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Missed Opportunities in Early Detection of Oral Potentially Malignant Disorders in Primary Dental Care: A Multi-Regional Evidence Synthesis

[1]*Jenikumari Gajendrasinh Mahida
[1]Gujarat University, India.

Abstract

Background: Oral potentially malignant disorders (OPMDs) are known precursors of oral cancer, and early detection is critical to enhancing patient prognosis. Oral lesions that are suspicious are often the initial stage of contact of a patient with a dental practitioner, but missed diagnostic opportunities in primary dental practice could also play a role in late disease detection and worsening.

Purpose: The purpose of the systematic review was to synthesize multi-regional evidence on missed opportunities in the early detection of oral potentially malignant disorders in the primary dental care setting.

Methods: A systematic literature review was carried out in line with PRISMA 2020 guidelines. Peer-reviewed studies published within 2017-2025 were searched in electronic databases, such as PubMed, Scopus, Web of Science, and Google Scholar. The studies that were eligible were observational, cohort, and cross-sectional studies that investigated diagnostic practice, screening behavior, referral pathway, and malignant transformation of OPMDs.

Findings: 19 studies fulfilling the inclusion criteria were obtained. The results suggest that clinician-related factors, patient behavior, and barriers to healthcare systems are often related to the causes of diagnostic delays. Routine dental screening was found to be one of the most important tools to screen for early mucosal abnormalities.

Conclusion: Clinical awareness, screening practices, and referral pathways can be strengthened to enhance early detection of OPMDs and help decrease the oral cancer burden.

Keywords: Oral cancer screening; Oral potentially malignant disorders; Primary dental care; Early detection; Diagnostic delay

Introduction

Oral cancer is a significant global health issue, with an estimated incidence of about 377,700 new cases and 177,700 deaths every year, and incidence rates are still increasing in most locations (Sung et al., 2021). The five-year survival rate of oral cancer is comparatively low, at approximately 5060 percent, in part due to a significant percentage of patients being diagnosed with the disease at advanced stages (Warnakulasuriya, 2009). Early diagnosis is therefore considered as one of the most effective steps towards improving prognosis and reducing the disease burden. Notably, most oral cancers are a result of oral potentially malignant disorders (OPMDs), a set of mucosal conditions in which the risk of malignant transformation is high (Warnakulasuriya et al., 2021).

The spectrum of lesions covered with OPMDs contains oral leukoplakia, erythroplakia, oral lichen planus, proliferative verrucous leukoplakia, and oral submucous fibrosis, each of which has a range of malignant potential based on clinical presentation, histopathological features, and exposures to risk factors (Speight et al., 2018). Leukoplakia is the most commonly reported OPMD, and malignant transformation rates are between 1 and 9%, whereas erythroplakia and proliferative verrucous leukoplakia have much more significant transformation risks (Warnakulasuriya et al., 2021). The use of tobacco, alcohol use, betel quid chewing, and viral infections (human papillomavirus) have been uniformly reported as key etiological agents in the occurrence and progression of these conditions (Rivera, 2015). Since OPMDs can be heralded by subtle mucosal changes before malignant change, regular oral examinations are essential to early detection.

Dental care practitioners are critical in the early diagnosis of OPMDs since dentists are often the initial encounter of

Jenikumari Gajendrasinh Mahida
Gujarat University, India.
Email: jenny.mahida96@gmail.com

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patients presenting with oral mucosal lesions. Opportunistic screening and clinical assessment of suspicious lesions can be performed during regular dental visits (González-Moles et al., 2022). Nonetheless, different studies have cited knowledge gaps, uncertainty in clinical decisions, and referral procedures in clinicians whose oral lesions have the potential to be malignant, which may lead to the late diagnosis or mismanagement (Coppola et al., 2022). Opportunities in dental visits such as failure to carry out complete mucosal examination, early lesion detection, or referral pathways might result in development of lesions that cause malignancy, eventually reducing patient outcomes.

Besides the reasons related to clinicians, there are systemic issues that might also lead to timely detection. These include insufficient training in oral medicine during dental training, variance of screening guidelines, lack of uniform diagnostic guidelines, and disparity of specialist care across regions (Villa, Stoopler, et al., 2025). These concerns are particularly acute in low- and middle-income countries in which a high rate of risk factors and insufficient healthcare infrastructure predisposes people to the disproportionate burden of oral cancer (Gupta et al., 2016). Consequently, patterns and determinants of missed detection during primary dental care environments need to be known to help improve early diagnosis and strengthen preventive measures.

Even though the epidemiology and malignant potential of OPMDs have been intensively studied, the data on missed diagnostic opportunities in primary dental care are scattered across individual studies. Current studies have mainly concentrated on the biological behavior of OPMDs or the knowledge and awareness of clinicians, with little emphasis having been laid on systematic findings on how diagnostic gaps arise during regular dental services and how the gaps differ in different geographic and healthcare settings. Moreover, syntheses of evidence across regions are lacking to determine common patterns, structural obstacles, and clinical practices associated with delayed detection.

Thus, there is a need to conduct a systematic synthesis of the existing evidence to gain a clearer insight into the mechanisms by which the opportunities to diagnose at an early stage are lost in the primary dental care environment. The proposed systematic review will synthesize multi-regional evidence about missed opportunities in the early diagnosis of oral potentially malignant disorders in the first instance of dental care in relation to diagnostic practice, screening behavior, clinician-related factors and systemic barriers that affect early detection and referral. This study will help inform specific educational activities, enhance the clinical screening procedures, and promote policy efforts to improve early oral cancer diagnosis and, eventually, decrease its worldwide incidence.

Methodology

Study Design

A systematic literature review (SLR) was carried out in this research to synthesize the evidence regarding missed opportunities in the early diagnosis of oral potentially malignant disorders (OPMDs) in primary dental care. To maintain the transparency, methodological rigor, and reproducibility of the review, it was designed and reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines (Page et al., 2021). The research question was formulated based on the Population Intervention Comparison Outcome (PICO) model, which made it possible to systematically identify and analyze the literature on detection practices and diagnostic delays in relation to OPMDs in dental practice (Frandsen et al., 2020).

In this context, the population targeted was a group of patients with oral potentially malignant conditions or oral cancer in either a dental or clinical environment. The exposure or intervention was clinical screening, oral examination, or diagnostic practice by dentists during primary dental care. The comparison was based on the delayed diagnosis, missed lesions, or lack of systematic screening practices. Early OPMDs detection, referral patterns, diagnostic delay, and malignant transformation outcomes were the main outcomes of interest.

PICO Framework

The research question and eligibility criteria were designed in relation to the Population Intervention Comparison Outcome (PICO) framework as the guideline to identify and select the relevant studies.

Search Strategy

A thorough and methodical literature search was carried out to find the pertinent studies that have investigated the clinical practice of the early recognition of oral potentially malignant conditions in dentistry. Peer-reviewed articles were obtained in electronic databases such as PubMed, Scopus, Web of Science, and Google Scholar. The search strategy was formulated based on three

Table 1: PICO framework

Component	Description
Population (P)	Patients presenting with oral potentially malignant disorders (OPMDs) or oral cancer in dental or clinical settings
Intervention / Exposure (I)	Early detection practices, including oral examination, screening, and diagnostic assessment, are performed by dentists in primary dental care
Comparison (C)	Delayed diagnosis, missed lesions, or absence of systematic screening practices
Outcome (O)	Early detection of OPMDs, diagnostic delay, referral patterns, and malignant transformation outcomes

conceptual areas that included oral potentially malignant disorders, early detection or diagnostic delay, and dental practice settings.

Oral potentially malignant disorders were searched using a combination of keywords and controlled vocabulary, such as oral potentially malignant disorders, oral leukoplakia, oral lichen planus, oral epithelial dysplasia, oral submucous fibrosis, oral cancer, and oral squamous cell carcinoma. These were combined with the terms that concerned detection, such as early detection, screening, diagnosis, diagnostic delay, referral delay, and missed diagnosis. Other keywords that were incorporated to make it relevant to dental practice include dentists, dental practice, primary dental care, oral examination, and dental screening.

The Boolean operators (AND/OR) were used to refine the database results by combining the search terms. The overall search format applied to databases was as follows:

("oral potentially malignant disorders" OR "oral leukoplakia" OR "oral lichen planus" OR "oral epithelial dysplasia" OR "oral submucous fibrosis" OR "oral cancer" OR "oral squamous cell carcinoma")

AND

("early detection" OR "screening" OR "diagnosis" OR "diagnostic delay" OR "referral delay" OR "missed diagnosis")

AND

("dentists" OR "dental practice" OR "primary dental care" OR "oral examination" OR "dental screening")

Only peer-reviewed studies published between 2017 and 2025 in English were included in the search. In order to have maximum coverage of the literature, the reference lists of the articles of interest were also screened manually to determine other eligible studies that were not retrieved using the databases.

Eligibility Criteria

The inclusion and exclusion criteria were set in order to select studies that were relevant to the research objectives. Articles were eligible provided they conducted research on early detection, screening habits, diagnostic pathways or malignant transformation of oral potentially malignant disorders in dental or clinical care environments. Study designs that were eligible were observational studies, cross-sectional studies, cohort studies, retrospective studies, and prospective studies. Articles that contained diagnostic delays/referral pathways/clinical outcomes related to OPMDs were also evaluated as eligible.

Research papers that were review articles, editorials, commentaries, abstracts of conference papers, and non-peer-reviewed journals were not included. Potentially malignant disorders of the oral cavity and the detection of oral cancer in the dental practice were not the subject of the studies, as they were excluded. The final synthesis also excluded articles without a detailed enough methodology or outcome data.

Study Selection Process

The process of study selection was carried out according to the PRISMA 2020 guidelines (Page et al., 2021). After the database search, all the records retrieved were imported into the reference management software, and duplicate records were deleted. The rest of the records were filtered in two phases. First, the titles and abstracts were examined to determine the potentially relevant studies according to the predefined inclusion and exclusion criteria. At this point, articles not meeting the eligibility criteria were eliminated. The entire texts of potentially eligible studies were then evaluated to identify their relevance to the research objectives. Two reviewers conducted the screening and eligibility assessment separately to reduce the chances of selection bias, and disagreements were addressed by discussing and reaching a consensus. The PRISMA flow chart depicts the overall identification, screening, and inclusion of the study.

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Data Extraction

An organized data extraction framework was used to extract facts in the included studies to ensure reliability and correctness. Information was extracted in the form of author, year of publication, country or geographic area, study design, sample size, type of oral potentially malignant disorder being studied and the main outcomes of the study in terms of early detection, diagnostic lag, or malignant transformation. Additional data on the clinical screening practices, referral patterns and diagnostic pathways were also gathered where available. The data extracted was tabulated into a summary table to enable systematic comparison across studies and to enable thematic interpretation of findings.

Quality Appraisal

Since the study designs were heterogeneous in the studies sampled, design-specific critical appraisal tools were used to evaluate methodological quality. The Newcastle-Ottawa Scale (NOS) was used to evaluate the cohort studies in terms of the quality of the study based on the selection of the participants, the similarity of the groups and the measurement of the outcomes. The AXIS critical appraisal tool was used to evaluate cross-sectional studies based on the quality of the study design, sampling methods, measurement validity, and statistical analysis. The Joanna Briggs Institute (JBI) checklist on analytical observational studies was used to evaluate the quality of observational and retrospective studies and includes aspects such as participant selection, exposure measurement, confounding factors, and outcome validity. The findings of quality appraisal are displayed in Table 2-4.

Table 2. Quality Appraisal of Cohort Studies (Newcastle–Ottawa Scale)

Study No.	Selection (0–4)	Comparability (0–2)	Outcome (0–3)	Total (0–9)	Quality Level
(Wang et al., 2018)	★★★☆	★★	★★★	8	High
(Tsushima et al., 2021)	★★★	★	★★★	7	Moderate–High
(Hankinson et al., 2021)	★★★	★	★★★	7	Moderate–High
(Nevanpää et al., 2022)	★★★★	★★	★★★	9	High
(Bernard et al., 2023)	★★★	★	★★★	7	Moderate–High
(Chu et al., 2025)	★★★☆	★★	★★★	8	High
(Villa, Lodolo, et al., 2025)	★★★★	★★	★★★	9	High

Table 3. Quality Appraisal of Cross-Sectional Studies (AXIS Tool)

Study No.	Study Design Quality	Sampling Strategy	Measurement Validity	Statistical Methods	Overall Quality
(Psoter et al., 2019)	Appropriate	Large national sample	Validated questionnaire	Regression models used	High
(Jaber & Elameen, 2021)	Appropriate	Clinical cohort sampling	Histological diagnosis	Descriptive statistics	Moderate–High

Data Synthesis

Quantitative meta-analysis was not deemed suitable because of high heterogeneity among the studies included in the study in terms of methodology, population characteristics, and reported outcomes. Thus, a narrative thematic synthesis methodology based on the SWiM (Synthesis Without Meta-analysis) reporting framework was used to synthesize the findings (Campbell et al., 2020). Synthesis was organized in the form of thematic categories depending on included studies, including characteristics of the included studies, types of oral potentially malignant disorders researched, missed opportunities in early diagnosis, factors that contribute to diagnostic delays, the risk of malignant transformation, and the effect of dental screening practices in improving early diagnosis. Such an approach allowed conducting an in-depth examination of the available evidence and finding out the similarities in the process of diagnosis in different clinical settings.

Table 4. Quality Appraisal of Observational Studies (JBI Checklist)

Study No.	Participant Selection	Exposure Measurement	Confounding Factors	Outcome Measurement	Overall Quality
(Abadeh et al., 2019)	Clearly defined	Pathology records	Partially addressed	Reliable diagnosis	Moderate–High
(Ahern et al., 2020)	Clearly defined cases	Clinical records	Limited control	Pathology confirmed	Moderate
(Hertrampf et al., 2022)	Appropriate recruitment	Clinical examination	Partially addressed	Clear outcome reporting	Moderate
(Watanabe et al., 2024)	Defined hospital cohort	Clinical records	Addressed statistically	Reliable outcomes	Moderate–High
(Keinänen et al., 2024)	Clinical cohort	Patient records	Partially controlled	Diagnostic confirmation	Moderate
(Morelatto et al., 2022)	Defined groups	Clinical diagnosis	Partially controlled	Outcome improvement reported	Moderate
(Varela-Centelles et al., 2017)	Hospital cases	Clinical timelines recorded	Limited adjustment	Reliable outcomes	Moderate
(Langevin et al., 2012)	Population-based sample	Clinical diagnosis	Adjusted in regression	Clear outcomes	Moderate–High
(Zhang et al., 2024)	Defined clinical cohort	Histopathological diagnosis	Partially addressed	Reliable follow-up outcomes	Moderate
(Roberts et al., 2024)	Defined patient cohort	Histological confirmation	Limited confounding control	Clear transformation outcome	Moderate

Results

Study Selection

A total of 1030 records were initially identified through database searching. Before screening, 332 duplicates, 228 records identified by automated screening tools as ineligible, and 128 records deleted due to other reasons were filtered out. Following these removals, there were 342 records left to be screened on title and abstract, of which 118 records were filtered out because they were irrelevant to the research question.

After that, 224 reports were requested to be retrieved, but some percentage of records were not retrieved (n = 116). After retrieval, 108 full-text articles were evaluated regarding their eligibility. In the eligibility assessment phase, 89 studies were eliminated, mostly due to lack of focus on early detection of oral potentially malignant disorders (n = 46), inappropriate study population (n = 28) or insufficient diagnostic outcome information (n = 15). Ultimately, the number of studies that were eligible to be incorporated in the final systematic review was 19, as shown in Figure 1.

Characteristics of Included Studies

The characteristics of the included studies are summarized in Table 5. The study was conducted in various geographical areas, including North America, Europe, Asia, and South America, which represents a wide range of clinical settings and healthcare systems. Included studies were highly heterogeneous with respect to research design, research methodology, and research population.

Majority of the studies employed were observational or retrospective clinical studies; other studies employed cohort or cross-sectional designs to investigate the progression and/or detection of oral potentially malignant disorders (Abadeh et al., 2019; Ahern et al., 2020; Bernard et al., 2023; Chu et al., 2025; Hankinson et al., 2021; Hertrampf et al., 2022; Jaber & Elameen, 2021; Keinänen et al., 2024; Langevin et al., 2012; Morelatto et al., 2022; Nevanpää et al., 2022; Psoter et al., 2019; Roberts et al., 2024; Tsushima et al., 2021; Varela-Centelles et al., 2017; Villa, Lodolo, et al., 2025; Wang et al., 2018; Watanabe et al., 2024; Zhang et al., 2024). The sample sizes of various studies were quite different, and they were comparatively

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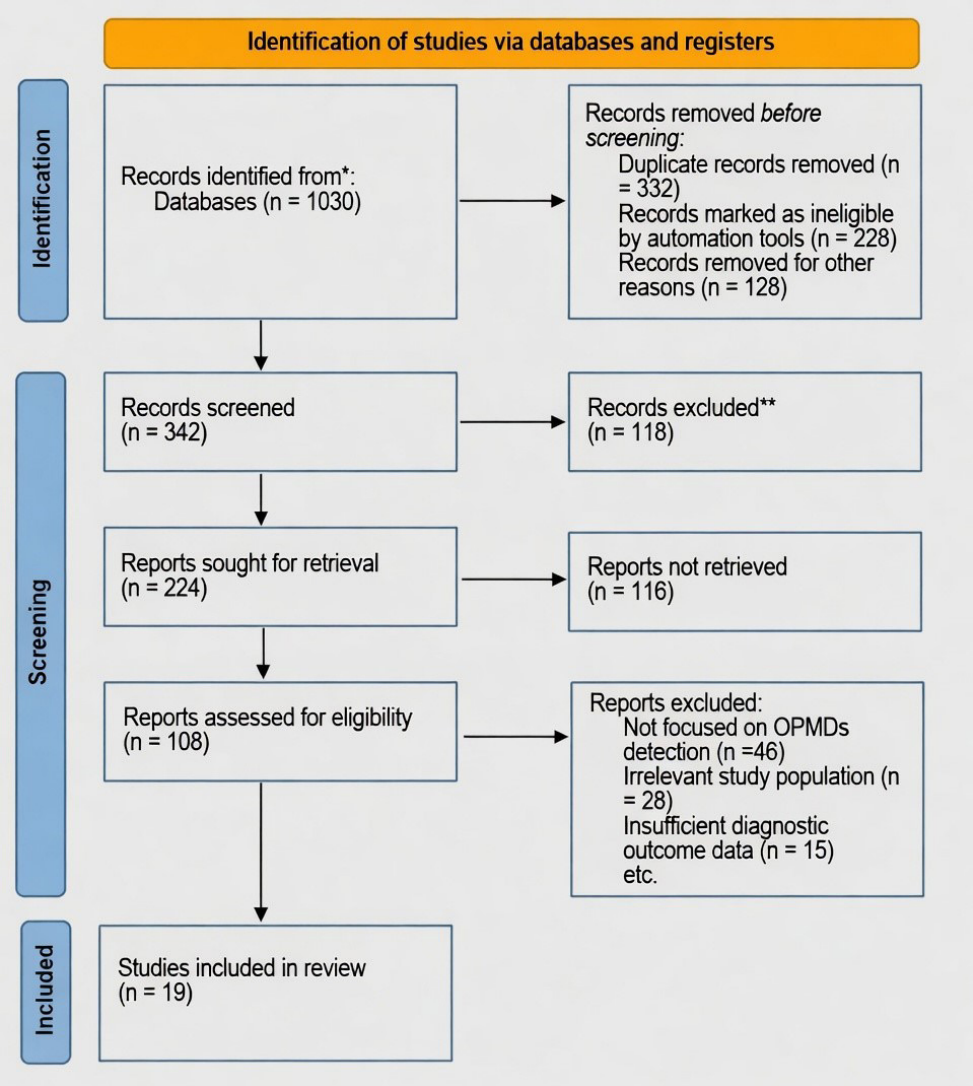

Figure 1. PRISMA flow chart

small clinical cohorts and extensive population-based data including several hundred or thousands of patients. Some of the studies were directly focused on the malignant development of oral potentially malignant diseases, and others focused on the diagnostic pathways, dental screening, and referral behavior in primary dental care.

Overall, the presented studies provide a coherent understanding of the clinical course of OPMDs, along with systemic issues concerning the early diagnosis of the disease in dental practice.

Types of Orals Potentially Malignant Disorders Investigated

The spectrum of oral potentially malignant disorders investigated in the included studies is presented in Table 6. Oral leukoplakia, oral lichen planus, and oral epithelial dysplasia were the most common lesions studied and are generally considered to be significant precursor lesions to oral squamous cell carcinoma (Bernard et al., 2023; Chu et al., 2025; Roberts et al., 2024; Wang et al., 2018). The clinical significance of these lesions is due to their possibility of developing malignant transformation, especially in cases of histological dysplasia.

A number of studies examined the incidence of malignant transformation of these lesions, emphasizing the necessity of close follow-ups and making early diagnosis in the dental practice. As an illustration, oral leukoplakia was also analyzed in large cohort studies evaluating its development to oral cancer (Wang et al., 2018), and oral lichen planus and erosive variants were also studied as they

Table 5. Characteristics of Included Studies (n = 19)

Study No.	Study Title (Short)	Country/Region	Study Design	Main Focus
(Abadeh et al., 2019)	Detection by the dentists' pathology service	Canada	Retrospective database	Detection of dysplasia and OSCC
(Ahern et al., 2020)	Detection of oral cancer/ OPMDs	Ireland	Observational retrospective	Opportunistic detection
(Hertrampf et al., 2022)	Early detection role of dentists	Germany	Prospective observational	Screening of suspicious lesions
(Watanabe et al., 2024)	Delayed referral from dentists	Japan	Retrospective clinical	Referral delay factors
(Keinänen et al., 2024)	Professional delay in OSCC	Finland	Observational clinical	Diagnostic delay
(Morelatto et al., 2022)	Intervention program awareness	Argentina	Interventional comparison	Impact of awareness program
(Varela-Centelles et al., 2017)	Diagnostic pathway intervals	Spain	Observational hospital	Time intervals to diagnosis
(Langevin et al., 2012)	Dental visits and cancer stage	USA	Population study	Effect of dental visits
(Psoter et al., 2019)	Lesion discovery by dentists	USA	Cross-sectional survey	Suspicious lesion detection
(Wang et al., 2018)	Leukoplakia transformation	Taiwan	Retrospective cohort	Cancer transformation risk
(Tsushima et al., 2021)	Oral lichen planus transformation	Japan	Retrospective cohort	Malignant transformation
(Jaber & Elameen, 2021)	OED follow-up study	Hospital based	Cross-sectional	Dysplasia progression
(Hankinson et al., 2021)	OED transformation cohort	Specialist center	Cohort	Dysplasia progression risk
(Nevanpää et al., 2022)	OED Finland registry	Finland	Registry cohort	OSCC risk
(Bernard et al., 2023)	OED clinical outcomes	USA	Retrospective cohort	Observation vs excision outcomes
(Zhang et al., 2024)	PVL transformation study	China	Retrospective longitudinal	PVL malignant transformation
(Roberts et al., 2024)	Erosive OLP transformation	UK	Retrospective study	Cancer risk
(Chu et al., 2025)	OLP precancerous lesions cohort	Asia	Retrospective cohort	Risk factors for oral cancer
(Villa, Lodolo, et al., 2025)	OPMD oncological outcomes database	USA	Large database cohort	Progression of OPMDs

are chronic inflammatory lesions and may be associated with malignant transformation (Chu et al., 2025; Roberts et al., 2024; Tsushima et al., 2021).

Furthermore, other studies focused on uncommon but clinically relevant lesions like proliferative verrucous leukoplakia that have been reported to show very high

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levels of malignant transformation and aggressive clinical behavior (Zhang et al., 2024). Together, the results highlight the clinical heterogeneity of OPMDs and the need to identify them at an early stage in the dental context.

Table 6. Types of Orals Potentially Malignant Disorders Investigated

OPMD Type	Studies Investigating	Key Clinical Features	Reported Transformation Risk
Oral Leukoplakia	(Villa, Lodolo, et al., 2025; Wang et al., 2018)	White mucosal plaque	Moderate–high risk
Oral Lichen Planus	(Chu et al., 2025; Roberts et al., 2024; Tsushima et al., 2021)	Chronic inflammatory lesions	Low–moderate risk
Oral Epithelial Dysplasia	(Bernard et al., 2023; Hankinson et al., 2021; Jaber & Elameen, 2021; Roberts et al., 2024)	Histological epithelial dysplasia	High predictor of OSCC
Proliferative Verrucous Leukoplakia	(Zhang et al., 2024)	Multifocal verrucous lesions	Very high risk

Missed Opportunities in Early Detection

Some of the studies have pointed out the major gaps in the early detection of oral cancer and oral potentially malignant disorders in primary dental care settings (Table 7). These missed opportunities were mainly linked to the inability to identify suspicious oral lesions at the routine dental check-up, the late referral to specialty care, or the miscommunication of initial pathological alterations (Ahern et al., 2020; Hertrampf et al., 2022; Keinänen et al., 2024).

According to some studies, potentially malignant lesions were often incidentally identified during regular dental care, not as a result of a systematic screening programme (Abadeh et al., 2019; Hertrampf et al., 2022; Psoter et al., 2019). This implies that, despite dentists being the primary medical professionals who are likely to see suspicious oral lesions, early diagnosis may still be reliant on opportunistic examination instead of systematic screening measures.

Moreover, diagnostic uncertainty and lack of awareness of early clinical manifestation were also found to have a role in late diagnosis in dental practice (Keinänen et al., 2024; Watanabe et al., 2024). Early lesions were, in some instances, misdiagnosed as benign oral conditions, thus delaying the referral and definitive diagnosis.

Table 7. Missed Opportunities in Early Detection

Study No.	Missed Opportunity	Clinical Impact
(Ahern et al., 2020)	Lack of opportunistic screening	Delayed lesion identification
(Hertrampf et al., 2022)	Limited documentation of lesions	Under-recognition
(Watanabe et al., 2024)	Misdiagnosis by dentists	Delayed referral
(Keinänen et al., 2024)	Failure to recognize malignancy	Diagnostic delay
(Varela-Centelles et al., 2017)	Delayed clinical pathway	Late diagnosis

Factors Contributing to Diagnostic Delay

Table 8 summarizes the factors leading to the delayed diagnosis of oral cancer and oral potentially malignant disorders. These determinants were generally divided into patient-related, clinician-related and healthcare system-related determinants.

The patient-related variables were poor healthcare-seeking behavior, ignorance of oral cancer symptoms, and poor estimation of the severity of the lesions (Langevin et al., 2012; Varela-Centelles et al., 2017). These delays may have a severe impact on the delay between symptom development and clinical assessment.

Factors related to clinicians were also commonly reported. A number of studies also reported that dentists sometimes struggled to identify early malignant lesions or differentiate between them and benign conditions of the mouth (Keinänen et al., 2024; Watanabe et al., 2024). Potential contributors to professional diagnostic delay

were identified as diagnostic uncertainty, experience, and insufficient training in oral cancer screening.

Factors in the healthcare system were also significant. Barriers to timely diagnosis were reported to be delays in referral pathways, low access to specialist diagnostic services, and broken care systems (Morelatto et al., 2022; Varela-Centelles et al., 2017). Such systemic problems indicate that there is a need to enhance clinical pathways and collaborative care between dental professionals and specialist services.

Table 8. Factors Contributing to Diagnostic Delay

Study	Patient Factors	Clinician Factors	System Factors
(Watanabe et al., 2024)	Delayed presentation	Misdiagnosis	Referral delay
(Keinänen et al., 2024)	Symptom misinterpretation	Diagnostic error	Limited pathways
(Morelatto et al., 2022)	Low public awareness	Limited training	Lack of screening programs
(Varela-Centelles et al., 2017)	Delayed care seeking	Late recognition	Diagnostic system delay

Malignant Transformation of Oral Potentially Malignant Disorders

Some of the studies that were included examined the potential malignant transformation of oral potentially malignant disorders (Table 9). Oral epithelial dysplasia showed one of the highest correlations with malignant progression, making it an important indicator of oral cancer development (Bernard et al., 2023; Hankinson et al., 2021). Epithelial dysplasia has been consistently linked to an increased risk of malignant transformation and the severity of the condition.

Oral leukoplakia was also widely investigated as one of the most common OPMDs associated with malignant transformation (Wang et al., 2018). Research found that the rate of variable transformation was variable based on the lesion features, histological features, and patient risk factors like tobacco or alcohol consumption.

Likewise, oral lichen planus and erosive forms were also studied in some studies because they are chronic inflammatory diseases and may be related to oral carcinogenesis (Chu et al., 2025; Roberts et al., 2024; Tsushima et al., 2021). Despite the lower malignant transformation rates of such lesions compared to the dysplastic lesions, long-term follow-up is crucial.

PVLA proved to have a high potential for malignant transformation that was most prominent in proliferative, which supports the need to diagnose it early and provide aggressive clinical treatment (Zhang et al., 2024).

Table 9. Malignant Transformation Rates of OPMDs

Study	Lesion Type	Sample Size	Transformation Rate
(Wang et al., 2018)	Leukoplakia	1898	~5.3%
(Tsushima et al., 2021)	Oral lichen planus	565	~0.7%
(Nevanpää et al., 2022)	Oral epithelial dysplasia	571	~10.9%
(Zhang et al., 2024)	Proliferative verrucous leukoplakia	36	~33%
(Roberts et al., 2024)	Erosive oral lichen planus	1920	~1.39%

Role of Dental Screening in Early Detection

Table 10 summarizes the role of dental practitioners in the early diagnosis of oral cancer and OPMDs. Some studies have indicated that routine dental check-ups and opportunistic oral screening are important in the detection of suspicious lesions at an early stage (Abadeh et al., 2019; Hertrampf et al., 2022; Psoter et al., 2019).

The dental attendance rate was also associated with earlier diagnosis of oral cancer where dental professionals were considered to be in a vantage position to detect early pathological changes in the oral cavity (Langevin et al., 2012). The conclusion means that systematic oral cancer screening needs to be implemented as an element of routine dental treatment.

Additionally, the education interventions and awareness programme assessment proved the enhancement of dentists in identifying potentially malignant lesions and subsequent referral to specialist care (Morelatto et al., 2022). These findings highlight the necessity of undertaking additional professional education and training to enhance early detection in dental practice.

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Table 10. Role of Dental Screening in Early Detection

Study	Screening Approach	Outcome
(Abadeh et al., 2019)	Dentist biopsy submissions	Increase in dysplasia detection
(Hertrampf et al., 2022)	Routine dental examinations	Suspicious lesions identified
(Langevin et al., 2012)	Regular dental visits	Earlier stage diagnosis
(Psoter et al., 2019)	Dentist screening survey	Multiple suspicious lesions were detected
(Morelatto et al., 2022)	Dentist awareness programs	Improved early diagnosis

Discussion

Oral potentially malignant disorders (OPMDs) preventive measures are a central concern of oral cancer prevention policies, particularly in the primary care environment of dentistry, where periodontal examinations are regularly performed. The findings of this systematic review suggest that dentists are in a key position in detecting suspicious oral conditions and there are still many barriers which prevent the timely detection and referral of potentially malignant conditions (Hankinson et al., 2021). These obstacles are based on a complex of clinical complexity, practitioner awareness, and systemic healthcare factors that interact to affect diagnostic pathways.

The clinical ambiguity of the initial manifestations of OPMD is regarded as one of the most significant problems outlined in the literature. Such lesions as oral leukoplakia, oral lichen planus, and oral epithelial dysplasia are usually accompanied by minor changes in the mucosa that may manifest as benign oral lesions and it is challenging to diagnose them at an early stage (Jaber & Elameen, 2021; Wang et al., 2018). This diagnostic difficulty may lead to delays in the referral or biopsy, especially when lesions are asynchronous or show little morphological alteration. Past research highlights that early diagnosis involves keen observation of the mucosa and sensitivity to risk factors that may lead to malignant transformation (Bernard et al., 2023; Hankinson et al., 2021; Nevanpää et al., 2022).

The other critical consideration is that of the professional preparedness of dental practitioners. Despite the regular check of the oral cavity by dentists, inconsistency in diagnostic confidence and experience can affect the identification of suspicious lesions (Keinänen et al., 2024; Watanabe et al., 2024). The literature exploring the patterns of referrals indicates that some delays are due to confusion when distinguishing between benign lesions and potentially malignant changes, which implies the necessity to enhance clinical training and diagnostic aid (Morelatto et al., 2022). It has also been demonstrated that continuing professional education programmes can increase the awareness of dentists about risk factors of oral cancer and help them to detect early-stage lesions and, hence, help them to refer to specialist assessment earlier (Hertrampf et al., 2022; Morelatto et al., 2022).

Another important theme in the literature is the role of regular check-ups of the mouth in the early detection of cancer. It has been reported that patients who undergo regular dental checkups are diagnosed with oral cancer earlier than those who do not undergo regular dental checkups (Langevin et al., 2012). Dental settings are a valuable avenue of opportunistic screening of OPMDs because dentists often engage in visual and physical screening of the oral mucosa. Enhancement of preventive screening measures when conducting routine dental check-ups could thus play an important role in increasing the rate of early diagnosis (Abadeh et al., 2019; Psoter et al., 2019). Alongside clinician-related variables, structures and referral pathways of healthcare systems are also important factors in diagnostic timelines. Effective communication between the primary dental care provider and the specialist services, such as oral medicine service or oral pathology, is necessary to have a timely assessment of the suspicious lesions. Nevertheless, there can be delays in case of unclear referral systems or restricted access to specialist services (Varela-Centelles et al., 2017). Enhancing referral practices and developing more definite multidisciplinary channels could consequently assist in decreasing the time of diagnosis and aiding in the timely intervention.

The potential of malignant transformation of a number of OPMDs also supports the significance of early diagnosis in dental practice. Oral epithelial dysplasia lesions have shown a consistent association with increased risk of malignant progression, especially in the presence of histological abnormalities (Hankinson et al., 2021; Zhang et al., 2024). Similarly, proliferative verrucous leukoplakia has also been reported as one of the most aggressive lesions with a high potential of malignant transformation (Zhang et al., 2024). Oral lichen planus and oral leukoplakia are

also overly studied due to their prevalence and potential relation to carcinogenesis of the mouth (Chu et al., 2025; Roberts et al., 2024; Tsushima et al., 2021; Wang et al., 2018). The early identification of these lesions will allow closer monitoring, risk stratification, and timely clinical therapy.

On a broader analysis of the problem of the population health, a multifaceted approach to the matter of the improvement of the early diagnosis of OPMDs involves the education of clinicians, the improvement of patient awareness, and the improved access to healthcare services. Some dental practitioners can be provided with educational programs to help increase the accuracy of the diagnosis, and an oral cancer risk factors awareness campaign among the population can encourage the early appearance of the patients (Langevin et al., 2012; Morelatto et al., 2022). In addition, the culture of early detection in primary care centers should be strengthened by integration of structured oral cancer screening process during routine dental check-ups.

Overall, the evidence at hand suggests that, despite the privileged role of dentists as frontline detectors of early mucosal abnormalities, clinical training, screening practices, and patterns of referrals must be systematically improved to achieve the oral cancer prevention potential of dental settings. These elements can ultimately be improved to detect oral cancer earlier and provide better patient outcomes.

Limitations

There are a few limitations that should be taken into account when interpreting the results of this systematic review. First of all, the included studies were extremely diverse in terms of study design, population, and outcome measures, which precluded the possibility of conducting a quantitative meta-analysis and forced the synthesis of the results in a narrative way. Second, most of the studies included employed an observational or retrospective study design, which may bring potential biases and limit the internalization of diagnostic pathways and screening practices as causal relationships. Third, the research was carried out in various geographic areas and healthcare systems, and this could affect referral practices, access to specialist care, and regular dental examination practices. These contextual differences may affect the external validity of the findings to other health care contexts. Additionally, the review has only been done with studies published in English; hence, the possibility of missing other studies published in different languages but may be relevant. Despite such limitations, the review provides an in-depth description of current evidence on the topic of timely identification of oral potentially malignant conditions in dental clinical practice.

Future Research Directions

Future research should aim at addressing the methodological and clinical gaps that are defined in the existing literature. Additional studies on diagnostic pathways and clinical decision-making in dental practice are needed in future cohort studies and multicenter. The comparability across the studies and the strength of evidence base would be enhanced with standardized reporting of oral potentially malignant disorders and malignant transformation outcomes. Additionally, more studies should be done on the effectiveness of organized oral cancer screening programmes in primary dental care practices. It should also consider educational programs to increase awareness and diagnostic confidence of dentists. New diagnostic techniques, including adjunctive screening devices, and computerized imaging, may also serve to improve the early identification of potentially malignant lesions of the oral cavity and warrant further studies.

Conclusion

Early detection of oral potentially malignant conditions is a vital component of oral cancer prevention. During routine oral examination, dental practitioners are at the front line to identify suspicious changes in mucosa. However, the timely identification and referral of potentially malignant lesions in the primary dental care setting still remains unaddressed. Increasing clinical awareness, encouraging screening behavior, and improving referral pathways of dental clinicians and specialist services could contribute to the early detection of oral cancer. It can therefore be an important step towards the improvement of early cancer detection and reduction in the burden of oral cancer, to introduce systematic oral examination protocols as a part of standard dental care.

Declarations

Ethics approval and consent to participate: This study is a systematic literature review that synthesized evidence from previously published peer-reviewed studies. No primary data collection involving human participants, animal subjects, or clinical interventions was conducted. Therefore, ethical approval and informed consent were not

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required.

Consent for publication: The manuscript does not contain any individual person's data or identifiable information. Consent for publication is not applicable.

Availability of data and material: All data are derived from publicly available peer-reviewed articles. The search strategy and data extraction framework are fully described in the Methodology section. No primary datasets were generated. Inquiries may be directed to the corresponding author.

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