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Delay in diagnosis and treatment of patients with oral cancer seeking treatment in a public hospital in India: a cross-sectional study

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Abstract

Introduction: The burden of oral cancer is rising, especially in the Indian subcontinent, which contributes one-third of all global cases. Oral cancer, though preventable, often goes undetected until later stages. This study aimed to estimate the patient, diagnostic and treatment intervals in the care trajectory of patients with oral cancer.

Methods: This cross-sectional observational study was conducted in Delhi. The study included 116 patients with histopathologically confirmed oral cancer who were receiving treatment within the last 3 months, selected by purposive sampling. Statistical analysis was performed using SPSS. The 'Aarhus statement' guidelines were followed in designing and reporting the study.

Results: The study population had a mean age of 47.6 ± 11.1 years; 87.3% were male, 51.8% were from a lower socioeconomic group and 67.3% presented with Stage IV disease. The median (interquartile range) patient, diagnostic, treatment and total intervals were 13.5 (5.0, 55.7) days, 89.5 (38.0, 228.7) days, 55.0 (29.0, 95.5) days and 202.0 (135.7, 451.5) days, respectively. Delays were mainly due to symptoms being dismissed as minor (98.1%), initial healthcare workers not suspecting cancer (47.2%) and excessive delays in completing investigations required before initiating treatment (20.9%).

Conclusion: A majority of the patients with oral cancer presented with advanced-stage disease, with diagnostic interval being the longest, followed by treatment and patient intervals. Future studies should evaluate interventions to reduce the three intervals and also assess the impact of these interventions on the disease outcome.

Keywords: *mouth neoplasms, head and neck neoplasms, health policy, delayed diagnosis, treatment delay*

Research

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Introduction

Globally, nearly 19.3 million people are diagnosed with cancer every year, which is the third leading cause of death globally [1, 2]. In 2020, nearly half of the new cases and 58.3% of the cancer-related deaths occurred in Asia, where 59.5% of the global population resides [2]. In India, cancer is the fourth leading cause of death, and nearly 1.5 million people are diagnosed with cancer every year, with the incidence expected to rise to 2 million per annum by 2040 [1, 3].

Oral cancers are preventable diseases with several risk factors. The commonest risk factors for oral cancer are tobacco use, alcohol consumption, infection with the Human Papillomavirus, chronic inflammation and genetic predisposition [4]. However, despite being a preventable cancer that can also be diagnosed at an early precancerous stage, the burden of oral cancer has been rising globally. It is the sixth most common cancer in males, accounting globally for 377,713 new cases and 177,757 deaths in 2020, increasing from 354,864 new cases and 177,384 deaths in 2018 [5]. The highest burden of oral cancer is in India, accounting for one-third of all oral cancer cases [6]. It is the commonest cancer affecting Indian men, and a regional distribution of oral cancer has also been noticed, with the highest burden being present in the northeastern part of the country [7, 8].

It is well known that the prognosis of oral cancer progressively worsens as the stage at diagnosis progresses [9]. However, as per the National Cancer Registry Program Report 2020, nearly two-thirds of the patients with oral cancer in India were diagnosed with advanced-stage disease [7]. Diagnosis at an advanced stage could be attributed to a combination of delays in symptom appraisal, help-seeking, diagnosis and initiation of treatment [10]. An Indian study identified deficiencies in the awareness of the risk factors and symptoms of oral cancer, despite approximately 80% of the study population having heard of the disease [11]. Another study revealed that oral cancer patients are referred to a specialist after a minimum of three consultations with a Healthcare Professional (HCP), contributing to diagnostic delays [12, 13].

Recognizing the inappropriateness of blaming the patient for these delays, the World Health Organization has suggested the term 'patient interval' rather than 'patient delay' [14]. Multiple studies have been conducted to measure and understand the reasons for these intervals. However, they have lacked uniformity in their definitions and approaches. This has made comparison across these studies difficult. To ensure comparability across studies assessing various intervals in cancer care, the 'Aarhus statement' was developed. The Aarhus Statement is a standardised reporting guideline developed to improve the quality, consistency and transparency of research on early cancer diagnosis, particularly studies examining diagnostic delay [15].

Currently, there is a paucity of literature on the duration and reasons for prolonged patient, diagnostic and treatment intervals in oral cancer patients in India. As the only previously done study using the Aarhus statement was from Kerala, a high-income state with high literacy levels, the results cannot be generalised to the rest of the country [16]. This creates a knowledge gap in guiding policy interventions for cancer prevention. Therefore, this study aimed to estimate the patient, diagnostic and treatment intervals in the care trajectory of patients with oral cancer for seeking treatment from a public hospital.

Methods

Study design and setting

This was a cross-sectional observational study consisting of a quantitative survey. The study was registered on the Clinical Trials Registry (CTRI) – India on 19th July 2023 (CTRI registration number: CTRI/2023/07/055360).

The study was done at the Lok Nayak Hospital, a teaching tertiary care hospital affiliated with Maulana Azad Medical College in Delhi, from November 2023 to May 2024. The hospital is a referral centre for cancer treatment in the northern Indian region. Ethical clearance was obtained from the Institutional Ethical Committee (F.1/IEC/MAMC/MD/MS(96/02/2023/No.125) on 15.05.2023.

Study population

Patients above 18 years of age with a histopathologically confirmed diagnosis of oral cancer and who had initiated treatment within the past 3 months were included in the study. The cancers of the following anatomical structures in the oral cavity were considered: lip, base, surface and border of the tongue, gum, the floor of the mouth, hard palate and buccal mucosa. Severely ill patients (i.e., patients in severe pain unable to talk, patients in need of urgent admission or patients admitted to intensive care units) and patients with a history of cancer of other body parts, or with recurrence of oral cancer, were excluded from the study.

Sample size and sampling method

The following formula was used for calculating the sample size [17]:

$$N = Z^2 \frac{pq}{d^2}.$$

The following values were used:

Z = 1.96, value of the standard normal variate corresponding to the level of significance, α = 5%, prevalence of patient interval of more than 3 months [16] (p) = 54% and q = 100-p = 46% absolute precision (d) = 10%.

Therefore, the minimum sample size was calculated to be 95 patients. Study participants were recruited from the Outpatient Departments (OPDs) and Inpatient Departments (IPDs) of ear, nose, throat (ENT) and radiotherapy departments using consecutive sampling [18].

Data collection

A pretested interview schedule was used to gather the information from the participants. The schedule was created using a literature review and expert consultation. It was pretested on ten people for face validity. Necessary modifications were made before finalizing the tool. Written informed consent was taken from all individuals willing to participate in the study.

Data on the three intervals (patient, diagnostic and treatment intervals) and factors contributing to these intervals were collected in a direct patient interview using the pretested interview schedule. The participants were interviewed in the OPD, IPD or daycare. To address recall bias and obtain a reliable date when the symptom was first noticed by the patient, pseudo-exact dates were chosen using a predefined protocol based on the patient's history. The pseudo-exact date protocol refers to a structured approach to approximate uncertain or partially recalled dates by assigning the most probable specific date based on patient recall, temporal cues, and predefined rules, thereby enabling consistent calculation of diagnostic intervals [19]. The date of first contact with the healthcare provider was either obtained from medical records or through the patient's history. Date of diagnosis and treatment initiation were obtained from medical records. The data were collected using EpiCollect5 software.

Operational definitions

Definitions of the following time points were based on the 'phases of clinical pathway' described by Olesen *et al* [20].

1. Date of the first symptom: Self-reported date on which a patient identified a bodily change or symptom in the oral cavity. This was estimated using a predefined protocol.
2. Date of the first presentation: The date on which the patient consulted a health care provider (doctor of modern medicine and others) to discuss the bodily change or symptom in the oral cavity, based on available records or patient recall.

3. Date of diagnosis: The date of diagnosis was decided based on a hierarchy produced by the European Network of Cancer Registries in the order of declining priority.
    a. Date of first histological or cytological confirmation of this malignancy (except histology or cytology at autopsy). This date was, in the following order: (a) the date when the specimen was taken (biopsy), (b) the date of receipt by the pathologist and (c) the date of the pathology report.
    b. Date of admission to the hospital because of this malignancy.
    c. When evaluated at an outpatient clinic only, the date of the first consultation at the outpatient clinic because of this malignancy.
4. Patient interval: The period between the 'Date of the first symptom' and the 'Date of the first presentation'.
5. Diagnostic interval: The period between the 'Date of the first presentation' and the 'Date of diagnosis'.
6. Treatment interval: The period between the 'Date of the diagnosis' and 'Date of initiation of treatment.'
7. Stage of disease: The stage of the disease was considered as per the 8th edition of the American Joint Committee on Cancer staging manual [21].

Statistical analysis

Descriptive statistical methods were used to summarise categorical and continuous variables. Mean and standard deviation (SD) were used for variables with a Gaussian distribution and median and interquartile range (IQR) for variables with a skewed distribution. Families were classified as below and above the poverty line based on the per capita family income cutoff for the urban Delhi population for 2023–2024 [22]. The updated Modified Kuppuswamy Scale for 2024 was used to assess socioeconomic status [23]. Univariate analyses were performed using the Mann–Whitney *U* test for comparisons between two groups and the Kruskal–Wallis test for comparisons involving more than two groups. Significance levels were defined at 0.05. All analyses were done in SPSS Ver 25.0.

Results

Sociodemographic characteristics and disease profile of participants

A total of 110 patients with oral cancer were included in this study. The mean age of the study participants was 47.6 ± 11.1 years. Most of the participants were male (87.3%), Hindu (67.3%), married (85.5%) and belonged to the General caste category (68.2%). With respect to education, 39 (35.5%) participants were illiterate, and the majority resided in nuclear families (75.5%). Over half of the participants were residents of Delhi (53.6%). The median per capita monthly family income was ₹1,464 (IQR: ₹0–₹2,500), with 36 (32.7%) families reporting no monthly income. Most participants were unemployed (89.1%) and belonged to the upper and lower or lower socioeconomic classes (97.3%) (Table 1).

Tobacco use was common in the study population. Overall, 61 (55.5%) participants reported exclusive use of smokeless tobacco, 9 (8.2%) reported exclusive use of smoked tobacco and 31 (28.2%) reported use of both smoked and smokeless forms; only 9 (8.2%) reported never having used tobacco. Among participants who used smoked tobacco (n = 39), bidis were the predominant form (92.3%), while cigarette smoking was reported by 7.7%. The median (IQR) smoking exposure was 5.5 (1.4–8.3) pack-years. Alcohol use was reported by 56 (50.9%) participants.

The most common site of cancer was the buccal mucosa (40.9%), followed by the tongue (33.6%) and the alveolus (11.8%). Other sites of cancer included the gingivobuccal sulcus (7.3%), retromolar trigone (3.6%) and hard palate (2.7%). All cases were histopathologically confirmed as squamous cell carcinoma. A majority of the patients were diagnosed with moderately differentiated carcinoma (59.1%), followed by well-differentiated carcinoma in 42 (37.3%) participants and poorly differentiated carcinoma in 5 (3.6%) participants.

Table 1. Sociodemographic characteristics of the study population (*N* = 110).

Variable		Frequency (%)
Age (Mean ± SD)		47.6 ± 11.1
Gender	Male	96 (87.3)
	Female	14 (12.7)
Religion	Hindu	74 (67.3)
	Muslim	35 (31.8)
	Sikh	1 (0.9)
Category of caste	General	75 (68.2)
	Other Backward Castes	21 (19.1)
	Scheduled Castes	14 (12.7)
Marital status	Married	94 (85.5)
	Unmarried	6 (5.5)
	Widowed	7 (6.4)
	Divorced	2 (1.8)
	Separated	1 (0.9)
Education	Illiterate	39 (35.5)
	Primary school	14 (12.7)
	Middle school	21 (19.1)
	High school	22 (20.0)
	Inter/Diploma	12 (10.9)
	Graduation	2 (1.8)
Monthly per capita family income (Median and IQR)	Median (IQR)	Rs 1,464 (0–2,500)
	Minimum–maximum	Rs 0–25,000
Present occupation of the patient	Clerical, shop-owner, farmer	2 (1.8)
	Skilled worker	6 (5.5)
	Semi-skilled	3 (2.7)
	Unskilled worker	1 (0.9)
	Unemployed	98 (89.1)
Socioeconomic status as per the Modified Kuppuswamy Scale (2024)	Lower middle	3 (2.7)
	Upper lower	50 (45.5)
	Lower	57 (51.8)
Type of family	Nuclear	83 (75.5)
	Joint	27 (24.5)
Place of residence	Delhi	59 (53.6)
	Uttar Pradesh	39 (35.5)
	Bihar	5 (4.5)
	Others	7 (6.4)

With respect to tumour staging, over half of the cases were classified as T4 (55.5%), whereas early-stage tumours (T1) were observed in only 7 (6.4%) participants. Nodal involvement varied, with 30 (27.3%) participants having no regional lymph node metastasis (N0), 29 (26.4%) classified as N1, 36 (32.7%) as N2 and 15 (13.6%) as N3. Distant metastasis was uncommon, with only 4 (3.4%) participants classified as M1. Overall, Tumour, Node, and Metastasis (TNM) staging indicated that most participants were diagnosed at an advanced stage, with 74 (67.3%) presenting with Stage IV disease. Stage III, II and I disease were observed in 25 (22.7%), 7 (6.4%) and 4 (3.6%) participants, respectively.

Factors impacting access to care in the study population

Patient-related factors: In response to the first symptom, 59 (54.7) consulted a doctor or informal medical practitioner, while 21 (19.1%) attributed the symptom to a minor issue and waited for it to resolve. Additionally, 17 (15.5%) self-medicated, and 13 (11.8%) tried home remedies. Most participants (80.9%) shared their symptom onset with a family member. The majority of these family members were spouses (43.6%), followed by sons/daughters (22.7%). When advising the patient, 71.8% suggested consulting a doctor, while only a small number advised self-medication (2.7%), using home remedies (3.6%) or stopping tobacco use (0.9%).

Healthcare worker-related factors: Study participants saw a median of two healthcare providers (IQR = 1–3) before being diagnosed with oral cancer, ranging from 0 to 25 providers. Cancer was first suspected by the first healthcare provider for 50 (45.5%) participants, while for 35.7% of the participants, it took a visit to more than two healthcare providers for cancer to be first suspected. The specialisation of the first doctor seen included dental specialists (31.8%), followed by informal medical providers (23.6%), general practitioners (18.2%), ENT specialists (20.0%), cancer specialists (2.7%) and others (3.6%). The advice given by the first healthcare provider varied, with 60 (54.5%) healthcare providers attributing the symptom as minor and advising follow-up. Meanwhile, 25 (22.7%) healthcare providers provided symptomatic treatment and advised a biopsy, and another 25 (22.7%) offered symptomatic treatment and referred the patient to a higher centre.

Health system-related factors: A total of 42 (38.2%) participants took more than 120 minutes from their homes to reach the hospital where they were seeking treatment. Additionally, 26 (23.6%) patients travelled between 31 and 60 minutes, and 22 (20.0%) patients travelled between 61 and 120 minutes. Only 7 (6.4%) patients reached less than 15 minutes. The public bus was the most common mode of transport, used by 58 (52.7%) of participants. Other modes included taxis (23.6%), intercity trains plus taxis (11.8%) and own vehicles (6.4%), with local trains being the least preferred (3.6%).

Patient, diagnostic and treatment interval durations

The median (IQR) duration of the patient interval was 13.5 (5.0, 55.7) days, the diagnostic interval was 89.5 (38.0, 228.7) days and the treatment interval was 55.0 (29.0, 95.5) days. The median total interval from identifying the symptom to initiating treatment was 202.0 (135.7, 451.5) days.

Factors associated with patient, diagnostic and treatment intervals

The median diagnostic interval was significantly higher in patients belonging to nuclear families ($p = 0.013$) (Supplementary Table 1). The median diagnostic interval was more than double for females compared to males, and the median treatment interval was nearly 1.5 times that of people above 60 years of age for people less than 60 years of age. Similarly, the median diagnostic interval was longer for patients who were illiterate and who did not have a partner, compared with patients who were literate and living with a partner, respectively. However, these differences were not statistically significant ($p < 0.05$).

Among health system-related factors, the diagnostic interval was significantly longer if the first healthcare provider gave symptomatic treatment and did not refer the patient ($p < 0.001$) (Supplementary Table 2). The diagnostic interval was longer when cancer was first suspected after the patient had consulted more than two healthcare providers ($p < 0.05$). The patient, diagnostic and treatment intervals were longer for patients using public transport to reach the hospital compared to those using private vehicles. However, these differences were not statistically significant ($p < 0.05$). The grade and stage of the disease were not significantly associated with patient, diagnostic and treatment intervals (Supplementary Table 3).

Reasons for perception of delay in diagnosis and treatment of oral cancer

Patient interval: A majority of the patients, i.e., 108 (98.1%), attributed delays in seeking healthcare to perceiving their symptoms as minor and expecting spontaneous resolution. Other reasons included being too busy to make time to see a doctor (3.6%) and concerns about the costs of consulting a doctor (2.7%) (Table 2).

Diagnostic interval: The most frequently reported reason for delay in diagnosis was failure of the initial healthcare provider to suspect malignancy, as reported by 52 (47.2%) participants. Financial barriers were also prominent; 18 (16.3%) participants were unable to afford diagnostic investigations on time, while a further 17 (15.4%) deferred biopsy after experiencing temporary symptomatic relief following initial treatment. Other contributing factors included difficulty in accessing facilities with biopsy services (9.1%), prolonged waiting times for diagnostic tests (9.1%) and apprehension regarding the biopsy procedure itself (4.5%). Notably, 23 (20.9%) participants perceived that there had been no delay in their diagnosis, indicating heterogeneity in patient perceptions of the diagnostic process (Table 3).

Treatment interval: Nearly half the participants, i.e., 48 (43.6%), perceived that there was no delay in initiation of treatment. Among those who felt treatment was delayed, the most commonly cited reasons were prolonged pretreatment investigations following biopsy (20.9%) and difficulty in securing timely appointments for cancer treatment (13.6%). Financial constraints contributed to delayed treatment initiation in 8 (7.2%) participants. Additional factors included postponement due to poorly controlled chronic comorbid conditions (7.2%) and the decision to pursue alternative forms of treatment (5.4%) (Table 4).

Discussion

This study reports the duration of patient, diagnostic and treatment intervals in patients seeking care for oral cancer in a public hospital, revealing significant delays in diagnosis and treatment of oral cancer in India. The diagnostic interval was the longest contributor to delay, with a median duration of 89.5 days, compared with 13.5 days for the patient interval and 55.0 days for the treatment interval, resulting in a total median interval of 202.0 days from symptom recognition to treatment initiation. Prolonged diagnostic intervals were significantly associated with health system factors, particularly failure of the first healthcare provider to suspect cancer and symptomatic treatment without referral, as well as the need to consult multiple providers. The impact of prolonged intervals in the study population was evident as most participants presented with advanced disease, with nearly two-thirds diagnosed at Stage IV.

Table 2. Reason for perception of delay in seeking healthcare after identification of symptom (patient interval) (*N* = 110).

Reason*	Frequency (%)
Attributed the symptoms as minor and waited for the symptoms to subside	108 (98.1)
Too busy to make time to go to the doctor.	4 (3.6)
Did not have the money to consult a doctor/visit a hospital	3 (2.7)
Believed cancer is not curable	2 (1.8)
Had too many other things to worry about.	1 (0.9)
Worried about tests prescribed by doctors.	1 (0.9)
Did not have an accompanying person to visit the hospital.	1 (0.9)
Found it difficult to get an appointment with a particular doctor.	1 (0.9)
Did not believe in allopathic medicines and treatment, and preferred alternative medicines	1 (0.9)
Afraid of cancer and delaying seeing the doctor	1 (0.9)
Did not share my symptoms with the family, as they would get worried	1 (0.9)

*Not mutually exclusive

Table 3. Reason for perception of delay in diagnosis after seeing a healthcare provider (diagnostic interval) (*N* = 110).

Reason*	Frequency (%)
The initial healthcare provider did not suspect cancer	52 (47.2)
Delayed biopsy due to initial relief of symptoms with symptomatic treatment	18 (163)
Did not have the money to get the tests done on time	17 (15.4)
False negative biopsy on initial evaluation	11 (10.0)
Found it difficult to reach the facility with biopsy testing available	10 (9.1)
The waiting time for tests to get done was long	10 (9.1)
Did not have the time to get the tests done	6 (5.4)
Was afraid of the biopsy procedure	5 (4.5)
Delayed biopsy to seek other opinions on the problem	4 (3.6)
Sickness of another person in the family	3 (2.7)
Was afraid of confirming the diagnosis of cancer	3 (2.7)
COVID lockdown delayed biopsy	1 (0.9)
Delayed biopsy, hoping the symptoms would subside on their own	1 (0.9)
Did not feel that the diagnosis was delayed	23 (20.9)

*Not mutually exclusive

Table 4. Reasons for perception of delay in initiation of treatment following diagnosis of oral cancer (treatment interval) (*N* = 110).

Reason*	Frequency (%)
Pretreatment investigations following biopsy took time	23 (20.9)
Found it difficult to get a timely appointment for cancer treatment	15 (13.6)
Did not have money for cancer treatment	8 (7.2)
Other uncontrolled chronic diseases delayed cancer treatment	8 (7.2)
Opted for alternate forms of treatment	6 (5.4)
Other personal reasons	6 (5.4)
Another acute illness delayed treatment	5 (4.5)
Was afraid of cancer treatment – chemotherapy/surgery/radiation	4 (3.6)
Did not have time to start cancer treatment	2 (1.8)
Found it difficult to reach a centre with cancer treatment	1 (0.9)
Did not feel that treatment was delayed	48 (43.6)

*Not mutually exclusive

Similar delays in oral cancer diagnosis have been reported from other parts of the country. A cancer treatment centre in Maharashtra classified delays in cancer care into primary, secondary and tertiary delays. The primary delay, from symptom onset to seeing a primary care physician, was the longest at 2.75 months. Secondary delay, from seeking advice to referral to a tertiary centre, was 1.94 months, while tertiary delay, from referral to the start of treatment, was 1.4 months [24]. A study by Swaminathan *et al* [25] examined diagnostic delays and the impact of various patient and tumour factors on these delays. The study interviewed 120 patients and found that the median primary delay was 90 days, while the median secondary delay was 11 days. While the diagnostic interval was comparable to other studies from India, the patient interval was significantly shorter in our study population. This could be due to easy access to informal healthcare providers and

pharmacies, both of which were also considered a part of the healthcare system in this study. However, the reliance on patient-reported recall for determining the date of first symptom onset, which forms the basis of the patient interval, could have introduced recall bias, impacting the reliability of the duration of the patient interval reported in this study. Although a pseudo-exact dating protocol was employed to improve temporal accuracy, recall of early, often nonspecific oral symptoms is inherently subject to recall biases. It is plausible that early symptom phases were not distinctly remembered or were retrospectively reclassified as less significant once a cancer diagnosis was established. This could have resulted in a systematic underestimation of the patient interval in our study, which should therefore be interpreted with caution. Consequently, while the study suggests that patient delay may be less prominent relative to diagnostic delay, the potential for recall bias implies that the contribution of patient-related factors to overall delay may be underestimated.

In 2014, Akram *et al* [26] in Uttar Pradesh reported that significant risk factors contributing to delays in seeking hospital care included older age, low socioeconomic status, rural residence, lack of awareness about head and neck cancer, downplaying of symptoms as minor, absence of fear and reliance on alternative therapies. Similar reasons for delay were reported by Rath *et al* [27]. For example, lack of awareness, hope that the lesion will heal spontaneously, lack of perception of seriousness and financial constraints were reported to be reasons for delay in cancer care [27]. Swaminathan *et al* [25] reported that education played a significant role with literate patients presenting earlier for treatment. However, similar findings were not reported in this study.

Delays in cancer care are a global concern. A study conducted in the Philippines found that cancer treatment was delayed by more than 30 days for 35.1% of patients, while 25.2% and 20% of patients experienced delays upwards of 60 and 90 days, respectively [28]. The factors contributing to delays are similar across the low and middle-income countries. In a study by Bayable *et al* [29] in Ethiopia, female gender, rural residence, low social support, not having any other comorbidity and poor awareness were associated with delayed health-seeking. In a study from Thailand by Poum *et al* [30], significant associations were reported between delays in breast cancer diagnosis and education, family income, time to referral and number of consultations with a surgeon before diagnosis. Health system-related days compound patient-related delays. Cancer survivors in Eswatini reported poorly trained healthcare workers with insufficient skill and knowledge, delays in diagnostic procedures and inadequate infrastructure as reasons for delayed care [31]. The findings of a systematic review in 2021 by Lima *et al* [32] suggested that a lack of awareness about the signs and symptoms of oral cancer, along with the undervaluation of self-care, are strongly linked to delays in its diagnosis. A study by Saka-Herrán *et al* [33] in 2021 reported that patients with advanced-stage disease, primary treatment with radiotherapy, treatment at an academic facility and transitions in care were associated with prolonged pretreatment intervals. Similar to this study, a study by Bhatia *et al* [34] in Botswana reported that patients living with larger families were less likely to experience a help-seeking delay for cancer. Evidence on factors associated with treatment delay in patients with oral cancer in India is lacking.

Such delays are known to adversely affect patient outcomes, leading to greater morbidity and mortality [35]. Early diagnosis of cancer is reported to be associated with reduced expenses and the mean costs of care rise with advancing stages of the disease [36]. This also holds for patients with oral cancer. A review of studies conducted in 15 countries demonstrated a sharp rise in the costs of oral cancer with disease progression, rising from 22% of gross domestic product (GDP) per capita to 373% GDP per capita in the advanced stages [37].

Recognising the urgency of reducing intervals in cancer treatment, it is essential to promote early access to medical professionals. The United Kingdom introduced the 62-day Treatment Standard as a part of the National Health Service in 2023, which recommended the initiation of cancer treatment within 62 days of referral by a general physician. The upper limit of the diagnostic interval was set at 28 days as per the Faster Diagnosis Standard, and the 31-day Treatment Standard promoted the initiation of treatment within 31 days of a decision to treat the patient. Notably, these standards replace and broaden the scope of earlier standards set in 2000, one of which included a Two Week Wait Standard, recommending a specialist appointment within 2 weeks of referral by a general physician [38]. The European Cancer Organization published a policy action report in 2024, emphasising the inclusion of goals for treatment timelines in national policies across the continent, stringent monitoring of delays in treatment to identify areas requiring improvement, digitisation of the patient's treatment journey to flag delays and understanding the financial benefits of reduced delays [39]. The benefits of employing digital systems to track treatment timelines of patients with breast cancer were demonstrated by a study in the United States, which showed a 55% reduction in time to treatment from 74 to 33 days [40].

To reduce delays resulting from a poorly trained workforce, community health workers (CHWs) may be trained to detect oral precancer and early-stage cancer cases. In a study conducted in India, such training resulted in near-perfect agreement with dentists and a sensitivity of

almost 97% [41]. Recent developments in artificial intelligence (AI) can also be leveraged by HCPs to expedite diagnosis and referral. While unaided clinicians accurately diagnosed 61%–98% of oral mucosal lesion photographs, AI achieved 74%–100% accuracy [42]. A review published by Kim *et al* [43] demonstrated 92% sensitivity of AI-assisted oral cancer screening. A study by Talwar *et al* [44] conducted in India evaluated AI models using photographs taken by CHWs and identified DenseNet201 and Swin Transformer (base) as high-performing tools for oral cancer screening. These applications may also empower patients residing in remote and resource-limited settings and help them recognise early symptoms of disease to seek prompt care [44].

In India, the Pradhan Mantri Jan Arogya Yojana (PMJAY), a public insurance scheme introduced in 2018, was found to have improved timely access to cancer treatment. A higher proportion of patients initiated treatment within 30 days of diagnosis after PMJAY was launched in 2018 compared to the period before that [45]. However, in the current study, the impact of PMJAY could not be assessed as this was a cross-sectional study, and the scheme was not implemented in Delhi when it was conducted. Additionally, PMJAY has expanded financial access to cancer care across both public and empanelled private facilities, but the present study does not capture patient experiences within private-sector settings. Noncorporate private hospitals, in particular, may differ substantially from public institutions in terms of referral pathways, diagnostic turnaround times, provider incentives and patient navigation mechanisms. These structural differences can influence both the duration and determinants of delays. Caution is warranted in extrapolating these findings to the heterogeneous private healthcare sector or to other regions with differing health system characteristics.

Policy recommendations

Interventions should be prioritised according to the observed distribution of delays, with primary emphasis on reducing the diagnostic interval, which was the principal bottleneck in this cohort. The relatively short patient interval (13.5 days) suggests that delays are not predominantly driven by patient health-seeking behaviour but rather by system-level factors, particularly failure of initial clinical suspicion and delayed referral. However, the possibility of recall and desirability bias, i.e., patients reporting early health-seeking, may have impacted the patient interval, which necessitates caution in its interpretation.

This requires strengthening of the diagnostic pathway, which would include targeted training of primary and secondary healthcare providers to improve early recognition of potentially malignant oral lesions, establishment and dissemination of clear clinical guidelines mandating timely biopsy of nonhealing oral lesions and development of streamlined, protocol-driven referral pathways. Expanding access to diagnostic services through decentralised models such as hub-and-spoke systems and the integration of digital health solutions (e.g., telepathology and remote consultation) will be critical. Additionally, inclusion of diagnostic procedures within government-funded insurance schemes can mitigate financial barriers that contribute to delays. While patient-directed interventions remain relevant, they should be considered supportive rather than central in this context. Efforts such as tobacco control, population-based screening and awareness campaigns may help sustain early presentation but are unlikely to substantially impact the primary delay observed.

Finally, reducing the treatment interval requires strengthening downstream health system capacity. This can be achieved by improving the availability and accessibility of cancer treatment services, particularly in underserved areas. In addition, financial risk protection through insurance coverage and social security mechanisms is essential to mitigate treatment-related financial toxicity.

Strengths and limitations

This is the first study to assess all three levels of intervals – patient, diagnostic and treatment – in patients with oral cancer in India. This study was conducted in a referral public health centre for cancer treatment, which sees footfall of people from the middle and lower socio-economic populations in India, most commonly affected by oral cancer. Therefore, the findings represent the challenges faced by a majority of the people who are diagnosed with oral cancer. However, despite these strengths, the study has a few limitations. First, since the date of symptom identification was based on memory recall, there is a possibility of recall bias. However, a pseudo-exact date method was used to address this bias to identify the most accurate date of symptom identification, which might not be exact. Another limitation relates to the reconstruction of treatment pathways based predominantly on patient interviews, particularly in instances where medical records from multiple facilities were unavailable or incomplete. Cancer care pathways in India often involve fragmented care across different providers and institutions, making accurate recall of sequences, referrals and timelines challenging. This also may have introduced imprecision in estimating the patient interval and in estimating the number of healthcare providers seen by the patient before receiving the right diagnosis and

treatment. Second, the relatively small sample size limited the number of women included, precluding a detailed analysis of gender disparities in treatment-seeking behaviour. However, the reported trend highlighted that women took longer to be diagnosed than men. This trend requires further investigation. Third, the study included only participants from public health centres, excluding patients enrolled at private setups. Therefore, the findings cannot be generalised to private-sector hospitals. Finally, the cross-sectional design of this study limits the ability to establish causal relationships between observed delays and clinical outcomes such as disease progression, stage migration or survival. While a high proportion of patients in this study presented with advanced-stage disease alongside prolonged diagnostic and treatment intervals, these associations cannot be interpreted as causal. The temporal sequence between delay and disease progression cannot be definitively established within this study design, and residual confounding by tumour biology, patient comorbidities or healthcare access factors may exist. Longitudinal studies with prospective follow-up are required to quantify the impact of specific intervals on survival outcomes and to identify critical time thresholds beyond which prognosis significantly worsens. Therefore, the findings of this study should be viewed as hypothesis-generating and primarily descriptive of delay patterns rather than inferential regarding patient outcomes.

Conclusion

A majority of the patients with oral cancer presented with advanced-stage disease with preventable delays at various levels. The diagnostic interval was found to be the longest, followed by treatment and patient intervals. There are various risk factors predisposing people to these delays. Our study highlights the need for enhanced screening in high-risk populations for oral cancer, improvement in awareness regarding early symptoms among healthcare providers and patients, and improved access to diagnostic and treatment services. However, as this is a single-centre study, the findings should be interpreted with caution and should not be generalised across the country.

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Conflicts of interest

The authors declare that they have no competing interests.

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Ethics approval and consent to participate

Ethics clearance was taken from the Institutional Ethical Committee (F.1/IEC/MAMC/MD/MS(96/02/2023/No.125) on 15.05.2023.

Availability of data and materials

All data will be available on reasonable request to the corresponding author.

Author contributions

PS – Conceptualisation, data collection, data analysis, data interpretation, manuscript – original draft writing.

MMS – Conceptualisation, data interpretation, manuscript – review and editing, supervision.

ALB – Conceptualisation, data interpretation, manuscript – review and editing.

DA – Data interpretation, manuscript – review and editing.

AS – Conceptualisation, data interpretation, manuscript – review and editing.

RM – Conceptualisation, data interpretation, manuscript – review and editing.

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Supplementary materials

Supplementary Table 1. Sociodemographic factors associated with patient, diagnostic and treatment intervals.

Variable		Frequency (%)	Patient interval		Diagnostic interval		Treatment interval	
			Median (IQR) days	*p* value	Median (IQR) days	*p* value	Median (IQR) days	*p* value
Age	Below 60 years	92 (79.3)	14.0 (5.0–60.8)	0.759	87.5 (39.8–251.5)	0.531	56.5 (31.5–94.8)	0.180
	60 years and above	24 (20.7)	8.0 (5.0–34.8)		89.5 (30.8–175.2)		35.5 (26.0–96.5)	
Gender	Male	102 (87.9)	14.0 (5.0–61.0)	0.342	86.0 (39.0–179.8)	0.067	55.5 (29.0–95.5)	0.796
	Female	14 (12.1)	8.5 (3.8–34.2)		198.0 (70.2–500.2)		46.0 (28.8–77.2)	
Religion	Hindu	77 (66.4)	15.0 (6.0–66.0)	0.165	87.0 (37.0–250.0)	0.759	60.0 (30.0–99.5)	0.183
	Other	39 (33.6)	7.0 (4.0–44.0)		95.0 (45.0–204.0)		45.0 (27.0–81.0)	
Category of caste	General	78 (67.3)	13.0 (4.8–58.5)	0.791	88.0 (41.2–246.2)	0.835	54.5 (28.0–92.8)	0.462
	Others	38 (32.7)	14.0 (5.0–63.5)		89.0 (38.0–178.5)		61.0 (32.5–97.0)	
Marital status	Married	100 (86.2)	13.5 (5.0–57.0)	0.801	86.0 (39.0–175.5)	0.357	54.5 (29.0–96.5)	0.442
	Other	16 (13.8)	13.5 (4.2–95.8)		150.0 (32.2–313.0)		63.5 (37.8–88.5)	
Education	Illiterate	39 (33.6)	12.0 (5.0–58.0)	0.829	127.0 (33.0–253.0)	0.188	45.0 (28.0–97.0)	0.440
	Literate	77 (66.4)	14.0 (4.5–60.5)		77.0 (40.5–180.0)		59.0 (31.0–95.0)	
Per capita family income	≤Rs 1,134	49 (42.2)	13.0 (4.0–56.0)	0.547	88.0 (42.0–207.5)	0.746	48.0 (28.5–86.5)	0.459
	>Rs 1,134	67 (57.8)	14.0 (5.0–73.0)		88.0 (35.0–246.0)		60.0 (29.0–97.0)	
Occupation	Employed	12 (10.3)	12.0 (6.0–27.0)	0.706	81.0 (37.0–225.8)	0.810	55.5 (22.8–120.8)	0.870
	Unemployed	104 (89.7)	13.5 (5.0–61.0)		88.0 (39.0–218.2)		55.0 (29.0–94.8)	
Socioeconomic status	Lower	58 (50.0)	13.5 (5.8–60.2)	0.648	86.5 (37.5–191.2)	0.787	55.5 (28.8–98.2)	0.776
	Upper lower or lower middle	58 (50.0)	12.0 (4.0–55.8)		92.5 (41.2–291.2)		55.0 (29.0–92.8)	
Type of family	Nuclear	86 (74.1)	13.0 (5.0–60.2)	0.967	101.0 (46.8–273.2)	0.013	56.0 (29.8–90.5)	0.781
	Joint	30 (25.9)	14.5 (4.5–63.8)		49.5 (23.0–118.5)		41.5 (26.8–108.5)	
Place of residence	Delhi	63 (54.3)	13.0 (5.0–61.0)	0.947	94.0 (45.0–289.0)	0.449	56.0 (30.0–94.0)	0.794
	Outside Delhi	53 (45.7)	14.0 (5.0–54.5)		86.0 (34.0–175.0)		55.0 (28.0–99.5)	

Supplementary Table 2. Association between the health system and healthcare worker-related factors and diagnostic interval.

Variable		Frequency (%)	Patient interval		Diagnostic interval		Treatment interval	
			Median (IQR) days	*p* value	Median (IQR) days	*p* value	Median (IQR) days	*p* value
Time taken from residence by the patient to reach the treatment hospital	Within 1 hour	49 (42.2)	13.0 (4.5–86.0)	0.827	107.0 (34.0–312.0)	0.408	60.0 (28.0–98.5)	0.698
	More than 1 hour	67 (57.8)	14.0 (5.0–46.0)		86.0 (39.0–176.0)		48.0 (29.0–95.0)	
Preferred mode of transport to reach the healthcare centre	Public transport	79 (68.1)	15.0 (5.0–61.0)	0.486	106.0 (43.5–297.0)	0.273	57.0 (33.0–102.0)	0.051
	Private or rented transport	37 (31.9)	8.0 (4.5–46.5)		80.0 (39.0–176.0)		38.0 (23.5–86.0)	
Cancer was first suspected in contact with	First or second healthcare provider	76 (65.5)	14.5 (5.2–88.0)	0.078	76.5 (28.2–196.5)	0.072	59.5 (34.5–104.5)	0.020
	Later	40 (34.5)	8.0 (3.0–40.8)		107.0 (55.2–251.5)		38.0 (26.0–66.2)	
Specialisation of the first doctor seen	Informal medical provider	27 (23.3)	7.0 (4.0–41.0)	0.324	94.0 (44.0–164.5)	0.893	47.0 (29.5–104.5)	0.836
	Trained modern medicine practitioner	89 (76.7)	14.0 (5.0–61.0)		86.0 (35.0–265.0)		56.0 (28.0–95.0)	
Advice given by first healthcare provider seen	Gave symptomatic treatment and did not refer	64 (55.2)	9.0 (4.0–42.5)	0.098	119.5 (76.0–262.0)	<0.001	46.0 (27.0–79.5)	0.159
	Gave symptomatic treatment and was referred to a higher centre	52 (44.8)	17.5 (5.0–88.0)		47.5 (21.0–103.5)		59.5 (36.2–100.8)	

Supplementary Table 3. Association of grade and stage of cancer with patient, diagnostic and treatment intervals.

Variable		Frequency (%)	Patient interval		Diagnostic interval		Treatment interval	
			Median (IQR) days	*p* value	Median (IQR) days	*p* value	Median (IQR) days	*p* value
Grade	Grade 1	42 (36.2)	13.5 (4.0–55.8)	0.886	98.0 (29.8–271.0)	0.796	51.0 (28.0–82.5)	0.237
	Grade 2 or 3	74 (63.8)	13.5 (5.0–61.0)		83.0 (41.2–194.2)		57.5 (32.5–102.2)	
Stage	Stage I or II	12 (10.4)	16.0 (3.8–34.0)	0.666	102.0 (45.5–379.5)	0.508	45.0 (26.8–64.0)	0.389
	Stage III or IV	104 (89.6)	13.0 (5.0–68.5)		88.0 (39.0–201.0)		56.0 (29.2–96.5)	

*Mann–Whitney *U* test was used for df = 1 and Kruskal–Wallis test was used for df >1