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Association Between Tobacco Consumption and Oral Cancer Among Adults In Central India

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Abstract
Oral cancer is a major public health problem in India, where tobacco use in smoked and smokeless forms remains common among adults. Central India has a long-standing pattern of tobacco chewing, gutkha, khaini, zarda, bidi smoking and dual use, creating a preventable exposure pathway for oral malignancy. The present thesis examines the association between tobacco consumption and oral cancer among adults in Central India, with emphasis on type of tobacco, frequency, duration, age at initiation and related behavioural factors. A hospital-based analytical case-control design was adopted among 300 adults aged 18 years and above in Central India. The study included 150 adults diagnosed with oral cancer and 150 controls without oral cancer. Data were collected through a structured questionnaire, oral examination and clinical record review. Tobacco use was assessed by type, frequency, duration, age at initiation and dual use. Tobacco consumption was substantially higher among oral cancer cases than controls. Among cases, 84.0% reported current or past tobacco consumption compared with 45.3% among controls. Smokeless tobacco was the most common form, followed by dual use and smoking only. Tobacco users had markedly higher odds of oral cancer than non-users, with risk increasing among participants using smokeless tobacco, dual users, those consuming tobacco for more than 10 years and those using tobacco more than five times per day. Buccal mucosa and tongue were the most frequent anatomical sites of oral cancer.
Keywords: Oral cancer, Tobacco consumption, Smokeless tobacco, Smoking

I. INTRODUCTION

Oral cancer is among the most visible yet frequently neglected cancers because its early lesions may be present in an accessible anatomical region while remaining unnoticed by the patient. It includes malignant lesions of the lip, tongue, buccal mucosa, gingiva, floor of mouth, hard palate and other intra-oral structures. The disease is largely represented by oral squamous cell carcinoma and is strongly shaped by social habits, commercial tobacco availability, delayed health-seeking behaviour and limited awareness of warning signs. Global cancer estimates

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continue to place oral cavity cancer among important cancers in regions where tobacco and areca nut use are common. In India, the public health importance of oral cancer is intensified by the diversity of tobacco products, early initiation, affordability of smokeless products and widespread social acceptance in many communities. Adults in Central India are exposed to products such as gutkha, khaini, zarda, tobacco-containing betel quid, bidi and cigarette smoking. These exposures are often combined with alcohol use, poor oral hygiene, nutritional vulnerabilities and limited access to regular oral examination. Studying the association between tobacco consumption and oral cancer in this population is therefore important for prevention and service planning.

Overview of Oral Cancer

Oral cancer refers to malignant neoplasms that arise from the oral cavity and lip. The majority of cases are squamous cell carcinomas originating from the mucosal epithelium after a multi-step process involving genetic injury, altered cell proliferation, dysplasia and invasive transformation. Clinically, oral cancer may present as a nonhealing ulcer, red or white patch, indurated growth, unexplained bleeding, tooth mobility, restricted mouth opening, difficulty chewing, altered speech or persistent pain. In high-risk tobacco users, such symptoms require prompt evaluation because delay leads to larger tumours, nodal metastasis and poorer survival. The burden of oral cancer is not only measured in deaths. Treatment can involve surgery, radiotherapy, chemotherapy, reconstructive procedures and long rehabilitation. Patients may face disfigurement, nutritional problems, communication difficulty, loss of livelihood and psychosocial distress. Families bear economic costs because diagnosis often occurs during the economically productive age group. Public health approaches that prevent tobacco initiation, support cessation and detect oral lesions early can reduce both clinical and social consequences of the disease.

II. LITERATURE REVIEW

Global Burden of Oral Cancer

Global cancer estimates identify lip and oral cavity cancer as a significant malignancy with marked regional variation. The burden is highest in areas where tobacco chewing, areca nut and smoking are culturally embedded. Incidence and mortality are influenced by exposure prevalence, early diagnosis, access to treatment and survival after therapy. In many low- and middle-income countries, oral cancer remains a disease of late detection despite the oral cavity being accessible for examination.

Global Burden of Oral Cancer

International evidence shows that oral cancer is not a uniform global phenomenon. Countries with lower tobacco exposure and stronger screening pathways have different patterns from South

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Asian settings. Therefore, studies in India must be interpreted in light of product-specific exposure, especially smokeless tobacco. Global comparisons are useful because they show that prevention policies can change risk profiles over time.

Oral Cancer Burden in India

India has a disproportionately high burden of oral cancer. Registry-based evidence reports cancers of the mouth and tongue among common cancer sites, particularly among men. Tobacco-related cancers form a substantial portion of the cancer burden. The importance of oral cancer in India arises from the convergence of multiple risks: smokeless tobacco, smoking, alcohol, low awareness, late diagnosis and differences in access to oral health services.

Indian public health programmes recognise cancer prevention and tobacco control as priorities, yet implementation gaps remain. Rural and semi-urban populations may not receive regular oral screening. Many users do not seek cessation support and continue products despite early lesions. Evidence from national surveys and registries strengthens the rationale for local studies that connect exposure patterns with disease outcomes.

Oral Cancer Pattern in Central India

Central India has wide socioeconomic diversity and high availability of low-cost tobacco products. Local chewing habits, use of gutkha and khaini, and bidi smoking create risk profiles that differ from regions where cigarettes predominate. The placement of smokeless tobacco in the buccal vestibule may explain why lesions of the buccal mucosa and gingivobuccal sulcus are frequently observed in tobacco-chewing populations.

Regional patterns of oral cancer should be understood through both exposure and access. Central India includes populations living far from tertiary oncology services. Early lesions may be ignored until pain, ulceration, bleeding or difficulty chewing occurs. Hence, regional research must support local prevention strategies, not merely describe cases seen in hospitals.

Risk Factors Associated with Oral Cancer

Major risk factors for oral cancer include tobacco use, smokeless tobacco, alcohol consumption, areca nut, poor oral hygiene, chronic mucosal irritation, nutritional deficiency and selected viral factors. Tobacco remains the most important preventable exposure in the Indian context. Socioeconomic status, literacy and occupation may influence risk indirectly by shaping initiation, dependence and healthcare access.

Risk Factors Associated with Oral Cancer Risk factor clustering is important. A person who starts tobacco use at a young age, consumes products many times a day, also drinks alcohol and has no regular oral check-up is not simply exposed to one factor; the person has cumulative vulnerability. Public health analysis should therefore include type, duration and frequency rather than a single yes-or-no tobacco variable.

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Tobacco Consumption and Oral Cancer

Evidence from epidemiological and biological research establishes a strong relationship between tobacco consumption and oral cancer. Tobacco products contain carcinogens capable of producing DNA damage, chromosomal alterations and epithelial dysplasia. The association is seen across smoked and smokeless forms, although risk magnitude varies by product, intensity and duration.

Tobacco Consumption and Oral Cancer

In South Asia, smokeless tobacco has particular importance. Products may be retained in the mouth for long periods, and the carcinogenic exposure occurs at the exact site where malignant transformation later develops. This direct contact pattern makes oral cancer prevention inseparable from smokeless tobacco control.

III. MATERIALS AND METHODS

Study Design

The study design was a hospital-based analytical case-control study. Cases were adults diagnosed with oral cancer, while controls were adults without oral cancer attending general outpatient or dental services during the same study period. This design was suitable because oral cancer is an outcome for which exposure history can be compared between diseased and non-diseased groups.

Study Area/Study Setting

The study was conducted in selected health care facilities in Central India, including dental, oral medicine, ear-nose-throat and oncology units attached to tertiary and secondary care hospitals. The setting was chosen because these units receive adults with oral lesions as well as adults seeking non-cancer services from surrounding urban, peri-urban and rural areas.

Study Population

The study population included adults aged 18 years and above residing in Central India. Cases were confirmed oral cancer patients. Controls were adults without clinical evidence or previous diagnosis of oral cancer. Both men and women were eligible. Participants were selected after applying inclusion and exclusion criteria and obtaining informed consent.

Study Duration

The proposed study duration was twelve months, including preparation of tools, pilot testing, data collection, data entry, analysis and report writing. Data collection was planned over six to eight months depending on patient flow and availability of eligible controls.

Sample Size

The total sample size was 300 participants, consisting of 150 cases and 150 controls. The sample size was considered adequate for comparing tobacco exposure between the two groups and

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estimating odds ratios for major exposure categories. Equal numbers of cases and controls were used to improve analytical balance.

Sampling Technique

A purposive consecutive sampling technique was used for cases, whereby all eligible oral cancer patients presenting during the study period were approached. Controls were selected from adults attending non-oncology services in the same hospitals and frequency matched broadly by age group and sex where feasible.

Inclusion Criteria

Inclusion criteria for cases were: age 18 years or above, resident of Central India, clinically and histopathologically diagnosed oral cancer, ability to provide information and willingness to participate. Inclusion criteria for controls were: age 18 years or above, resident of Central India, absence of oral cancer on clinical screening, and willingness to participate.

Exclusion Criteria

Participants were excluded if they were severely ill and unable to respond, had recurrent oral cancer after previous treatment, had incomplete clinical records, were unwilling to provide consent, or were unable to provide reliable tobacco history. Controls with suspicious oral lesions requiring diagnostic referral were not included as controls.

Study Variables

The dependent variable was oral cancer status. Independent variables included tobacco consumption, type of tobacco used, frequency, duration, age of initiation, alcohol consumption and socio-demographic characteristics. Covariates included age, gender, education, occupation, socioeconomic status and residence.

Data Collection Tool

A structured questionnaire was prepared in simple language and administered by trained investigators. It included sections on socio-demographic details, tobacco consumption, alcohol use, awareness of oral cancer, oral symptoms and health-seeking behaviour. The tool was prepared after reviewing standard survey methods and relevant oral health guidance.

Description of Questionnaire

The questionnaire included closed-ended and semi-structured questions. Tobacco use questions recorded product type, age at initiation, duration in years, frequency per day, placement site for smokeless tobacco, attempts to quit and exposure to warning labels. Oral health questions recorded ulcers, patches, restricted mouth opening, pain, bleeding and previous dental consultation.

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Assessment of Tobacco Consumption Pattern

Tobacco consumption was assessed as never use, past use or current use. Current and past users were further classified as smoking only, smokeless only or dual users. Frequency was categorised as one to five times per day, six to ten times per day and more than ten times per day. Duration was categorised as less than five years, five to ten years and more than ten years.

Method of Data Collection

After obtaining permission from the institution and consent from participants, interviews were conducted in a private area. Cases were recruited from oncology, oral medicine and ENT departments. Controls were recruited from general outpatient and dental departments. Clinical information was verified from records wherever available. Each questionnaire was checked for completeness on the same day.

Pilot Study

A pilot study was conducted on a small group of adults not included in the final sample. The pilot tested clarity, time required, sequence of questions and feasibility of oral examination recording. Minor changes were made to improve wording and reduce ambiguity in tobacco consumption questions.

Validity and Reliability of Tool

Content validity was established by review from experts in public health, dentistry and oncology. The questionnaire was checked for relevance, clarity and completeness. Reliability was improved through investigator training, standard definitions and repeat checking of selected entries. Internal consistency was assessed for awareness-related items where applicable.

Ethical Considerations

Ethical principles of voluntary participation, informed consent, confidentiality, privacy and non-maleficence were followed. Participants were informed about the purpose of the study and their right to withdraw at any time. No identifying information was disclosed in analysis or reporting.

IV. DATA ANALYSIS AND INTERPRETATION

The analysis follows the objectives of the study and focuses on socio-demographic profile, tobacco consumption patterns, oral cancer distribution, association between tobacco exposure and oral cancer, and estimation of risk among tobacco users. Percentages were calculated using the total number within each group. Chi-square test and odds ratio were used for inferential interpretation.

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Table 1: Socio-demographic profile of study participants

Variable	Category	Cases n (%)	Controls n (%)	Total n (%)
Age	18-30 years	12 (8.0)	18 (12.0)	30 (10.0)
Age	31-45 years	42 (28.0)	48 (32.0)	90 (30.0)
Age	46-60 years	64 (42.7)	55 (36.7)	119 (39.7)
Age	>60 years	32 (21.3)	29 (19.3)	61 (20.3)
Gender	Male	108 (72.0)	101 (67.3)	209 (69.7)
Gender	Female	42 (28.0)	49 (32.7)	91 (30.3)
Residence	Rural	74 (49.3)	66 (44.0)	140 (46.7)
Residence	Urban/peri-urban	76 (50.7)	84 (56.0)	160 (53.3)
Education	No formal/primary	78 (52.0)	54 (36.0)	132 (44.0)
Education	Secondary and above	72 (48.0)	96 (64.0)	168 (56.0)

The socio-demographic profile shows that most cases were in the age group of 4660 years, followed by 31-45 years. Males formed a larger proportion of both cases and controls. A higher proportion of cases had no formal or only primary education, suggesting that lower educational attainment may influence tobacco exposure, awareness and delay in seeking care. Rural residence was slightly higher among cases, but oral cancer was not limited to rural populations.

Table 2: Age and gender distribution of cases and controls

Age group	Male cases	Female cases	Male controls	Female controls	Total
18-30	8	4	11	7	30
31-45	31	11	34	14	90
46-60	47	17	37	18	119
>60	22	10	19	10	61
Total	108	42	101	49	300

Table 3: Distribution of tobacco consumption among adults

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Tobacco status	Cases n (%)	Controls n (%)	Total n (%)
Current or past tobacco user	126 (84.0)	68 (45.3)	194 (64.7)
Never tobacco user	24 (16.0)	82 (54.7)	106 (35.3)
Total	150 (100.0)	150 (100.0)	300 (100.0)

Note: Chi-square = 49.8; $p < 0.001$.

The distribution indicates a clear difference in tobacco exposure between cases and controls. More than four-fifths of oral cancer cases had a history of tobacco use, compared with less than half of controls. This finding supports the central hypothesis that tobacco consumption is associated with oral cancer among adults in Central India. The statistically significant chi-square value suggests that the difference is unlikely to be due to chance.

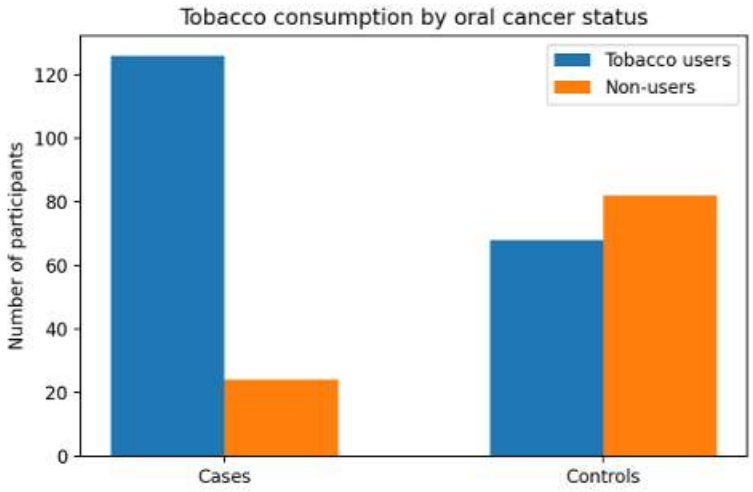

Figure 1: Tobacco consumption by oral cancer status

Table 4: Pattern of smoking tobacco use

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Smoking pattern	Cases n (%)	Controls n (%)	Total n (%)
Bidi only	28 (18.7)	19 (12.7)	47 (15.7)
Cigarette only	10 (6.7)	7 (4.7)	17 (5.7)
Both bidi and cigarette	14 (9.3)	6 (4.0)	20 (6.7)
No smoking tobacco	98 (65.3)	118 (78.6)	216 (72.0)

Bidi smoking was more common than cigarette smoking among participants. Smoking exposure was reported by 34.7% of cases and 21.4% of controls. Although smoking alone was not the dominant exposure, its contribution remains important, especially among dual users and alcohol users. Bidi smoking requires specific attention in tobacco control because it is inexpensive and socially common among working adults.

Table 5: Pattern of smokeless tobacco use

Smokeless product	Cases n (%)	Controls n (%)	Total n (%)
Khaini	35 (23.3)	21 (14.0)	56 (18.7)
Gutkha/pan masala with tobacco	38 (25.3)	16 (10.7)	54 (18.0)
Zarda/tobacco betel quid	21 (14.0)	8 (5.3)	29 (9.7)
Multiple smokeless products	10 (6.7)	5 (3.3)	15 (5.0)
No smokeless tobacco	46 (30.7)	100 (66.7)	146 (48.6)

Smokeless tobacco was the dominant form of exposure among cases. Gutkha, khaini and zarda-containing preparations were frequent products. The proportion of controls who never used smokeless tobacco was much higher than cases. This pattern is consistent with the biological mechanism of direct mucosal contact, where the product is placed against the buccal mucosa or gingiva for repeated periods.

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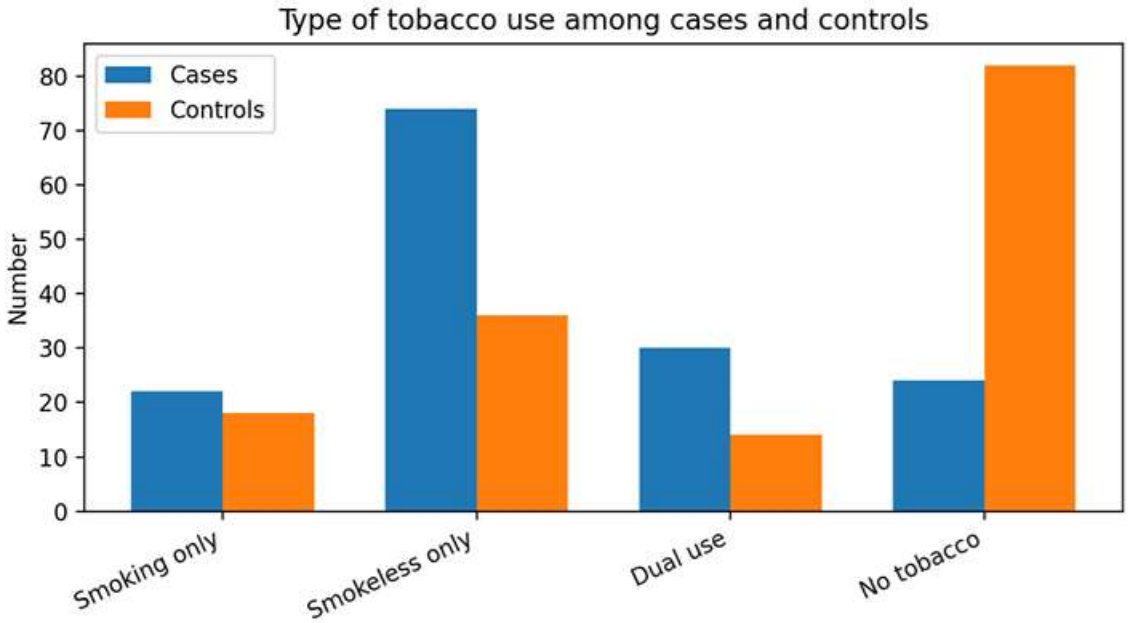

Figure 2: Type of tobacco use among cases and controls

V. RESULTS AND DISCUSSION

Major Findings Related to Socio-Demographic Characteristics

The study included 300 adults, with 150 oral cancer cases and 150 controls. The largest proportion of cases belonged to the 46-60 year age group. Male participants formed a higher proportion of both cases and controls. Lower education and lower socioeconomic status were more common among cases and showed statistically significant association with oral cancer. These findings indicate that social vulnerability may contribute to exposure and delayed diagnosis.

Major Findings Related to Tobacco Consumption Pattern

Tobacco use was reported by 64.7% of total participants. Among cases, 84.0% were current or past tobacco users, compared with 45.3% of controls. Smokeless tobacco was the most frequent exposure, followed by dual use and smoking only. Khaini, gutkha and zarda-containing preparations were prominent smokeless products. Bidi smoking was more common than cigarette smoking among smoking tobacco users.

Major Findings Related to Oral Cancer Distribution

Most cases presented after symptoms had persisted for more than three months. Non-healing ulcer, growth or swelling, pain, burning sensation and restricted mouth opening were common presenting complaints. Buccal mucosa was the most common site of oral cancer, followed by

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tongue and gingivobuccal sulcus. The site pattern was consistent with smokeless tobacco placement practices.

Major Findings Related to Association Between Tobacco Use and Oral Cancer

A strong association was observed between tobacco consumption and oral cancer. The crude odds ratio for any tobacco use was 6.33, and the adjusted odds ratio was 5.42 after controlling for selected socio-demographic and behavioural factors. The association was statistically significant with p value less than 0.001. This result supports the alternative hypothesis of the study.

Major Findings Related to Type, Duration and Frequency of Tobacco Use

Smokeless tobacco and dual use showed higher odds of oral cancer than smoking only. Duration greater than ten years and frequency greater than five times per day were strong predictors of oral cancer. The odds increased progressively with higher frequency categories, demonstrating a dose-response relationship. Early initiation before 18 years was more common among cases than controls.

Major Findings Related to Other Associated Risk Factors

Alcohol consumption was associated with oral cancer in crude analysis. Lower education and lower socioeconomic status were also significantly associated with oral cancer. Oral potentially malignant disorders were more common among tobacco users than non-users. These findings indicate that oral cancer risk is shaped by a combination of behavioural and social determinants, although tobacco remains the dominant modifiable factor.

VI. DISCUSSION

Discussion of Socio-Demographic Findings

The study found that oral cancer cases were concentrated in middle and older adult age groups, particularly 46-60 years. This is consistent with the long latency of tobacco-related carcinogenesis, where exposure begins earlier but disease develops after years of repeated mucosal injury. The predominance of males reflects higher tobacco use among men in national surveys, although the presence of female cases reinforces that women using smokeless products should not be overlooked.

Discussion of Socio-Demographic Findings

Lower education and lower socioeconomic status were significantly associated with oral cancer. These findings may reflect limited awareness, occupational stress, greater use of low-cost tobacco products and delayed access to diagnostic services. Public health interventions must therefore be designed for low-literacy settings and delivered in local languages through primary care, community workers and workplace platforms.

Discussion of Tobacco Consumption

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Pattern Tobacco use was reported by most oral cancer cases. Smokeless tobacco was the most common form, which agrees with evidence from India and South Asia showing strong association between chewing tobacco products and oral cancer. Local products such as khaini, gutkha and zarda are easy to purchase and are often used repeatedly throughout the day. The findings indicate that tobacco control messages in Central India must directly name these products.

Discussion of Tobacco Consumption

Pattern Bidi smoking remained an important exposure. Although smokeless tobacco dominated in this study, smoking contributes additional risk and may be more harmful when combined with alcohol or smokeless products. Dual use was common among cases, indicating that cessation programmes should screen for all product types rather than asking only about smoking.

Discussion of Smoking Tobacco and Oral Cancer

Smoking-only participants had increased odds of oral cancer compared with nonusers. Tobacco smoke contains carcinogens that damage oral epithelium and the aerodigestive tract. Bidi smoking may be particularly relevant in lower-income groups because it is cheaper than cigarettes. The findings support the inclusion of bidi users in oral cancer screening and cessation initiatives.

Smokeless tobacco showed a strong association with oral cancer. This finding is biologically plausible because products are retained in direct contact with oral mucosa. Tobacco-specific nitrosamines, areca nut ingredients and alkaline additives can induce chronic epithelial injury, dysplasia and malignant transformation. The high proportion of buccal mucosa cancers further supports the role of local placement of smokeless tobacco.

Discussion of Duration and Frequency of Tobacco

Use The present study showed that risk increased with duration and frequency. Participants using tobacco for more than ten years or more than five times per day had markedly higher odds of oral cancer. This dose-response relationship strengthens causal interpretation. It also has practical value: clinicians and community health workers should ask not only whether tobacco is used but also how long and how often it is used.

VII.CONCLUSION

It can be concluded from this study that oral cancer in Central India is largely preventable through reduction of tobacco exposure. The findings support the integration of tobacco cessation, oral cancer awareness and regular oral screening in public health services. Adults using tobacco for more than five to ten years, high-frequency users, dual users and those with oral potentially malignant disorders should be considered high-priority groups for intervention.

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