

# Prevalence and Exposure Pattern of Oral Precancerous Lesions Among Smokeless Tobacco Users of Rural Bareilly, Uttar Pradesh

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## ABSTRACT

**Background:** Smokeless tobacco (SLT) consumption is still a serious public health issue in India, especially in rural regions, where access to oral healthcare and knowledge are scarce. Long-term use of SLT puts people at risk for oral precancerous lesions (OPLs), which, if left untreated, can develop into cancer.

**Objectives:** To ascertain the frequency and trends of OPLs among rural tobacco chewers in Bareilly district, Uttar Pradesh, and to identify associated socio-demographic and behavioural determinants.

**Methods:** From August to November 2025, 403 regular SLT users aged  $\geq 18$  years participated in a community-based cross-sectional study selected by simple random sampling. A pretested, semi-structured questionnaire was used to gather information on sociodemographic factors and SLT practices. Socioeconomic status was classified using the Modified BG Prasad Scale 2025. Oral examinations were performed following the WHO Oral Health Survey (2013) criteria. Jamovi was used to analyse the data, and the chi-square test was used to examine relationships at a significance level of 5%.

**Results:** The overall prevalence of OPLs was 37.5% (of 151/403). The most common

lesions were oral submucous fibrosis (15.9%) and leucoplakia (12.4%), followed by lichen planus (6.0%) and erythroplakia (3.2%). OPLs were significantly associated with illiteracy ( $p=0.026$ ), farming occupation ( $p=0.034$ ), duration  $\geq 5$  years ( $p<0.001$ ), and frequency  $>5$  times/day ( $p<0.001$ ).

**Conclusion:** In Bareilly, rural SLT users have a significant prevalence of oral precancerous lesions. Community-based screening, early detection, and tobacco cessation initiatives at the primary care level are essential to prevent malignant transformation.

**Keywords:** Oral precancerous lesions, Oral submucous fibrosis, Rural Area, Smokeless tobacco, Bareilly.

## INTRODUCTION

In India, tobacco smoking continues to be a significant avoidable cause of illness and death, responsible for nearly one million deaths annually [1]. Smokeless tobacco, gutkha, khaini, and betel quid are deeply rooted in rural life [2]. These products contain areca nut alkaloids and tobacco-specific nitrosamines that induce epithelial dysplasia and submucosal fibrosis [3,4].

Oral precancerous lesions (OPLs) that are important markers of malignant transition include leucoplakia, erythroplakia, and oral

submucous fibrosis (OSMF) [5]. Due to cultural acceptability, low literacy, and a lack of oral health infrastructure, SLT usage continues despite national initiatives and laws [6, 7].

The purpose of this study was to ascertain the prevalence of OPLs among Bareilly's rural tobacco chewers and look into the behavioural and sociodemographic factors associated with their occurrence.

**Aim:** To determine the prevalence of oral precancerous lesions and the frequency of exposure to smokeless tobacco users in rural Bareilly, Uttar Pradesh.

### Objectives:

To evaluate the prevalence and types of oral precancerous lesions, with the goal of investigating the relationship between sociodemographic characteristics and oral lesions, and to assess the impact of tobacco usage frequency and duration on the development of lesions.

## METHODOLOGY

### Study Design and Setting:

From August to November 2025, community-based cross-sectional research was carried out in a few rural villages under the field-practice area of the Department of Community Medicine at the Rajshree Medical Research Institute (RMRI), Bareilly, Uttar Pradesh, utilising simple random sampling.

### Study Population:

Those who habitually used smokeless tobacco, were at least eighteen years old, and had lived in the study communities for at least a year made up the research population.

- ✓ **Inclusion criteria:** Adults currently consuming any form of SLT (e.g. khaini, gutkha, betel quid with tobacco, zarda) for  $\geq 6$  months.
- ✓ **The exclusion criteria were as follows:** (a) individuals with a previous diagnosis of oral cancer or precancer under treatment, (b) those with a systemic illness that precluded oral examination, and (c) those unwilling to participate.

### Sample Size Determination

The required sample size was calculated using the single proportion formula:

$$n = \frac{Z^2 pq}{d^2}$$

Where,  $Z = 1.96$  (for 95 % confidence),  $p = 0.35$  (anticipated prevalence of oral precancerous lesions based on previous literature [10]),  $q = 1 - p = 0.65$ , and  $d = 0.05$  (absolute precision).

Hence the sample size,  $n = 350$

Furthermore, allowing for  $\approx 15\%$  non-response, the final sample size was 403 participants.

### Study Tools and Data Collection

Data was collected during the in-person interviews using a pre-tested, semi-structured questionnaire. The tool captured sociodemographic data on age, gender, occupation, education, and socioeconomic status (coded according to the Modified BG Prasad Scale 2025 [8]). Tobacco-use characteristics: type of SLT used, duration of habit ( $< 5$  years or  $\geq 5$  years), and frequency of use ( $\leq 5$  times/day or  $> 5$  times/day). Clinical findings: Presence and type of oral precancerous lesions.

### Oral Examination:

A clinical oral examination was performed on each subject in sufficient natural light. During the examination, sterile gloves, tongue depressors, and disposable mouth mirrors were utilised. The WHO Oral Health Survey Methods (2013) were followed during the examination process [9].

Oral precancerous lesions were clinically diagnosed using standard definitions.

- Leukoplakia: a white patch or plaque not attributable to other causes.
- Erythroplakia is a bright-red, velvety lesion with no inflammatory cause.
- Oral submucous fibrosis (OSMF): Blanching and stiffness of the mucosa with reduced mouth opening.
- Lichen planus: Reticular white striae or plaque lesions.

### Statistical Analysis

Jamovi software was used to examine the data after it had been input and cleaned in

Microsoft Excel. For categorical variables, descriptive statistics were reported as frequencies and percentages, and for continuous data, they were expressed as mean  $\pm$  SD. The Chi-square ( $\chi^2$ ) test was used to examine associations between oral precancerous lesions and factors such as gender, education, occupation, duration, and frequency of use of smokeless tobacco. Statistical significance was set at  $p < 0.05$ .

## RESULTS

A total of 403 smokeless tobacco users were examined, of whom 300 (74.4%) were men and 103 (25.6%) were women. The majority belonged to the 31-50 years age group (46.9%), followed by those aged  $> 50$  years (29.3%). Nearly half of the respondents were farmers (48.1%), and more than one-third were illiterate (38.7%). Over half (52.1%) of the participants belonged to the lower socioeconomic classes (Class IV-V) according to the Modified BG Prasad Scale 2025 (Table 1).

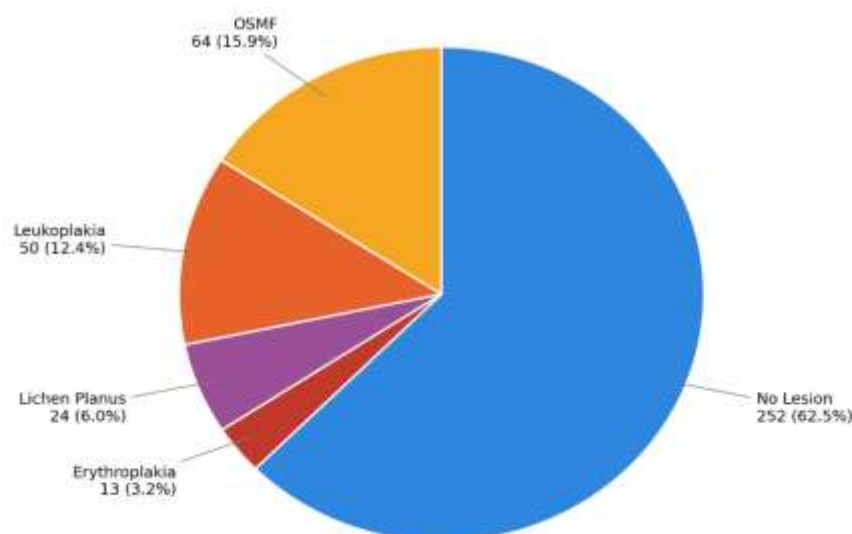
**Table 1. Socio-demographic characteristics of participants (n=403)**

| Variable             | Category   | Frequency | Percentage (%) |
|----------------------|------------|-----------|----------------|
| Gender               | Male       | 300       | 74.4           |
|                      | Female     | 103       | 25.6           |
| Age                  | 18-30      | 96        | 23.8           |
|                      | 31-50      | 189       | 46.9           |
|                      | $>50$      | 118       | 29.3           |
| Education            | Illiterate | 156       | 38.7           |
|                      | Literate   | 247       | 61.3           |
| Occupation           | Farmers    | 194       | 48.1           |
|                      | Others     | 209       | 51.9           |
| SES (BG Prasad 2025) | I-II       | 51        | 12.7           |
|                      | III        | 142       | 35.2           |
|                      | IV-V       | 210       | 52.1           |

Most of the study participants were middle-aged males, illiterate or semi-literate, engaged in farming, and from lower socioeconomic groups.

### Prevalence and patterns of oral precancerous lesions:

Among 403 participants, 151 (37.5%) had at least one oral precancerous lesion (OPL). The most common type observed was oral submucous fibrosis (OSMF) in 64 cases (15.9%), followed by leukoplakia (50 cases; 12.4%), lichen planus (24 cases; 6.0%), and erythroplakia (13 cases; 3.2%) (Figure 1).



**Figure 1. Distribution of Oral Precancerous Lesions (n=403)**

Figure 1 shows that OSMF accounted for the largest share (15.9%) of lesions, followed by leucoplakia (12.4%). Together, these two conditions comprised over two-thirds of all OPLs, whereas 62.5% of the participants showed no lesions.

#### Association of OPLs with sociodemographic and behavioural factors:

The association between the presence of OPLs and various factors is summarised in Table 2.

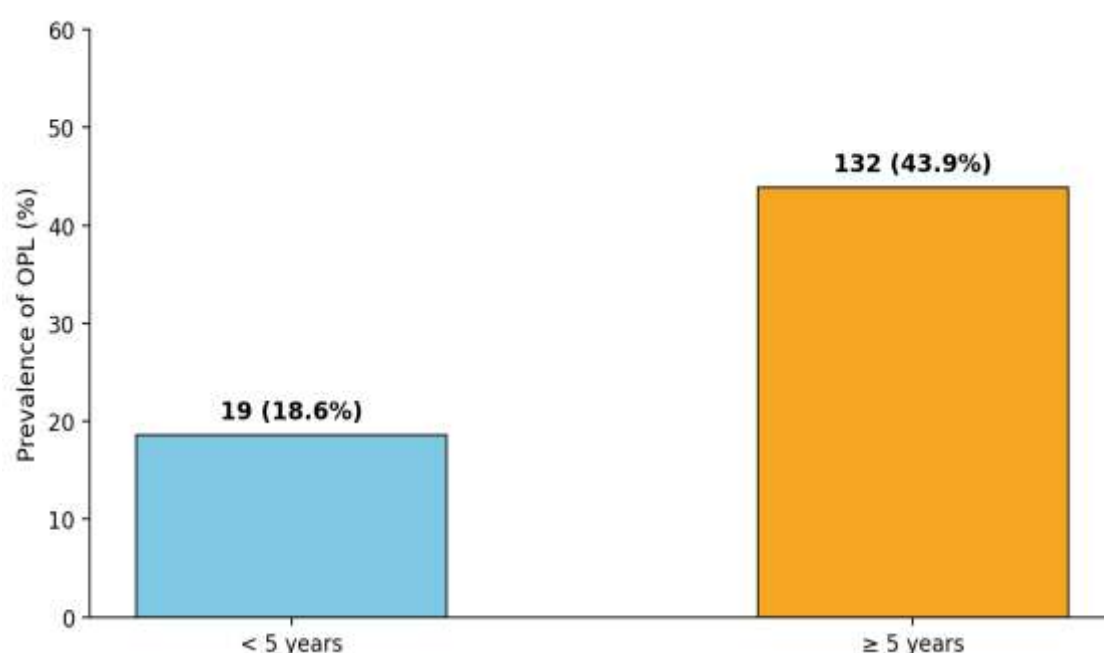
Although males had a higher prevalence of lesions (39.7%) than females (31.1%), this difference was not statistically significant ( $p = 0.120$ ). OPLs were significantly more frequent among illiterates (44.2%) and farmers (42.8%) than among their counterparts ( $p < 0.05$ ).

The duration and frequency of tobacco chewing showed a clear dose-response relationship. The prevalence was 18.6% among users for  $<5$  years versus 43.9% for  $\geq 5$  years, and 22.4% among those chewing  $\leq 5$  times/day versus 44.2% among those  $>5$  times/day (both  $p < 0.001$ ).

**Table 2. Association between oral precancerous lesions and selected variables (n=403)**

| Variable        | Category               | OPL Present n (%) | OPL Absent n (%) | p-value  |
|-----------------|------------------------|-------------------|------------------|----------|
| Gender          | Male                   | 119 (39.7)        | 181 (60.3)       | 0.120    |
|                 | Female                 | 32 (31.1)         | 71 (68.9)        |          |
| Education       | Illiterate             | 69 (44.2)         | 87 (55.8)        | 0.026    |
|                 | Literate               | 82 (33.2)         | 165 (66.8)       |          |
| Occupation      | Farmers                | 83 (42.8)         | 111 (57.2)       | 0.034    |
|                 | Others                 | 68 (32.5)         | 141 (67.5)       |          |
| Duration of use | $<5$ years (n=102)     | 19 (18.6)         | 83 (81.4)        | $<0.001$ |
|                 | $\geq 5$ years (n=301) | 132 (43.9)        | 169 (56.1)       |          |
| Frequency/day   | $\leq 5$ (n=125)       | 28 (22.4)         | 97 (77.6)        | $<0.001$ |
|                 | $>5$ (n=278)           | 123 (44.2)        | 155 (55.8)       |          |

Significant associations were found with education, occupation, duration, and frequency of chewing habits, whereas sex differences were not statistically significant.



**Figure 2. Prevalence of OPL by Duration of Tobacco Use**

The bar chart (Figure 2.) demonstrates that individuals with a chewing history of  $\geq 5$  years had a much higher prevalence of OPLs (43.9%) than those who had used tobacco for  $< 5$  years (18.6%), confirming a significant duration-dependent pattern.

The study found that over one-third of the rural smokeless tobacco users had oral precancerous lesions, with OSMF and leucoplakia being the most frequent types. Illiteracy, farming occupation, and prolonged and frequent tobacco use were identified as key determinants. Although gender differences were observable, they were not statistically significant.

## DISCUSSION

The present study found that 37.5% of rural smokeless tobacco (SLT) users in Bareilly had at least one oral precancerous lesion (OPL). This figure is consistent with the range of 30-40% reported by other community-based Indian studies of tobacco-related oral lesions [10,11], and confirms that the oral disease burden associated with SLT use remains substantial in rural North Indian populations, where khaini, gutkha, and betel quid with tobacco continue to be used from an early age with limited awareness of their health consequences.

Oral submucous fibrosis (OSMF) was the single most frequent lesion in our cohort (15.9%), followed by leucoplakia (12.4%). This pattern mirrors the dominance of OSMF reported wherever areca nut-containing products such as gutkha and pan masala are widely chewed, since areca alkaloids stimulate collagen cross-linking and fibroblast proliferation in the oral mucosa, producing progressive submucosal fibrosis [4,12]. The comparatively lower proportion of leucoplakia and erythroplakia in this cohort, relative to some hospital-based series, may reflect differences in the type and combination of SLT products used locally, as well as the community-based, rather than clinic-based, sampling frame of the present study, which is likely to capture disease at an earlier and less symptomatic stage.

OPLs were significantly more common among illiterate participants (44.2% versus 33.2% among literate participants,  $p=0.026$ ) and among farmers (42.8% versus 32.5% among other occupations,  $p=0.034$ ). This association is consistent with prior work linking limited education and agricultural occupation to higher rates of tobacco-related oral disease [13,16]. Illiteracy likely limits exposure to health education on the dangers of SLT and reduces the likelihood of early self-recognition of oral lesions, while agricultural work in rural Bareilly is often accompanied by long working hours, physical fatigue, and a culturally embedded practice of chewing tobacco as a stimulant and appetite suppressant during fieldwork. Additionally, farmers could have less access to oral screening programs and basic healthcare, which would further delay discovery.

Both the length and frequency of SLT usage showed a distinct dose-response relationship. The prevalence of OPLs increased from 22.4% among those chewing five times or less per day to 44.2% among those chewing more than five times per day, and from 18.6% among users with less than five years of habit to 43.9% among those with five years or more (both  $p<0.001$ ). This gradient is biologically plausible because areca nut alkaloids and tobacco-specific nitrosamines act cumulatively on the oral mucosa, and longer, more frequent exposure increases the risk of developing submucosal fibrosis and epithelial dysplasia. This relationship has been shown in both more recent epidemiological surveys and classical dose-response studies of tobacco chewing and oral leucoplakia [15,17]. Given that even a little decrease in daily frequency may significantly reduce lesion risk, this study supports the use duration and frequency as quantifiable, adjustable objectives for quitting counselling.

Although men in this sample had a numerically higher OPL prevalence than women (39.7% versus 31.1%), the difference did not reach statistical significance ( $p=0.120$ ). This is a notable finding given

that SLT use in India has traditionally been reported as far more common among men, and it is consistent with a growing body of evidence that smokeless tobacco use among women, including in rural and agricultural settings, is increasing and may now be contributing a comparable oral disease burden [14]. This underscores the need for tobacco-cessation and screening programmes that are not narrowly targeted at men, but reach women in the same rural communities.

Taken together, these findings suggest that the burden of oral precancerous disease in this population is concentrated among socioeconomically disadvantaged, illiterate, agricultural workers with long-standing, high-frequency SLT habits, a profile that aligns closely with national data on the social patterning of tobacco use in India [7, 16]. This has direct implications for the design of preventive services: screening and cessation programmes are likely to have the greatest impact if they are delivered through existing rural and primary-care platforms, such as village health camps and ASHA-led outreach, rather than relying solely on dental or hospital-based clinics that this population accesses infrequently.

**Strengths and limitations:** The principal strengths of this study are its community-based design, which reduces the referral and severity bias inherent in hospital-based samples, its adequately powered sample size, and its use of standardised WHO diagnostic criteria for oral examination. However, several limitations should be acknowledged. First, the cross-sectional design precludes any causal inference about the temporal relationship between SLT use and lesion development. Second, clinical diagnosis of OPLs was based on visual oral examination without routine histopathological confirmation, which may have led to some misclassification, particularly between early OSMF and other fibrotic changes. Third, self-reported data on duration and frequency of tobacco use are subject to recall and social-desirability bias, which may have led

to under-reporting of habit severity. Ultimately, as the research was limited to the field-practice villages of a singular institution in Bareilly district, the results may not be entirely applicable to other areas of Uttar Pradesh or to SLT-using demographics with varying product inclinations.

## Recommendations

Incorporating oral examinations into NPCDCS, educating ASHAs and primary care practitioners in SLT cessation counselling, implementing community IEC initiatives for early identification of oral lesions, and enforcing COTPA 2003 regulations to limit SLT accessibility. Early detection and cessation interventions can prevent malignant transformation and improve rural oral health outcomes.

## CONCLUSION

The prevalence of oral precancerous lesions among rural tobacco chewers in Bareilly was significant (37.5%), with OSMF and leucoplakia being the most common lesions.

## Declaration

**Ethical Approval:** Approved

**Acknowledgement:** None

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**Conflict of Interest:** The authors declare no conflict of interest.

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