Original Article

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Oral Cancer and Its Risk Factors: A Case–Control Study in Haryana

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Abstract:

Objective: Oral cancer, a common and deadly mouth cancer, is linked to oral health behaviors and dietary imbalances, which cause 11–15% of oral and laryngeal cancers. This study aimed to establish the relationship between oral cancer and its risk factors in the study population and to compare these findings with healthy controls to determine their significance.

Material and Methods: This hospital-based case-control study included 86 oral squamous cell carcinoma patients aged 18+. Categorical data are shown as frequencies and proportions; continuous data as mean±S.D. Chi-square test assessed categorical variables.

Results: All 86 cases were in the age range of 44–62 years. The difference in occurrence of oral cancer in relation to education, marital status, type of food consumed, frequency of the consumption of fresh fruits, hot/spicy foods, saturated fats, consumption of onion/garlic, iron deficiency anaemia, malaligned, decayed and missing teeth, halitosis, frequency of toothbrushing, and using mouthwash, presence of dentures, and past history of dental procedure/trauma were statistically significant (p-value<0.05).

Conclusion: We found that the type of food consumption and poor oral hygiene play a significant role in the causation of oral cancer. The prevalence of OC can be decreased by altering one's lifestyle through education, the promotion of healthy eating habits, practicing proper oral hygiene, and avoiding denture/brush stress to the oral cavity.

Keywords: dental hygiene, epidemiology, food, nutrition, oral cancer, squamous cell carcinoma

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Introduction

Oral cancer (OC), which is described as a cancerous growth in the mouth, is one of the most common cancers and a leading cause of death worldwide[1]. The major site of oral cancer in both Asian and non-Asian patients is the tongue, followed by the oral buccal mucosa and gums in Asian regions, and the floor of the mouth, lip, and alveolar mucosa in non-Asian regions. In general, men are at a two-fold to four-fold higher risk than women for developing OC[2].

In 2020, the Global Burden of Disease study reported 890,000 new head-and-neck cancer cases worldwide, accounting for 5.3% of all cancers. Lip and oral cavity cancers were the most common, followed by laryngeal cancers. HNCs caused 507,000 deaths, also 5.3% of total cancer deaths[3].

Oral and lip cancer is one of the 5 most frequent cancers in India among men and women. In India, oral cancer constitutes 40% of all cancers and is the most prevalent cancer in males and the third most prevalent in females[4].

Dietary imbalances contribute to 11–15% of oral and laryngeal cancers. Low fruit and vegetable intake, frequent red meat consumption, and regular use of hot-and-spicy foods increase the risk, possibly due to repeated mucosal damage and non-healing lesions[5,6]. Poor oral health behaviours can increase the risk of oral cavity cancer. Key indicators include infrequent brushing, denture and filling materials, tooth loss (especially losing more than 5 teeth), damaged or filled teeth, rare dental check-ups, gum bleeding, and overall dental condition. Dental plaque harbours pathogens and nitrosamines that promote inflammation and cancer risk. Regular brushing helps remove harmful substances, reducing the chance of oral cancer[7,8]. The link between alcohol-based mouthwash and oral cancer has been debated in recent years. Some studies suggest a positive association, but ethanol concentration in these products remains insufficiently studied[9].

Therefore, unhealthy dietary habits and poor oral health behaviors are significantly associated with an increased risk of oral cancer compared to healthy individuals. In this study, we aimed to ascertain the prevalent risk factors for OC in our population and to compare our findings with healthy controls to establish their significance.

Material and Methods

This hospital-based case-control study was conducted at BPS Government Medical College for Women, Haryana, from January 2020 to January 2021. Using nMaster 2.0, the sample size was calculated as 86 cases and 86 controls based on tobacco chewing exposure (23.6%)[10], OR 2.5, 80% power, and 95% confidence interval. Consecutive cases and age (±2 years), gender, and residence-matched controls were selected (1:1 ratio, 86 each). Controls had no oral or oropharyngeal issues and were randomly chosen from ENT outpatients. Ethical approval was obtained from the BPSGMCW Ethics Committee (IEC No. BPSGMCW/RC531/IEC/19, dated 21/12/2019).

Study participants and eligibility criteria

All participants were patients from the Department of Otorhinolaryngology at the BPS GMC(W) Khanpur Kalan, Sonepat, who were diagnosed with oral squamous cell carcinoma on histopathology by the Department of Pathology. Controls were patients attending the Department of Otorhinolaryngology at BPS GMC (W), Khanpur Kalan, Sonepat, who did not have any lesion in the oral cavity and oropharynx as determined on examination, and who came for ear or nose pathology.

Inclusion and exclusion criteria for cases:

New histopathologically confirmed oral cancer cases aged 18+ who gave consent were included. Those with other malignancies, severe medical or mental conditions, end-stage cancer, or blindness preventing interviews were excluded.

Inclusion and exclusion criteria for controls:

Participants aged 18+ who gave consent were included. Those with oral or oropharyngeal conditions, other malignancies, severe illnesses, or impairments preventing interviews were excluded.

Data collection tools and measurements

Written consent was obtained from all participants. The investigator conducted face-to-face interviews using a pre-tested, semi-structured questionnaire in the local language, collecting socio-demographic, dietary, environmental, and general health information.

Operational definitions

'Oral Cancer' is used as a collective term for cancers of the oral cavity and oropharynx.

Vegetables: Group A (green leafy vegetables), B (roots and tubers), and C (all other vegetables except green leafy vegetables and roots and tubers)[18].

Halitosis: It is defined as the presence of an unpleasant odor in exhaled air, regardless of its cause.

Dental trauma: It refers to accidental damage to the teeth, their supporting structures, and surrounding soft tissues, such as the gums and lips, resulting from an abrupt forceful impact.

Statistical analysis

Data were entered in Excel and analyzed with SPSS. Descriptive statistics reported means±S.D. for continuous variables and frequencies for categorical ones. Odds ratios with 95% CI and Chi-square tests assessed categorical data; p-value<0.05 was significant.

Results

Participants were aged 44–62 years, mostly in the 51–60 age group. Both groups were matched by age (±2 years) and gender, with 79.1% males. The majority were Hindus (70.9% cases, 79.1% controls). Most cases had primary education (46.5%), while controls (52.3%) were educated up to matric or above. Of the cases, 89.5%were married vs. 59.3% of controls; 40.7% of controls were widowed. Most belonged to joint families (90.7% cases, 91.9% controls). The majority were from the upper lower class (39.5% cases, 37.2% controls). Education and marital status differences were statistically significant (Table 1).

A non-vegetarian diet was more common among cases (61.6%). Low vegetable intake (1–2 times/week) was higher in cases; odds for types A, B, and C vegetables were 5.3, 9.76, and 14.21 times higher in cases. Fruit consumption was lower in cases (91.9% consumed weekly/occasionally); odds were 42.6 times higher. Hot/spicy food habit was seen in 79.1% of cases vs. 8.1% of controls. Medium saturated fat intake was more common in cases (67.4%) vs. controls (11.6%). Frequent onion/garlic use was higher among cases (90.7%) vs. controls (38.4%). Iron deficiency anemia (moderate/severe) was present in 74.4% of cases. All differences were statistically significant (Table 2).

Figure 1 shows the distribution of cases by site of oral cancer (n=86), in which 42% of cases were carcinoma of the base of the tongue, followed by 18 % of cases belonging to lip cancer. Of the cases, 12% were related to buccal mucosa cancer; 9% were cancer of the floor of mouth, while 5 % were oropharyngeal cancer.

Poor oral hygiene was more common among cases (72.09% brushed rarely or never) compared to controls (58.1% brushed daily). Dental procedures were reported by 61.6% of cases vs. 23.3% of controls. No difference in mouthwash use (11.6% in both groups). Denture use was higher among cases (67.4%) than controls (34.9%); all used full plastic-acrylic sets. Dental trauma was more frequent in cases (66.3%) vs. controls (25.6%). Halitosis history was very high in cases (96.5%) vs. 33.7% in controls. Differences in brushing habits, dental procedures, denture use, trauma, and halitosis were statistically significant (Table 3).

Table 1 Distribution of the study population as per sociodemographic information (n=172)

Variables		Cases	Controls	p-value	Odds ratio
Age (Years)	40–50	36 (41.9)	35 (40.7)	Matched	
	51–60	45 (52.3)	48 (55.8)		
	>60	05 (5.8)	03 (3.5)		
	Mean age (S.D.)	52.74±5.21	52.38±4.78		
Sex	Male	68 (79.1)	68 (79.1)	Matched	
	Female	18 (20.9)	18 (20.9)		
Religion	Hindu	61 (70.9)	68 (79.1)	0.218	0.646
	Muslim	25 (29.1)	18 (20.9)		1
Education	Illiterate	23 (26.7)	16 (18.6)	0.003	2.81
	Primary	40 (46.5)	25 (29.1)		3.13
	Matric & above	23 (26.7)	45 (52.3)		1
Marital status	Married	77 (89.5)	51 (59.3)	<0.001	5.871
	Widowed	9 (10.5)	35 (40.7)		1
Type of family	Nuclear	8 (9.3)	7 (8.1)	0.787	1.158
	Joint	78 (90.7)	79 (91.9)		1
SES	Lower Middle	25 (29.1)	31 (36)	0.787	0.687
	Upper Lower	34 (39.5)	32 (37.2)		0.905
Occupation	Unemployed	27 (31.4)	23 (26.7)	0.744	1.174
Occupation	Elementary occupation	34 (39.5)	32 (37.2)		1.063
	Skilled agriculture	18 (20.9)	24 (27.9)		0.75
	Skilled worker	7 (8.1)	7 (8.1)		1

SES=socio economic status

Table 2 Distribution of the study population by food preferences (n=172)

Variables		Cases	Controls	p-value	Odds ratio
Type of food consumed	Vegetarian	33 (38.4)	48 (55.8)	0.122	0.493
	Non-vegetarian	53 (61.6)	38 (44.2)		1
Consumption Frequency (Type A vegetables)	1–2 times/week	62 (72.1)	28 (32.6)	<0.001	5.351
	Daily	24 (27.9)	58 (67.4)		1
Consumption Frequency (Type B vegetables)	1–2 times/week	62 (72.1)	18 (20.9)	<0.001	9.76
	Daily	24 (27.9)	68 (79.1)		1
Consumption Frequency (Type C vegetables)	1–2 times/week	78 (90.7)	35 (40.7)	<0.001	14.21
	Daily	8 (9.3)	51 (59.3)		1
Consumption frequency of fresh fruits	Weekly/occasionally	79 (91.9)	18 (20.9)	<0.001	42.635
	Daily/alternate day	7 (8.1)	68 (79.1)		1
Hot and spicy food	Yes	68 (79.1)	7 (8.1)	<0.001	42.635
	No	18 (20.9)	79 (91.9)		1
Saturated fat consumption	Low	28 (32.6)	76 (88.4)	<0.001	0.0635
	Medium	58 (67.4)	10 (11.6)		1
Frequency of consumption of onion and garlic	Daily/alternate	78 (90.7)	33 (38.4)	<0.001	15.659
	Occasional	8 (9.3)	53 (61.6)		1
Iron deficiency Anemia	Absent	22 (25.6)	74 (86)	<0.001	0.056
	Present	64 (74.4)	12 (14)		1

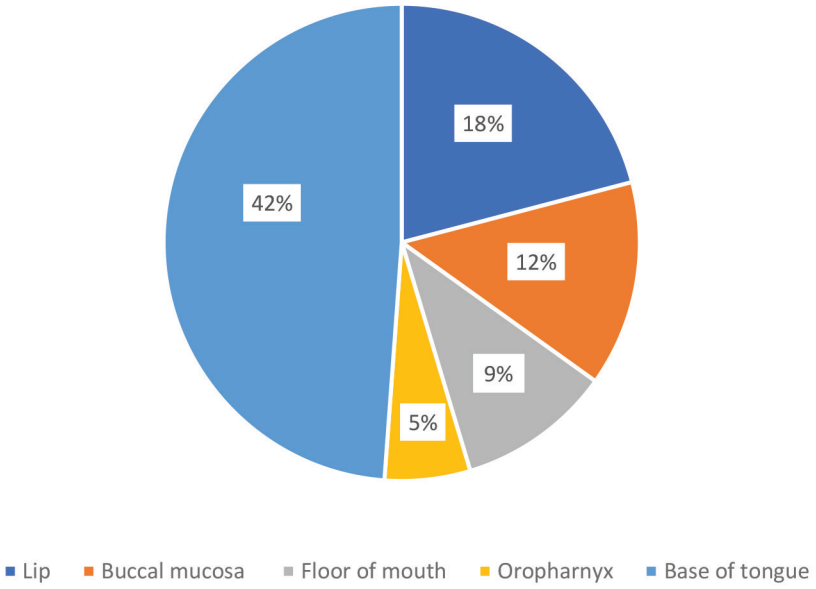

Figure 1 Distribution of cases by site of oral cancer (n=86)

Table 3 Distribution of the study population by oral hygiene practices (n=172)

Variables		Cases	Controls	p-value	Odds ratio
Frequency of toothbrushing	Nil to Occasional	62 (72.09)	36 (41.86)	<0.001	3.59
	Daily	24 (27.91)	50 (58.14)		1
Exposure to dental procedure	Yes	53 (61.6)	20 (23.3)	<0.001	5.3
	No	33 (38.4)	66 (76.7)		1
Mouthwash Use	Yes	10 (11.6)	10 (11.6)	1.000	1
	No	76 (88.4)	76 (88.4)		1
Use of dentures	Yes	58 (67.4)	30 (34.9)	<0.001	3.867
	No	28 (32.6)	56 (65.1)		1
History of dental trauma	Yes	57 (66.3)	22 (25.6)	<0.001	5.718
	No	29 (33.7)	64 (74.4)		1
History of halitosis	Yes	83 (96.5)	29 (33.7)	<0.001	54.379
	No	3 (3.5)	57 (66.3)		1

Most cases had mal-aligned (69.8%), decayed (90.7%), or missing teeth (75.6%), while most controls had no normal dentition. The differences were statistically significant, with odds 9.3 (mal-aligned), 23.79 (decayed), and 5.2 (missing teeth) times higher among cases (Table 4).

Table 4 Distribution of the study population by the presence of abnormal teeth (n=172)

Variables		Cases	Controls	p-value	Odds ratio
Malaligned teeth	Yes	60 (69.8)	17 (19.8)	<0.001	9.367
	No	26 (30.2)	69 (80.2)		1
Decayed teeth	Yes	78 (90.7)	25 (29.1)	<0.001	23.79
	No	8 (9.3)	61 (70.9)		1
Missing teeth	Yes	65 (75.6)	32 (37.2)	<0.001	5.223
	No	21 (24.4)	54 (62.8)		1

Discussion

Oral cancer, among all other oral lesions, is a major problem in the Indian Subcontinent, where it ranks among the top 3 cancers in the country. In this study, 58% of cases were aged 50 or older, with a mean age of 52.74 years. According to Russel K et al.[11], the maximum incidence of oral cancer was between the ages of 50–70 years, and they opined that it could affect children as young as 10 years old, and that the incidence of oral cancer increases with age.

In India, cancer of the oral cavity and oropharynx is the most common cancer in men and the third most common cancer in women. Oral cancers are more common in males than females[12]. In our study, the majority (79.1%) of cases were males.

In our study, with regard to marital status, it was observed that 89.5% of cases were married. Some other studies[13–15] also showed a higher percentage of the married population with tobacco habits and lesions, and it was statistically significant in causing cancers of the oral cavity.

In our study, 70.9% of cases were Hindu, likely reflecting the area's population. Other studies[16] reported higher oral cancer incidence in Muslims. These differences may result from regional and cultural variations in risk factors.

In our study, 26.7% of cases were illiterate, and 46.5% had primary education. Those without formal education had higher odds of early and regular tobacco and alcohol use, highlighting education's role in preventing such habits.

In our study, 61.6% of cases were non-vegetarians. Most cases consumed type A and B vegetables 1–2 times weekly (72.1%), onion/garlic daily or every other day (90.7%), and type C vegetables 1–2 times weekly. Fresh fruit consumption was weekly to occasional in 91.9%, and 79.1% regularly ate hot/spicy foods. Additionally, 67.4% consumed medium saturated fats, while 88.4% of controls had healthy diets. Some other studies[5,6] have also had similar findings.

The association between dietary products and the risk of developing cancer has been recently evaluated[17]. Excluding alcohol and tobacco, pro-inflammatory foods increase cancer risk, while fruits, vegetables, and vitamins offer protection. Regions with limited access to these foods show a higher cancer prevalence[18].

Studies show that certain food compounds can cause epigenetic changes, affecting gene expression without altering DNA. These changes may influence oncogenes or tumor-suppressor genes. Diets rich in fruits, vegetables, vitamins, and minerals may promote apoptosis and suppress tumour growth[17,19].

Pro-inflammatory diets (e.g., red meat, fried foods) promote cancer through chronic inflammation and biomarkers like CRP and IL-6. Oral microbiota imbalance may also contribute to oral and head-neck cancers.

Selenium, found in meats, may have anti-cancer effects via DNA methylation and HDAC inhibition[17,20].

Vegetables and fresh fruits contain folate and high levels of micronutrients (beta-carotene, alpha-carotene, lycopene, vitamins A, C, and E) with anti-cancerous, anti-proliferative, and antioxidant properties, which decrease reactive oxygen species apart from inhibiting lipo-oxygenase and cyclo-oxygenase activity. Some compounds found in vegetables have anti-tumoral properties, such as glycates and indole-3-carbinol, which are responsible for eliminating reactive oxygen species and aid in DNA repair[6,17]. Another study showed that individuals on a plant-based diet had good overall oral health conditions. These features are in agreement with the behavior of these subjects towards an overall healthy lifestyle[21].

Vegetables such as garlic, from the Liliaceae family ("allium vegetables"), despite being used as a condiment, are also well known for their therapeutic properties, such as antioxidant, anti-carcinogenic, anti-inflammatory, and antimicrobial. However, in relation to oral cancer, and with only one valid study, it can be admitted that there is very limited evidence to support the consumption of garlic and its relationship as a protective factor against oral cancer[17]. Another study[22] also established the potent in-vitro cytotoxic effect of onion oil on oral cancer cell lines.

In our study, 74.4% of cases had moderate to severe iron deficiency anemia, compared to 86% of the controls with no anemia. This aligns with Singh M et al., iron imbalance can lead to free radical formation, causing cell damage and potential malignant transformation[17].

In the present study, 70% of the cases had cancer at the base of the tongue and the lip. Among the tongue cancer cases, the anterior two-thirds of the tongue was 4 times more frequently involved than the posterior one-third. Cancers of these sites are frequently more exophytic than other cancers in the oral cavity. This finding is concordant with the results of other studies[23-25].

Most cases (72.09%) reported brushing their teeth never or occasionally; 61.6% had a past history of dental procedures; 69.8% had malaligned teeth; 90.7% had decayed teeth; 75.6% had missing teeth; 67.4% were using dentures for more than a year; 66.3% had a past history of dental trauma; and 96.5% had a past history of halitosis.

Oral infections and inflammation play a key role in carcinogenesis. Dental plaque can trigger inflammation and produce nitrosamines, which may contribute to cancer. Moreover, oral microorganisms produce nitrosamine, which may be involved in carcinogenesis. Some studies have reported that poor oral health is associated with an increased risk of (Upper Aero Digestive Tract) UADT cancer[26-29]. However, the relationship between oral hygiene and UADT cancer has been inconsistent. Tooth brushing is the most effective and convenient method to remove dental plaque and nitrosamine.

Infections are increasingly seen as triggers for carcinogenesis, alongside alcohol and tobacco. Bacterial toxins and inflammation can cause DNA damage, leading to malignant transformation[30]. A pilot study indicates that there were no changes in microflora in dental plaque in cancer patients within 7 days of the first course of chemotherapy[31].

The DMF index revealed a substantial loss of molars (59.2%), the teeth essential for chewing[32]. Regarding anterior teeth, 41.3% were lost due to caries, which inevitably affects aesthetics and self-esteem and compromises the patient's psychological state and quality of life. Treating dental decay before chemo or radiotherapy helps prevent complications like osteonecrosis, preserves natural teeth, supports chewing ability, and maintains self-esteem[33].

Strength(s): This is one of the most exhaustive studies conducted regarding the risk factors of oral cancer in this part of the country, as all the cases and controls were interviewed regarding: socio-demographic characteristics, personal history, dietary history, and dental history.

Clinical examinations of all the study participants were also performed under the supervision at the ENT OPD. The findings from this study can be used to design cohort studies to further understand the relation between various risk factors and oral cancer lesions.

Limitation(s): Potential recall bias (cases remember better) and observer bias (non-blinded investigator) may have influenced results. Since the study was conducted at a single hospital with participants from Sonipat District, the findings may not be generalizable. Residual confounding from behavioral factors, such as smoking and alcohol, may still exist.

Conclusion

This study identified modifiable risk factors for oral cancer, including education, poor dietary habits (low intake of vegetables/fruits, high intake of spicy food, onion/garlic, saturated fats), iron deficiency anemia, poor oral hygiene, denture use, and dental trauma/procedures.

Healthy eating, regular physical activity, good oral hygiene, avoiding oral trauma, and the excessive use of ethanol-based mouthwash are essential preventive measures. Early detection through mass education and raising public awareness can potentially improve the cure rate and lower the cost and morbidity associated with treatment. The findings from this study can be used to design cohort studies to further understand the relation between various risk factors and oral cancer lesions.

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Conflict of interest

Nil

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