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Screening the silent: Oral potentially malignant disorders burden among rural communities of Villianur, Puducherry, South India

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ABSTRACT

Background: Oral cancer ranks as the 16th most common cancer worldwide. In India, it is the most common cancer among males and the fourth most common among females. Oral Potentially Malignant Disorders have a malignant transformation rate of approximately 7 to 10%. According to the National Family Health Survey (2019–2021), only 0.4% of women and none of the men aged 30–49 years in rural areas have undergone oral cavity examination for oral cancer. This study aimed to determine the prevalence of suspected Oral Potentially Malignant Disorders and assess associated factors among adults in Villianur Commune, Puducherry.

Methods: A community-based cross-sectional study was conducted among 196 permanent residents aged ≥18 years using multistage sampling. Written informed consent was obtained. Data on sociodemographic characteristics, oral hygiene practices, and adverse oral habits were collected using a validated self-structured questionnaire. Visual oral examination followed by toluidine blue staining was performed to confirm potentially malignant disorders.

Results: The prevalence of suspected Oral Potentially Malignant Disorders was 14.28%. The most common conditions were Leukoplakia (5.61%), Lichen planus (3.06%), Erythroplakia (2.55%), and Oral Submucous Fibrosis (2.04%). Prevalence was significantly higher among men (20.17%) than women (6.09%, p=0.007). The buccal mucosa was the most affected site (35.7%). Toluidine blue staining confirmed 78.6% of clinical findings. Tobacco use, poor oral hygiene, and low socioeconomic status were significant risk factors.

Conclusions: Oral Potentially Malignant Disorders are prevalent in Villianur and are strongly associated with male gender, tobacco use, and poor oral hygiene. Community awareness and routine primary healthcare screening are essential for early detection and prevention of oral cancer.

Keywords: Oral potentially malignant disorders, Oral hygiene, Toluidine blue, Tobacco,visual screening

BACKGROUND

A group of oral mucosal illnesses known as Oral Potentially Malignant Disorders (OPMDs) have a high chance of evolving into Oral Squamous cell carcinoma (OSCC).[1] Although oral cancer is the 16th most common cancer globally, it is the most common among men and the second most common in India.[2] Tobacco use (45%), areca nut chewing (25%), and alcohol use (16%) are all substantial risk factors for OPMDs,[3] and screening rates remain low in rural areas.[4]

Leukoplakia, Erythroplakia, Oral SubMucous Fibrosis (OSMF), and Oral Lichen Planus are common OPMDs.[5] Lesion type, site, and dysplasia intensity all have an impact on their malignant transformation potential, which ranges from 1.4% in Leukoplakia to approximately 49.5% in Proliferative verrucous leukoplakia.[6,7] Middle-aged and older males are more likely to have OPMDs.[8]

In order to increase survival rates, reduce morbidity, and halt the progression of invasive cancer, early detection is crucial.[9,10] This is particularly important in high-risk and underprivileged regions where poor oral habits are prevalent and access to specialized care is limited.[11,12] In primary care settings, low-cost screening techniques such as visual oral examination combined with Toluidine blue staining can improve early diagnosis and support public health initiatives.[13-15]

METHODS

This community-based cross-sectional study was conducted from October 2025 to December 2025 to assess the prevalence of OPMDs and the factors associated with them among the rural population of Villianur Commune, Puducherry, South India. Participants were recruited using a multi-stage sampling technique. Cochran's Formula was used to determine the sample size: $n = (Z^2 \times p \times (1 - p)) / e2$, where $Z = 1.96$ (at a 95% confidence interval), $p = 0.1328$ (prevalence of OPMD from a prior study[15]), and $e = 0.05$ (margin of error). In order to account for an anticipated 10% non-response rate, the minimum needed sample size of 178 was raised to 196.

The study included participants who were 18 years of age and above, were long-term residents of the study area, and provided voluntary written informed consent. Individuals who refused to provide informed consent were excluded from the study. Ethical approval was obtained from the Institutional Human Ethics Committee of Aarupadai Veedu Medical College and Hospital in accordance with the principles of the Declaration of Helsinki. All participants were provided with an informed consent form and a pamphlet explaining the objectives of the study. The confidentiality and privacy of all participant data were maintained throughout the study.

A total of 114 males and 82 females participated in the survey. The study objectives were clearly explained to all participants prior to the interview. Participants were examined while seated in their homes. A trained examiner conducted a face-to-face interview and performed a clinical oral examination.

A self-structured, validated proforma (composed of Part A and Part B) was used to collect data. In addition to medical and dental history, Part A recorded sociodemographic traits such age, gender, and socioeconomic status (measured using the B.G. Prasad scale 2025), oral hygiene practices, and harmful habits like chewing tobacco, pan chewing, areca nut use, and alcohol intake. In Part B, visual oral examination and Toluidine blue vital staining were used to screen for OPMD. The examiner received training on the diagnosis of common OPMD, including Erythroplakia, Leukoplakia, Lichen Planus, and OSMF.[16]

Using disposable tongue depressors and mouth mirrors, the oral mucosa was carefully examined under sufficient lighting using the ADA Type III method of examination to find any worrisome lesions. The same expert conducted both the oral examination and data collecting in order to reduce bias. 1% Toluidine blue staining was applied to lesions that were clinically suspected. After rinsing the mouth twice for 20 seconds to get rid of debris, ropey saliva was removed by applying 1% acetic acid for 20 seconds. After that, a cotton swab was used to apply the 1% Toluidine Blue solution to the suspicious lesion for 20 seconds. Mechanically held discolouration was eliminated with a second application of 1% acetic acid and a final water rinse. For suspected OPMDs, lesions that preserved a dark blue stain were deemed positive, whereas those that did not were deemed negative.[17]

IBM SPSS Statistics version 29 was used to analyse the data after it had been entered into a Microsoft Excel spreadsheet. The demographic and clinical features of the participants were compiled using descriptive statistics. The association between independent variable and the existence of OPMDs was evaluated using inferential statistics, such as correlation analysis.

RESULTS

There were 41.8% females and 58.2% males in the study population. Participants over 60 made up the largest age group (33.2%), followed by those between the ages of 51 and 60 (26.0%) and 41 and 50 (23.5%). In terms of education, only 5.1% of participants had completed postgraduate studies, and 30.1% of participants were illiterate, suggesting poorer literacy levels in this community. The majority of participants fell into the middle (36.2%) and upper-middle (24.0%) socioeconomic classes, while 9.7% belonged to the lower socioeconomic class, according to socioeconomic status as determined by the B.G. Prasad scale -2025.Oral hygiene practices revealed that 10.20% of people did not brush their teeth at all, and 81.63% brushed only once a day. When it came to bad habits, 33.1% of participants said they smoked tobacco, 23.4% said they used smokeless tobacco, and 17.8% said they used both tobacco and alcohol. Just 30.6% of participants said they had no adverse oral habits (Table 1)

Among the 196 participants, suspected OPMDs were more common in males (20.17%) than in females (6.09%), (Table 2).

The prevalence of suspected OPMDs increased with age. Participants above 60 years showed the highest prevalence (21.53%), followed by those aged 51 to 60 years (17.64%) and 41 to 50 years (6.52%). Very few cases were identified among younger individuals, with only 6.25% in the 31 to 40 years group and 5.5 % among those below 30 years (Table 3).

The study revealed an overall prevalence of suspected OPMDs of 14.28% within the rural population of Villianur Commune. The disorder profile was dominated by Leukoplakia (5.61%) was most common, followed by Lichen planus (3.06%), Erythroplakia (2.55%), and OSMF (2.04%) and Actinic chilitis (1.02 %), (Table 4).

The buccal mucosa was the most common site for suspected OPMDs, accounting for 35.7% of the lesions, followed by the tongue (21.4%). Lesions involving the labial mucosa and gingiva/alveolar ridge were observed in 10.7% of cases each. The floor of the mouth, palate, and retromolar trigone each comprised 7.1% of the identified sites (Table 5).

The adjunctive use of Toluidine blue vital staining proved highly relevant, with a substantial overall positive rate of 78.6% among suspected OPMD cases. The stain's uptake varied by anatomical site, demonstrating perfect sensitivity in high-risk areas such as the floor of the mouth and retromolar trigone (100% positive), followed closely by the tongue (83.3%) and buccal mucosa (80%), (Table 6).

This Logistic Regression analysis of 196 participants identified male gender, older age, lower socioeconomic status, infrequent tooth brushing, and adverse oral habits as significant risk factors for OPMDs. Men had 3.91 times the odds of OPMDs compared to women. A significant age trend was observed, with individuals over 60 years showing 4.67 times the odds compared to the youngest group. A powerful social gradient was evident, as the lowest socioeconomic group had 50 times the odds of OPMDs. Infrequent brushing was a strong risk factor, with occasional tooth brushers having 15 times the odds (95% CI: 1.66-135.27) compared to those brushing twice or more daily. The use of smokeless tobacco was the strongest behavioral risk factor, associated with 11.39 times the odds of an OPMDs(Table 7).

DISCUSSION

The current study found that 81.63% of participants brushed their teeth once daily, 8.2% twice daily, and 10.20% never brushed. Oral hygiene practices are crucial in preventing potentially malignant disorders of the mouth because poor oral hygiene has been shown to increase the frequency of precancerous lesions when combined with behaviours such as alcohol and tobacco use.[3,8,22] Our results show that a significant percentage of people have poor dental hygiene, which may be a factor in the development of OPMDs.

Numerous recent studies conducted in Puducherry and throughout India have found a connection between the prevalence of OPMDs, poor oral hygiene, and alcohol and tobacco usage. Sekizhar et al. (2023)[18] found that the frequency of OPMDs was 16.79% among Pondicherry fishermen who used tobacco and alcohol excessively. The study found that unhealthy habits and poor oral hygiene practices increased the risk of getting OPMDs. Dorai Raghav et al. (2023)[19] noted that the Irular tribes of Pondicherry had a 7.8% prevalence of Leukoplakia, along with poor health-seeking behaviour and a lack of knowledge about oral hygiene, underscoring the significance of early preventive efforts.

Our findings are comparable to those of Gautam JK et al. (2023)[20], who discovered that alcohol, tobacco, and smokeless forms were significantly associated with the 14.84% prevalence of OPMDs in Rajasthan. Interestingly, they found that prevalence rates were higher among individuals in lower socioeconomic strata, which is congruent with our study population, whose brushing habits may have been influenced by limited access to oral hygiene teaching.

It is interesting to note that Muthanandam et al. (2022)[21] discovered a shocking 48.3% prevalence of precancerous lesions in the Narikurava tribal population, with the majority of them located in the buccal mucosa. Their study validated our findings by emphasising the clear link between the prevalence of oral precancer and regular use of tubacco and poor oral hygiene.

Additionally, according to Varughese CM et al. (2023)[22], opportunistic screening in Puducherry Primary Health Centre revealed 14.3% suspected OPMDs, especially in senior age groups (>60 years). They asserted that bad oral hygiene practices and poor tooth brushing habits exacerbated the negative effects of smoking and chewing betel quid. According to S et al. (2023)[23], people with OSMF often had numerous OPMDs, such as Leukoplakia and Candidiasis. This demonstrates how persistent risk factors and poor dental hygiene raise the chance of numerous lesions.

Erythroplakia (1.3%) and OSMF (6.21%) were found to be the two most prevalent OPMDs by Jose et al. (2023)[24], with risky behaviours and inadequate brushing techniques acting as significant predictors. Singh et al. (2021)[25] found that OSMF and speckled Leukoplakia were more prevalent in adults aged 31–40, especially those with poor dental hygiene.

Furthermore, socioeconomic status turned out to be a reliable predictor. Poor eating habits and low socioeconomic level enhanced the prevalence of OPMD in Puducherry, with females somewhat more impacted, according to Paulose et al. (2020).[26] Strong links between tobacco use, poor oral hygiene, and OPMDs were found in Kanpur by Srivastava et al. (2020),[27] highlighting the preventive importance of oral hygiene habits such as brushing frequent toothbrushing.

Additionally, studies by Kaur et al. (2020)[28] and George et al. (2019)[29] highlighted the significance of opportunistic oral screening because poor brushing frequency and tobacco use were consistently connected to the larger prevalence of Leukoplakia and OSMF.

This is especially evident in populations with low awareness of oral hygiene. The claim that routine dental care is a modifiable protective factor is supported by Meena et al. (2018),[30] who point out that oral lesions were prevalent in low socioeconomic groups with inadequate hygiene practices.

Lastly, earlier research by Pawha et al. (2018)[31] and Sivakumar et al. (2018)[32] revealed a substantial prevalence of OPMDs in younger age groups with poor brushing frequency and tobacco and alcohol habits, suggesting that preventative oral health practices are crucial from an early age. All these results support our conclusion that the risk of OPMDs is greatly increased when risky behaviours are paired with brushing once a day or not at all.

The Limitations of the study include the small sample size, and the information on habits was self-reported, which may not be fully accurate. Histopathological confirmation was not performed.

CONCLUSION

The current study shows a high prevalence of OPMDs in the study population, with significant associations with lower socioeconomic status, tobacco use, and poor oral hygiene practices. The higher prevalence in lower and middle socioeconomic groups highlights the impact of social determinants of health. Infrequent brushing and the higher rate of tobacco and betel nut use, especially among men, probably contributed to the increased burden of OPMDs. These results highlight the need for focused health education, tobacco cessation programs, and oral hygiene promotion, especially among vulnerable groups. Improving oral health outcomes and preventing malignant transformation can be achieved by strengthening community-based opportunistic screening and early detection strategies.

LIST OF ABBREVIATIONS

OPMDs-Oral Potentially Malignant Disorders

OSCC-Oral Squamous cell carcinoma

OSMF-Oral SubMucous Fibrosis

DECLARATIONS

Ethical approval and Consent for participants:Aarupadai Veedu Medical College &Hospital - Institutional Human Ethical Committee (ECR/847/INST/PY/2016/RR-20).

Informed consent was obtained from the participants before data collection.

Consent for publication:Not applicable

Availability of data and materials:The datasets collected and analysed during this study were available from the corresponding author upon reasonable request.

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Authors' contributions:Vijayareka.K collected and analysed the data, and she was the primary contributor to the text. Nithya S. and Thirumal.M assisted with lesion interpretation and subsequent procedures. All authors read and approved the final version of the manuscript.

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