6] However, the widespread habit of chewing tobacco, areca nut, and betel quid is a major contributor to India’s high incidence of oral cancer. The mutagenic potential of these substances depends on their dose, frequency, and duration of use, with synergistic effects observed when used in combination. Yet, not all individuals with these habits develop cancer, indicating possible roles of genetic susceptibility and environmental modifiers.⁷

Early diagnosis is critical, as early-stage lesions

often respond well to medical management, while late-stage lesions typically require multimodal interventions, including surgery, radiotherapy, and chemotherapy. In Punjab, cancer incidence rose by 7.45% between 2021 and 2024, further highlighting the urgency for regional data and intervention strategies. This study aims to evaluate the prevalence of oral cancer and precancerous lesions over a decade, identify associated risk factors, and assess clinical outcomes. By doing so, it seeks to enhance awareness and inform strategies for early detection and prevention in high-burden regions.

MATERIALS AND METHODS:

The present retrospective observational study was conducted at the Departments of Oral Medicine and Radiology (OMDR) and Oral and Maxillofacial Surgery (OMFS) at BJS Dental College, Punjab, from 2014 to 2024. Ethical clearance was obtained from the Institutional Ethical Committee prior to initiation of the study.

A total of **1,503 patients** presenting with clinically evident oral lesions were included in the analysis. Of these, **1,424 patients** were diagnosed with **early-stage lesions**, while **79 cases** were classified as **late-stage lesions** based on clinical, therapeutic, and histopathological criteria.

Early lesions were defined as those demonstrating positive response to conservative medical treatment and behavioral counselling (specifically cessation of tobacco, smoking, and betel nut chewing), and were monitored through routine follow-ups. **Late lesions** were defined as clinically advanced lesions exhibiting significant surface irregularities and lack of response to conservative management, even after habit cessation.

All patients were initially assessed by trained professionals in the Department of Oral Medicine and Radiology. Patients with habits such as tobacco use, smoking, or areca nut chewing were referred to the institutional Tobacco Cessation Centre for structured counselling.

Clinical interventions for early lesions included topical corticosteroids and vitamin-based therapy for keratotic patches. Patients presenting with restricted mouth opening were managed by the OMFS department using **intra-lesional injections of corticosteroids** (Injection Hynidose with Dexona) and were reviewed during follow-up visits.

Lesions showing no significant clinical improvement underwent further evaluation by the OMFS team. Based on histopathological examination, these were classified as late lesions.

Lesions <4 cm underwent **excisional biopsy**, while larger lesions (>4 cm), particularly those involving the tongue, gingiva, buccal mucosa, or regional lymph nodes, underwent **incisional biopsy**. Patients diagnosed with **Stage III or Stage IV malignancies** were referred to tertiary cancer care centers for advanced management.

Inclusion Criteria:

- Patients presenting with clinically visible oral lesions.
- Patients who provided informed consent.
- Patients with relevant deleterious habits and associated clinical symptoms.
- Exclusion Criteria:
- Patients unwilling or unable to provide informed consent.
- Patients without visible lesions, regardless of deleterious habits.
- Patients previously diagnosed or treated for early or late oral lesions.

Sample Size Calculation:

The sample was derived from retrospective handwritten case records maintained by trained departmental staff. Eligible cases were identified and stratified into early and late lesion groups, followed by analysis of their management outcomes and follow-up data.

Inter-examiner Calibration:

To ensure consistency and reliability, a group of 2–3 trained observers independently verified and analyzed the collected data in collaboration with clinical faculty members involved in patient care and record keeping.

Statistical Analysis:

Data were entered into Microsoft Excel and subsequently analyzed using SPSS software (Version XX, IBM Corp., Armonk, NY, USA). Descriptive statistics such as frequency and percentage were used to summarize categorical variables including types of lesions and associated risk factors. Chi-square tests were applied to evaluate the association between lesion type (early vs. late) and risk factors such as tobacco use, betel nut chewing, alcohol consumption, socioeconomic status, denture fit, and family history of malignancy. Cross-tabulation and graphical representations were used where appropriate to visualize trends and regional variations, especially in high-risk areas such as Punjab's Malwa belt.

RESULTS:

The cases of early and late lesions have increased with dominance of tobacco pouch keratosis for early lesion as shown in figure 1a and squamous cell carcinoma for late lesion L as shown in figure 2a).

In early lesion cases leukoplakia was found to be the second common lesion followed by smokers palate as shown in figure 1a. for late lesion, well differentiated forms most commonly seen followed by moderately and poorly differentiated. As these cases require specialized care and were referred to higher centres.

The mean age group of individuals affected with early and late lesion lies in 41-50 years of age followed by 31-40 years of age for early lesion (as shown in figure 1b) and 51-60 years for late lesion (as shown in figure 2b).

Both early and late cases shows male predominance as shown in figure 1c and 2c, the difference between affected male and female is greater in early cases than in late lesion.

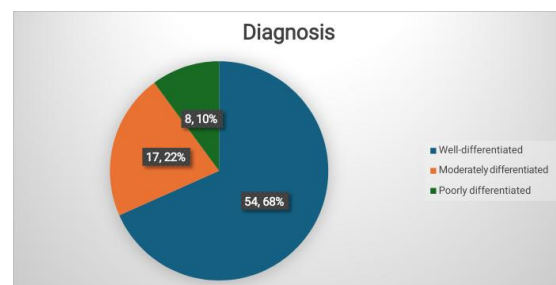


Figure. 2a

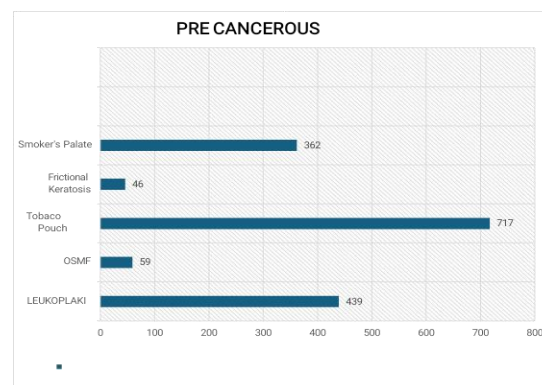


Figure. 1a

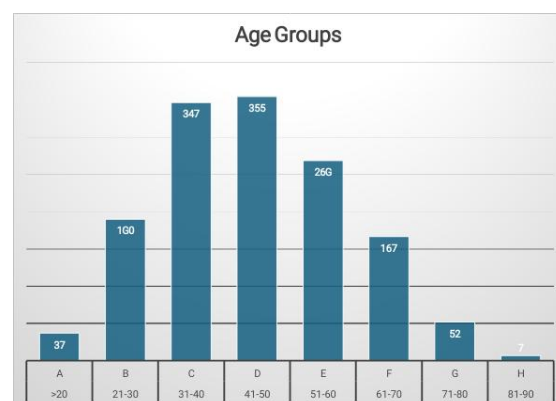


Figure. 1b

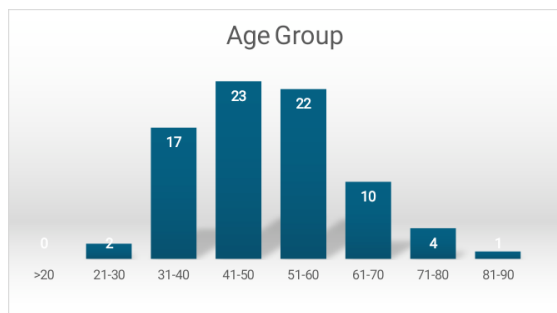


Figure.2b

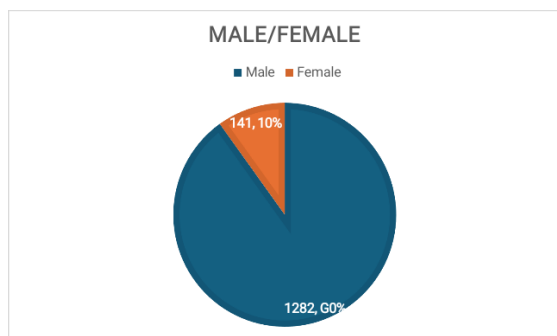


Figure.1c

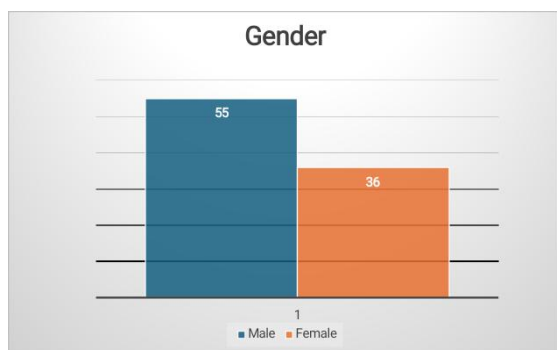


Figure. 2c

Patient with early and late lesion were found to be significantly associated with habits of betel nut chewing, alcohol consumption and smoking as shown in figure 3a,3b, 3c. The odds of betel nut chewing, alcohol and smoking in developing of early and late condition were considered almost eight to nine times for those who did not engage in these habits ¹.

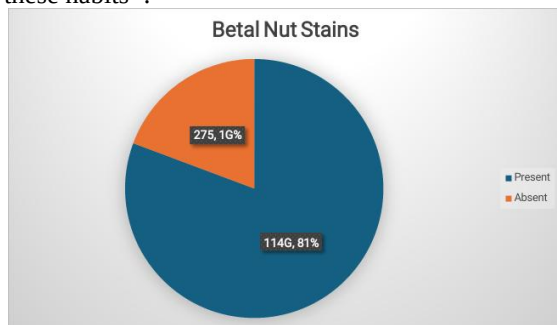


Figure. 3a

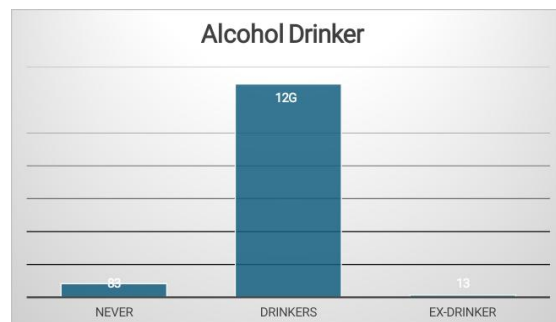


Figure. 3b

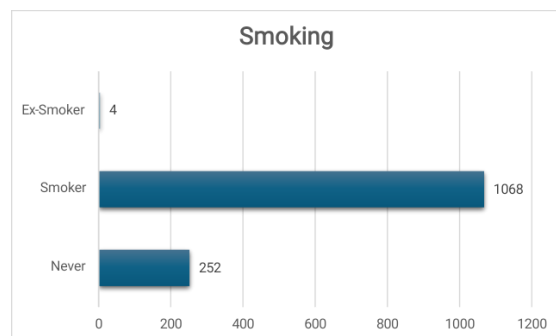


Figure. 3c

The low economic status group was most commonly affected followed by high economic group as shown in figure 4.

Most of the late lesion present with no lymph node involvement with no metastasis found so far as shown in figure 5

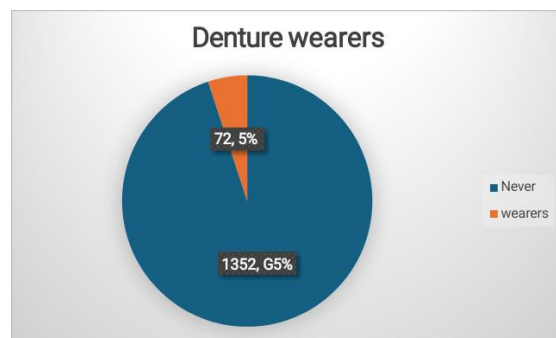


Figure. 4

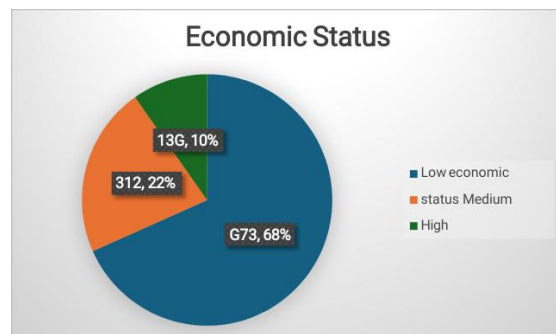


Figure. 5

DISCUSSION:

The current study investigates the rising burden of oral potentially malignant disorders (OPMDs) and oral cancer in India, highlighting associated risk factors and demographic trends. Our findings indicate tobacco pouch keratosis as the most prevalent lesion, while frictional keratosis was the least reported. These results contrast with studies from Maharashtra and Taiwan, where oral submucous fibrosis (OSMF) was most frequently encountered^{8,9}. In Thailand, however, leukoplakia was the dominant lesion¹⁰. Such discrepancies emphasize the geographical variation in the distribution of OPMDs across populations.

The highest frequency of early and late lesions in this study was observed among individuals aged 41–50 years, differing from Northeast Thailand, where the peak incidence occurred in the 60–69 age group¹⁰. A German cohort study spanning two decades reported a significant rise in oral squamous cell carcinoma (OSCC) among 30–39-year-olds, with a male-to-female ratio of 3.8:1^[11]. Consistent with global literature, the tongue was the most affected anatomical site for OSCC in younger individuals¹².

Genomic studies comparing young and elderly patients with tongue SCC revealed similar mutational profiles, regardless of tobacco exposure¹². Although smoking is implicated in disease progression, it lacks the distinct mutational signatures found in lung or laryngeal cancers, suggesting its role as a tumor promoter rather than initiator.

This study found a male predominance in OPMDs, aligning with global data^{8,13}. However, research indicates that females may exhibit greater susceptibility to head and neck cancers in the context of smoking, with odds ratios (ORs) as high as 2.33 (95% CI: 1.56–3.49)¹³. The combined use of tobacco and alcohol increases cancer risk up to 13-fold, compared to 2–4-fold risk for individual exposures¹³. Several studies support the multifactorial etiology of OSCC, particularly in younger populations, and consistently report a male predominance in OPMDs^{8,11}.

Our study also reaffirms the strong association between tobacco usage and OPMD development, as reported extensively in the literature^{14,15}. Over 60 known carcinogens have been identified in tobacco products¹⁵. Likewise, betel and areca nut chewing have long been established as high-risk behaviors, with multiple studies documenting their adverse impact on oral health^{8,9}.

Areca nut contains specific nitrosamines, such as MNPA, MNPN, N-nitrosoguvacine (NGC), and N-nitrosoguvacoline (NGL)—all of which are suspected carcinogens. MNPA, in particular, causes DNA single-strand breaks and protein cross-links, facilitating malignant transformation¹⁵.

The role of HPV-16 in OSCC was found to be negligible in Dutch cohorts, where only 3.2% of young patients tested positive¹³. Therefore, routine HPV screening is not recommended in such populations. Moreover, familial cancer history, socioeconomic status, and nutritional deficiencies were also shown to impact oral cancer risk¹⁴. Studies by Kabat et al. and Thomas et al. emphasized the inverse association between BMI, economic status, and OPMDs, proposing that individuals in these groups may adapt physiologically to chronic stressors¹⁴.

Systemic conditions, particularly diabetes mellitus, are increasingly recognized as contributors to OPMD pathogenesis. Diabetic patients often experience hyposalivation, xerostomia, and mucosal atrophy, which increase susceptibility to infection and impair mucosal defense¹⁶. These oral changes, coupled with poor glycemic control, create an environment conducive to lesion progression.

Interestingly, a higher prevalence of OPMDs was noted among dental visitors, possibly reflecting delayed presentation when symptoms became severe—a phenomenon described as the "healthy person non-visitor effect"¹⁷. However, logistic regression analysis did not show statistically significant associations.

LIMITATIONS:

This study had several limitations. The lack of histopathological confirmation for all OPMDs may affect diagnostic precision. Additionally, overlapping risk behaviors, such as concurrent tobacco smoking and chewing, made it challenging to isolate individual risk contributions. Social desirability bias may have led to underreporting of habits. Other potential confounding factors—including genetic predisposition, environmental exposures, and dietary patterns—were not fully accounted for, limiting generalizability.

CONCLUSION:

The present study underscores the rising incidence of oral cancer and OPMDs in India, predominantly driven by tobacco use, betel nut chewing, and alcohol consumption. Tobacco pouch keratosis and leukoplakia emerged as common early lesions, whereas squamous cell carcinoma was the primary late-stage presentation. A distinct male

predominance and peak incidence in the 41–50-year age group were observed.

Socioeconomic factors, systemic diseases such as diabetes, and nutritional deficiencies were found to influence lesion progression. Early detection, counseling, and preventive measures can significantly curb disease progression. Therefore, integration of habit cessation programs, public awareness campaigns, and accessible healthcare services is essential for effective management of OPMDs. Future research should focus on genetic and environmental risk mapping to develop personalized prevention and therapeutic strategies.

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