

The Role of Teledentistry in the Early Detection of Oral Lesions: A Systematic Review of Diagnostic Accuracy

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ARTICLE INFO	ABSTRACT
<p>Manuscript Received: 21 Nov, 2025 Revised: 06 Mar, 2026 Accepted: 25 Apr, 2026 Date of Publication: 12 Jun, 2026 Volume: 9 Issue: 6 DOI: 10.56338/mppki.v9i6.9159</p>	<p>Introduction: Diagnosis of oral lesions, especially potentially malignant lesions, is complicated by their asymptomatic presentation and variable clinical appearance. Delayed diagnosis in rural areas where there are few specialists may lead to high morbidity and mortality rates. The use of teledentistry as an innovative tool to detect oral lesions has been explored. The present study aims to explore the application of teledentistry for the early diagnosis of oral lesions, examining diagnostic accuracy, advantages, clinical challenges, and future potential.</p> <p>Methods: Publications from the last 10 years were chosen based on specific inclusion criteria. The present systematic review was conducted in accordance with the PRISMA guidelines. Studies assessing diagnostic accuracy were critically appraised using the QUADAS-2 tool, while other types of studies were critically appraised using the appropriate JBI critical appraisal tool. In total, 11 studies were included.</p> <p>Results: The majority of the research used store-and-forward (SAF) methods, with some using real-time consultations. Studies have indicated that there is a high level of agreement with face-to-face consultation ($\kappa > 0.80$). It was recognized that it avoids unnecessary referrals as well as improves access to healthcare services in areas with minimal medical facilities. The limitations involved are problems relating to imaging quality, the need for palpation, and proper training of the operators involved.</p> <p>Conclusion: Teledentistry serves as a useful alternative for diagnosing mouth lesions in their initial stages. Despite the fact that it does not substitute for face-to-face consultations, it can be an potential screening and triage tool.</p>
<p>KEYWORDS</p> <p>Teledentistry; Oral Lesions; Early Diagnosis; Telemedicine; Digital Health</p>	

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INTRODUCTION

Oral lesions, especially potentially malignant disorders, have emerged as a significant global health problem characterized by high incidences of morbidity and mortality. Orally, cancer stands at the eight position amongst other cancers with over 300,000 new cases per annum and 145,000 deaths annually. The major problem associated with the treatment of oral lesions is late diagnosis, especially in remote areas where experts are not easily accessible, leading to an increase in mortality rates and lowering of patients' quality of life (1).

Telemedicine has rapidly evolved as a solution to address limited access to healthcare services, particularly during the COVID-19 pandemic, which expedited the integration of technological advances in medical practice. Teledentistry, a branch of telemedicine in dentistry, offers an innovative approach for remote diagnosis and management of oral conditions (2). Teledentistry encompasses store-and-forward (SAF) solutions enabling asynchronous communication between the patient and the doctor at different times (for example, through a chat application) as well as real-time (RT) solutions facilitating direct online interaction (for example, a video conference). Teledentistry could allow electronic health record transfer, teleconsultation, tediagnosis, online therapeutic planning, follow-up, remote patient tracking, online studies, and teleeducation.

The oral cavity has a complex anatomy involving various medical specialties and oral health experts. Numerous physiological variations and differential diagnoses can confuse clinicians (3). The visual accessibility of many oral lesions makes teledentistry, combined with oral cavity photography, particularly useful in oral medicine. Although teledentistry does not entirely replace the traditional approach of conducting physical oral exams, the quick exchange of photos between healthcare practitioners makes it possible to obtain specialist consultations and make changes to treatment sooner.

It is important to diagnose premalignant lesions to initiate treatment. Early-stage oral cancer does not show symptoms such as ulcerations, bleeding, or indurations. It was reported in India and Malaysia that smokeless tobacco, such as chewing betel, is common. Infections, sun exposure, oral hygiene, and genetics are among other risk factors. The diagnosis process is frequently delayed in rural regions due to a lack of experts and limited resources, facilitating the emergence of potentially malignant oral diseases. Teledentistry has the potential to help address these issues (4).

Previous research has demonstrated the potentialness of teledentistry in various aspects of dental care. Estai et al. (2018) found that teledentistry can reduce unnecessary referrals by up to 40% and save patient transportation costs (3). Meanwhile, Birur et al. (2015) reported that mobile applications for oral cancer screening have 95% sensitivity and 81% specificity in identifying suspicious oral lesions. Perdoncini et al. (2021) also showed 92.7% agreement between their synchronous teleconsultation study's tediagnosis and reference standards ($k = 0.922$) (5).

Though these studies have positive outcomes, they differ in terms of study design and outcome. Estai et al. concentrate on the systemic advantages of reduced referrals and costs, while Birur et al. and Perdoncini et al. concentrate on the diagnostic accuracy of teledentistry through sensitivity, specificity, and agreement. It would seem that teledentistry is both a service delivery innovation and a diagnostic innovation. The results of these studies support a theoretical framework that proposes teledentistry as a screening/triage tool.

Although teledentistry has been increasingly investigated in the context of dental healthcare, previous systematic reviews have mainly focused on general applications of teledentistry, such as teleconsultation schemes, patient triage, and follow-up. There have been some meta-analyses on teledentistry performance for specific diagnoses, but these tended to combine different dental conditions without isolating the implementation of early oral lesion detection. In addition, previous systematic reviews have tended to focus either on diagnostic accuracy or feasibility, and rarely have they combined both aspects in a single framework.

Thus, the current understanding of teledentistry performance as a diagnostic tool while also being feasible in real-world healthcare systems is still not comprehensive. To fill this knowledge gap, this systematic review combines diagnostic performance with the challenges of implementation, particularly in areas where early detection of potentially malignant oral disorders is of prime importance.

The purpose of this study is to explore the use of teledentistry to early diagnose oral lesions from the aspect of the diagnostic accuracy, advantages, clinical challenges, and future potential. The results of this research are expected to provide strong scientific evidence to optimize the implementation of teledentistry in early detection of oral lesions, particularly in resource-limited areas.

METHOD

This systematic review was carried out following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 guidelines. Because of heterogeneity in study design, population, and outcomes, a meta-analysis is not feasible. A comprehensive literature search was carried out on PubMed, Scopus, and Google Scholar up to March 26, 2025. The literature search strategies for each database along with the use of Boolean operators and keywords.

This systematic review is not registered on the PROSPERO database. However, a protocol for this systematic review is developed before the inclusion of studies for extraction of data for ensuring the highest level of methodological rigor. For evaluating the quality of included studies, the QUADAS-2 tool is used for diagnostic accuracy studies. Other studies were assessed using a variety of critical appraisal tools provided by the Joanna Briggs Institute.

Literature Search Strategy

A comprehensive literature search was conducted in Google Scholar, PubMed, and Scopus from database inception to March 26, 2025. The following keywords are included:

Table 1. The keywords for literature research

Teledentistry	("Teledentistry"[MeSH] OR "telemedicine in dentistry"[tiab] OR "Teleconsultation" [tiab] OR "Teleconsultation in Dentistry" [tiab])
Oral Lesions	("Oral lesions"[MeSH] OR "oral mucosal lesion" [tiab])
Diagnosis	("Early diagnosis" [MeSH] OR "early detection" [tiab] OR "screening" [tiab] OR "digital oral screen" [tiab])

The three concept groups were combined using the Boolean operator AND in each database search

Inclusion and Exclusion Criteria

Eligible Studies were those that were original research articles on the role of teledentistry in the detection or assessment of oral lesions. The studies were eligible if they were: (1) quantifiable study on the diagnostic performance of teledentistry, including sensitivity, specificity, positive predictive value, negative predictive value, and kappa statistics of teledentistry compared to a reference standard; or (2) quantifiable study on clinical implementation/feasibility of teledentistry services in relation to the impact of teledentistry on the early detection of oral lesions.

Studies that were not included were those that were not eligible based on the inclusion criteria, such as literature reviews, meta-analyses, conference abstracts, studies on a single case or case series of less than 10 cases, studies without clinical application of teledentistry, studies on the technical aspects of teledentistry without data on clinical impact, studies without data on quantification of teledentistry's impact on the detection of oral lesions and studies without access to full text were excluded.

Screening and Selection

The records obtained from the databases were imported into EndNote to remove duplicates. Title and abstract screening was done by the primary researcher according to the predetermined inclusion criteria. Final evaluation of the inclusion criteria for the full text and inclusion of the records was reviewed and approved in consultation with the second researcher (supervising author).

Quality Appraisal

The quality of the diagnostic accuracy studies was assessed using the QUADAS-2 tool, while the quality of the descriptive, cross-sectional, and feasibility studies was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklists, depending on the type of study. The appraisal was done by the first author, and the results were checked and validated by the supervisor.

Data Extraction

All articles searched from PubMed, Scopus, and Google Scholar were imported into EndNote software. The selection process was carried out step by step by the primary author. The first page stage involves title and abstract screening based on predefined inclusion and exclusion criteria. Articles that met the initial criteria were then reviewed in full text to confirm their eligibility according to the study objectives.

Data extraction was performed manually using a Microsoft Excel spreadsheet, where each study was recorded according to key variables including author, publication year, and country; study design sample size and population characteristics; type of teledentistry technology (store-and-forward or real-time); hardware and software used; diagnostic method and reference standards and main outcomes such as sensitivity, specificity, accuracy, and reported image quality.

RESULTS

A total of 140 records were identified and 138 were screened after duplicate removal. Following title and abstract screening, 117 records were excluded. Twenty-one full-text articles were assessed for eligibility, and 10 were excluded. Ultimately, 11 studies were included in the final synthesis.

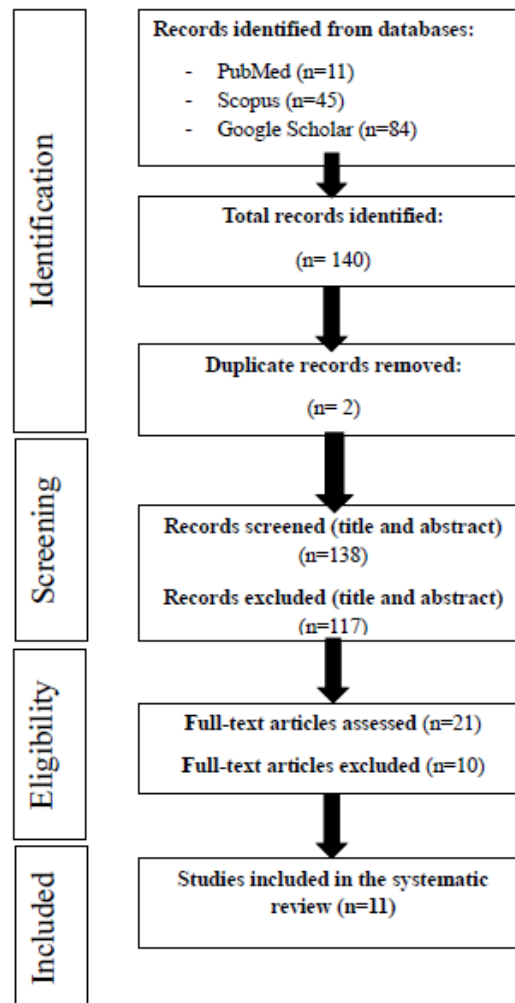


Figure 1. PRISMA Flow Diagram

Characteristics of the included studies

Table 1. Review of Teledentistry Studies: Diagnostic Accuracy

Author (year)	Country	Telemedicine Mode	N	Sensitivity (%)	Specificity (%)	Reference Standard	Lesion Type	Care Setting	Blinding
Akeel et al (2024) (6)	Saudi Arabia	Store-and-forward	49	85	100	Expert Panel Validation	Simulated oral lesion cases	Specialist-based survey	Not applicable
Fonseca et al (2021) (8)	Brazil	Store-and-forward	113	97	86,5	Face-to-face clinical diagnosis	Oral Mucosal Lesions	Clinical setting	NR
Gomez et al (2025) (9)	Chile	Store-and-forward	20	88,6	85,8	Histopathology and expert	Benign, Premalignant, and Malignant Lesions	University oral medicine clinic	NR
Mitbender et al (2025) (11)	USA	Store-and-forward	149	93,9	79,3	Histopathology and expert	Oral Mucosal lesions include cancer	University cancer centers	NR
Niknam, et al (2024) (13)	Malaysia	Store-and-forward	NR	NR	NR	Direct clinical examination	Oral Lesions	University Clinic	Yes
Perdoncini et al (2021) (15)	Brazil	Real-time	38	NR	NR	Direct clinical examination by a second specialist	Suspicious oral lesions	Primary care referral	Yes
Birur N et al (2019) (5)	India	Store-and-forward	344	84,7	97,6	Histopathology	Oral potentially malignant disorders	Community	Yes

Table 2. Interpretive Findings: Impact, Challenge, and Potential

Author (year)	Country	Telemedicine Mode	Impact	Challenge	Potential
Akeel et al (2024) (6)	Saudi Arabia	Store-and-forward	Teledentistry enhances early detection of oral diseases and their management.	The Image quality may be different	The potential of teledentistry to reduce costs, travel, and waiting times for patients
Cardozo et al (2021) (7)	Brazil	Store-and-forward	Teleconsultations can decrease unnecessary referrals to specialists	Lack of patient’s history, such as age, gender, time of evolution, habits, and medications	The potential of teledentistry to improve oral health care and reduce inequities
Fonseca et al (2021) (8)	Brazil	Store-and-forward	It quickly identifies oral lesions and refer patients to the most suitable treatment	The need of technology and photography training for dentists	Telemedicine enhances healthcare access and efficiency across distances
Gomez et al (2025) (9)	Chile	Store-and-forward	strong performance in identifying oral mucosal lesions	This new mode of care does not require eliminating in-	The findings suggest that oral medicine specialists provide

			through digital images.	person clinical care, including medical history, palpation, and dentist-patient communication.	reliable diagnostic guidance through e-consultation
Haron et al (2019) (10)	Malaysia	Store-and-forward	The app (MeMoSA) promotes early intervention and reduces missed diagnoses	MeMoSA has not yet been integrated into the national health care system	MeMoSA is potentially to be used to early detection of OC (oral cancer)
Mitbender et al (2025) (11)	USA	Store-and-forward	mDOC enhances early detection of oral precancers and cancers in primary care settings	Lack of expertise general dentists can lead to delayed referrals and diagnosis	The mDOC can decrease unnecessary referrals to specialists
Nguyen et al (2023) (12)	USA	Real-time	Telehealth can improve referral compliance in low-resource populations, with 83% completing telehealth visits	The brief in-person training is important, as without this training, they may face adoption challenges	The telehealth platform was user-friendly, requiring minimal technical skills.
Niknam, et al (2024) (13)	Malaysia	Store-and-forward	OralMedTeledent demonstrates excellent reliability for diagnosing oral lesions	The usability improvements are needed to enhance user comfort and potentialness in daily clinical practice.	OralMedTeledent has a diagnosis rate almost the same as face-to-face diagnosis.
Northridge, et al (2022) (14)	USA	Real-time	It reduced waiting times, improved patient compliance, and enhanced documentation of lesions.	telementoring for training dental residents and educating patients.	Enhanced Early Detection of Oral Cancer
Perdoncini et al (2021) (15)	Brazil	Real-time	Teleconsultation enhances early detection of oral precancers and reduces unnecessary referrals	Video call-based teleconsultation depends on the internet connection and device used.	Enhanced Early Detection of Oral Cancer
Birur N et al (2019) (5)	India	Store-and-forward	Teledentistry enhances early detection of oral diseases in rural areas	the Image quality may be different	mHealth benefits for long-term follow-up and monitoring

Quality Appraisal Results

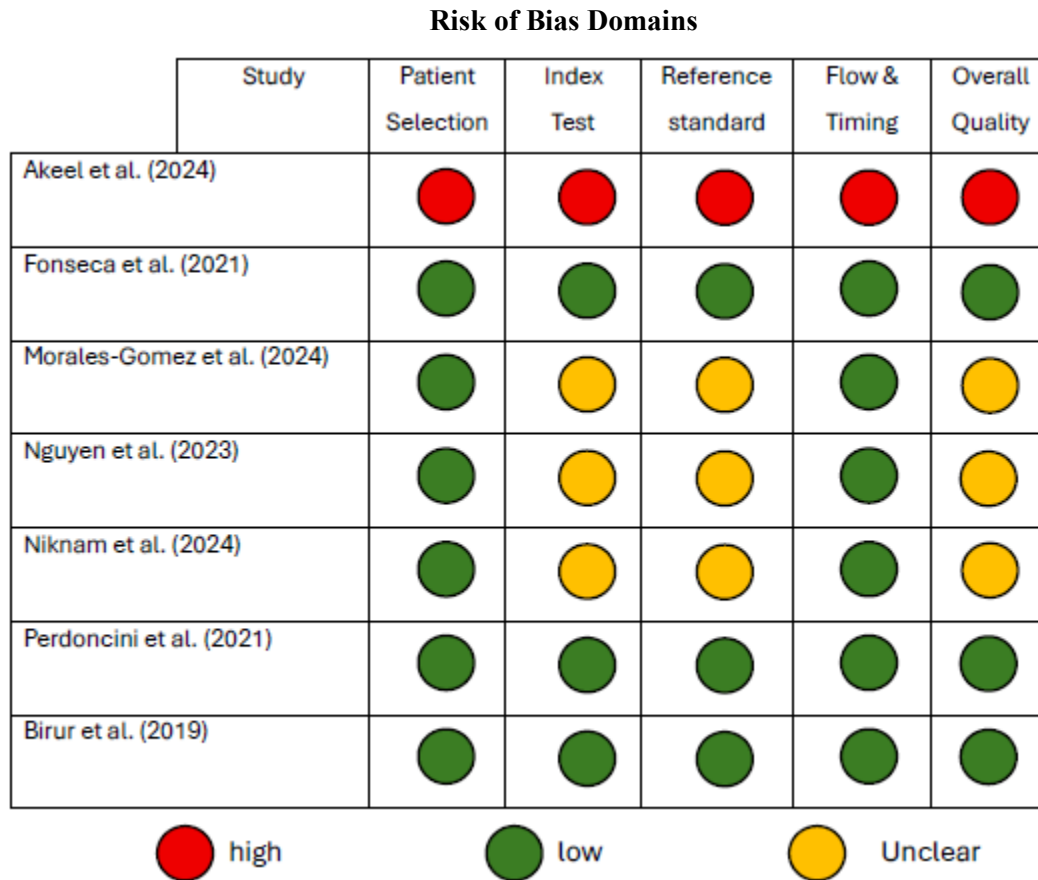


Figure 2. Traffic light plot for the risk of bias assessment using the QUADAS-2 tool for the diagnostic accuracy studies. The risk of bias assessment domains considered were patient selection, index test, reference standard, and flow and timing. Green represents low risk, yellow represents unclear risk, while red represents high risk.

Table 4. Methodological Quality Assessment Using JBI Checklist

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Overall Quality
Cordozo et al. (2024)	Yes	Yes	Unclear	Unclear	No	Yes	Yes	Moderate
Haron et al. (2019)	Yes	Yes	Unclear	Unclear	No	Yes	Yes	Moderate
Mitbander et al. (2025)	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	Moderate
Northridge et al. (2023)	Yes	Yes	Unclear	Yes	No	Yes	Yes	Moderate

Q1 = Clear inclusion criteria

Q2 = Study subject and setting described

Q3 = Exposure measured validity and reliably

Q4 = Objective and standard criteria for measurement

Q5 = Confounding factors identified

Q6 = Strategies to deal with confounding factors

Q7 = Appropriate statistical analysis

The questions Q1-Q7 refer to the seven domains of the JBI Critical Appraisal Checklist. A "Yes" indicates that the criteria were met, "No" indicates that the criteria were not met, and "Unclear" indicates that the criteria were not met due to poor reporting. The quality was assessed on the basis of the criteria met.

DISCUSSION

Risk of Bias Assessment

The presence of unclear risk in both the index text and reference standard domains suggests potential limitations in diagnostic interpretations. It also indicates a lack of standardized assessment protocols, which may contribute to variability in these outcomes. This issue is particularly relevant in teledentistry, where image quality, examiner experience and the absence of direct clinical examination can affect diagnostic performance.

Access Barriers and the Role of Teledentistry

Based on the article search, 11 articles were obtained, where the articles were conducted in developing and developed countries. In developing countries such as Malaysia, Brazil, and Chile, while in developed countries such as Saudi Arabia and the USA. Adequate medical and dental services for both daily and emergency needs are essential in both developed and developing countries (27). This often occurs in developing countries, where access to health services is difficult and there are limited health workers, especially specialists. High treatment costs and inadequate infrastructure are obstacles to dental health services. The existence of disparities in dental health services in remote areas makes various ways to overcome it, one of which is by using *teledentistry*.

Teledentistry Mode in Oral Lesions Diagnosis

This systematic review identifies some of the main methodologies used in teledentistry for the diagnosis of oral lesions. In general, these methodologies can be categorized into two main approaches: store-and-forward (asynchronous) and real-time (synchronous).

Store-and-Forward (Asynchronous)

Teledentistry has two main methods of use: direct consultation (real-time) and the save and forward method (store-and-forward). Both methods are potential in the early diagnosis of oral lesions and in reducing unnecessary referrals. Fonseca et al. (2021) reported the use of smartphone photography for telediagnosis of oral lesions, where images were emailed along with clinical information to the evaluator (8). This study showed that telediagnosis was similar to the gold standard in 76% of cases, with kappa coefficients showing near-perfect agreement ($k = 0.817-0.903$). A mobile detection of oral cancer (mDOC) imaging system, a smartphone-based autofluorescence and white light imaging device that takes pictures of the oral cavity, was also created in a study by Mitbander et al. (2025) (11). A sensitivity of 93.9% and a specificity of 79.3% were demonstrated by the multimodal image classification algorithm designed to provide "refer" or "no refer" recommendations from mDOC pictures in relation to expert clinical referral judgments.

Real-Time (Synchronous)

Not only the method of store-and-forward, which is potential in diagnosing oral lesions, but also the method of real-time, such as telephone-based teleconsultation video *call* proven reliable for remote diagnosis of oral lesions (15). This study assessed the feasibility and accuracy of synchronous teleconsultation in oral medicine via video call using a smartphone application (WhatsApp). It was found that in 92.7% of cases, there was a match between telediagnosis and the reference standard ($k = 0.922$), with an average length of teleconsultation of around 10 minutes. In addition, research conducted by Nguyen et al. (2023) stated that the level of compliance of patients who consulted via video call was higher for continuing referrals compared to patients who consulted face-to-face (12).

Devices and Applications

Various devices and applications are used in teledentistry for the diagnosis of oral lesions. Haron et al. (2019) developed a mobile application called Mobile Mouth Screening Anywhere (MeMoSA) to facilitate early detection of oral cancer (10). The application allows documentation of oral lesions and communication between dentists and specialists for management decisions. The study found that 12 out of 48 patients had oral lesions or signs suspicious for cancer, and 3 required referral. Niknam et al. (2024) evaluated the reliability of a web-based teleconsultation system for the remote diagnosis of oral lesions (13). Despite identifying 66 usability issues, the system demonstrated substantial significant performance ($0.81 \leq \kappa < 1$; $P > 0.05$) in a reliability test with 109 participants. Akeel et al. (2024) reported that 23 out of 49 oral medicine specialists in Saudi Arabia had previous experience with teledentistry, especially via WhatsApp (95.7%). This study showed correct diagnosis scores ranging from 73.50% to 100%, and correct management ranging from 51% to 98%.

Accuracy of Teledentistry Diagnosis

One of the interesting findings from this systematic review is the high degree of diagnostic agreement between teledentistry and face-to-face assessment that was reported by the majority of studies reviewed. Some studies reported κ values of 0.80 or even higher, which indicate high agreement between teledentistry and face-to-face assessment. It should be noted that κ values are affected by the prevalence of lesions, the structure of diagnostic categories, expert raters, and blinding.

Perdoncini et al. (2021) reported a 92.7% agreement between telediagnosis and the reference standard ($k = 0.922$) in their synchronous teleconsultation study (15). Fonseca et al. (2021) found that telediagnosis was similar to the gold standard in 76% of cases, with a kappa coefficient indicating near-perfect agreement ($k = 0.817-0.903$). A study by Morales-Gómez et al. (2025) compared the performance of oral medicine specialists and general dentists in diagnosing oral mucosal lesions through digital images in Chile (16). The study found that specialists showed a higher proportion of correct diagnoses than general dentists (86.5% vs 49.2%). Specialists also showed higher sensitivity (88.5% vs 59.3%) and greater specificity (85.8% vs 48.6%) in the diagnosis of oral cancer and potentially malignant oral disorders compared to benign oral lesions.

This study is in line with the study of Mitbander et al. (2025), who reported that the multimodal image classification algorithm developed for the mDOC imaging system showed a sensitivity of 93.9% and a specificity of 79.3% with respect to expert clinical referral decisions (11). This shows the potential of using artificial intelligence in improving the diagnostic accuracy of teledentistry. Akeel et al. (2024) found that the correct diagnosis score ranged from 73.50% to 100% in their teledentistry study in Saudi Arabia (6). This variation in diagnostic accuracy may be related to the complexity of the cases and the quality of the images transmitted(17).

Advantages of Teledentistry in Early Diagnosis of Oral Lesions

This systematic review identified several significant advantages of teledentistry in the context of early diagnosis of oral lesions:

Improving Access to Healthcare

Teledentistry significantly improves access to oral medicine specialist services, especially for patients in remote or resource-limited areas. Cardozo et al. (2021) reported the use of a telehealth platform in southern Brazil to connect primary care dentists with oral medicine specialists, allowing patients in remote areas to receive diagnoses and treatment recommendations without the need for long-distance travel (7). The Malaysian platform MeMosa has the potential to promote care and accelerate early detection of oral cancer in low- and middle-income countries. The application allows dentists in remote areas to consult with specialists for cases that suggest oral lesions. Akeel et al. (2024) noted the role of teledentistry in addressing the shortage of specialists in rural areas of Saudi Arabia (6). This study suggests that teledentistry can play a significant role in patient management in areas with limited specialist resources.

Reduction of Unnecessary Referrals

The advantage of teledentistry in the referral system can reduce unnecessary referrals to specialists. A study conducted by Cardozo et al. (2021) reported that specialists considered 48.1% of cases could be resolved in primary care without referral, saving time and resources for both patients and the health system (7). Fonseca et al. (2021) found that evaluators considered referrals to be avoidable on average in 35.4%. This shows the potential of teledentistry in optimizing the use of limited specialist resources (8). Perdoncini et al. (2021) mentioned the reduction of unnecessary referrals as one of the practical implications of synchronous teleconsultation in oral medicine (15). By enabling general dentists to consult with specialists in real-time, cases that can be managed at the primary care level can be identified, reducing the burden on specialist services(18).

Early Detection of Precancerous Lesions and Oral Cancer

One of the most important aspects of teledentistry is the potential to improve early detection of precancerous lesions and oral cancers. Mitbander et al. (2025) developed a specialized mDOC imaging system to aid in the early detection of oral cancer (11). This system demonstrated high sensitivity (93.9%) in identifying cases requiring referral to an oral cancer specialist. A study by Haron et al. (2019) reported that the MeMoSA application can facilitate early detection of oral cancer through documentation of oral lesions and communication between dentists and specialists (10). In their study, 12 out of 48 patients were found to have oral lesions or signs suspicious for cancer. This is in line with a study by Morales-Gómez et al. (2025) showing that oral medicine specialists have high sensitivity (88.5%) in diagnosing oral cancer and potentially malignant oral disorders through digital imaging (16).

Improving Patient Compliance

Nguyen et al. (2023) evaluated the impact of telehealth on specialist referral adherence in individuals with positive oral cancer risk screening results (12). The study found that adherence was 30% in the face-to-face group and 83% in the telehealth group. Overall, 72.5% of subjects who had selected a remote first specialist visit had entered the continuum of care by the end of the study, compared with only 25% of individuals in the face-to-face specialist group. This suggests that a two-step approach using telehealth may improve specialist referral adherence in individuals from low-resource, minority, and underserved populations.

Improving the capability of Healthworker

Research by Birur et al (2019) was conducted in a factory workplace with a high-risk population for tobacco use (5). The results of the study stated that initial screening carried out by CHW (Community Health Workers) assisted by MHealth, significantly increased the capability to detect potentially malignant oral mucosal lesions(19,20).

Challenges and Limitations of Teledentistry

Teledentistry has various advantages, but in its implementation, there are several challenges and limitations in the diagnosis of oral lesions.

Image Quality

Image quality is a critical factor affecting diagnostic accuracy in teledentistry. Perdoncini et al. (2021) stated that image quality was one of the factors affecting the accuracy of tediagnosis in their synchronous teleconsultation study (15). Unclear or unfocused images can affect the specialist's ability to diagnose oral lesions accurately. In addition, Cardozo et al. (2021) reported that no images were attached in 11.70% of cases in the study (7). This shows the challenges in ensuring the quality and completeness of the data transmitted for tediagnosis(21).

Limitations in Clinical Examination

One of the major limitations of teledentistry is the inability to perform clinical examinations such as palpation. This examination is an important component in the diagnosis of various oral lesions, especially submucosal lesions. Akeel et al. (2024) stated that the need for clinical palpation is one of the challenges in teledentistry (6). Morales-Gómez et al. (2025) noted that the margin of error in telediagnosis must be considered, especially for lesions that require palpation or additional examination (16). This suggests that teledentistry may not be able to completely replace direct clinical examination for all types of oral lesions.

Limited Access to Technology

Teledentistry can improve access to care, but its use is still limited by technology, infrastructure, and resources (22). Haron et al. (2019) highlighted the challenges in implementing the MeMoSA application in low- and middle-income countries, including limited access to technology and infrastructure (10). Nguyen et al. (2023) noted that although telehealth can improve specialist referral compliance, there are still challenges in implementing it in low-resource, minority, and underserved populations (12).

Training and Standardization Needs

Teledentistry in its use still requires training for both dentists and other health workers. Northridge et al. (2022) emphasized the importance of training dentists in the use of intra-oral cameras and telementoring systems (14). This suggests that potential implementation of teledentistry requires adequate training for health professionals.

Health Worker's Readiness in Implementing Teledentistry

A study conducted by Akeel et al (2024) among health workers, of the 49 participants, 23 (46.9%) had previous experience in using teledentistry services, with the majority of utilization being done via the WhatsApp application (95.7%) (6). This reflects that health workers have begun to get used to using digital platforms in clinical communication. These findings indicate that health workers are willing to accept and integrate teledentistry into their clinical practice, although challenges such as training needs, protocol standards, and integration of electronic medical record systems still need to be addressed for wider and sustainable implementation. This is in line with previous research which states that there is a positive perception towards the implementation of telehealth services due to their potential to improve clinical practice efficiency and patient advantages (28).

Future Potential and Clinical Implications

Teledentistry shows great potential for the diagnosis and management of oral lesions in the future:

Integration with Artificial Intelligence

Research conducted by Mitbander et al. (2025) has led to the formation of an algorithm for image classification in the mDOC imaging instrument, which was extremely sensitive and specific in detecting those images which needed a specialist consultation for oral cancer (11). This indicates the potential application of this technique in future research whereby artificial intelligence is integrated into teledentistry to aid in diagnosis without much dependence on the subjectivity involved in image interpretation. The advancement of deep learning techniques and computer vision algorithms could make teledentistry more potential in oral lesion detection and classification (23).

Integrated Platform Development

According to Cardozo et al. (2021) an example of the incorporation of teledentistry technology in the health system is the use of Telessaúde Brasil Redes in southern Brazil (7). This shows how potential it can be to integrate teledentistry in the health care system to ensure continuity of services.

Improving Access in Remote Areas and Vulnerable Populations

A Study done by Nguyen et al. (2023) showed that a two-step approach using telehealth can improve specialist referral compliance in individuals from low-resource, minority, and underserved populations (12). This shows the potential of teledentistry in addressing health disparities and improving access to care for vulnerable populations. Haron et al. (2019) highlighted the potential of MeMoSA applications in promoting equitable health care in low- and middle-income countries (24). With the development of mobile technology and increasing smartphone penetration, teledentistry can reach populations previously underserved by conventional health services (25).

Standardization of Protocols and Regulations

The study by Morales-Gómez et al. (2025) emphasized the importance of standardization in the telediagnosis of oral mucosal lesions to improve diagnostic accuracy (16). Such as standardization in image acquisition, data format, and diagnostic criteria. Akeel et al. (2024) mention the need for further research with a larger sample size and collaboration with international centers to confirm their findings on the potentialness of teledentistry(6). This shows the importance of international collaboration in developing standards and protocols for teledentistry.

Integration in Education and Training

Teledentistry plays a role in the education and training of dental health professionals. Research by Northridge et al. (2022) demonstrated the potential of telementoring using an intra-oral camera to train dentists in detecting and identifying oral lesions (14). Morales-Gómez et al. (2025) demonstrated a significant difference in diagnostic accuracy between oral medicine specialists and general dentists in interpreting digital images of oral lesions (16). Integrating teledentistry into dental education curricula can prepare a new generation of dentists to use this technology potentially in clinical practice (26).

Recommendations for Future Research

There is a need to investigate the design and validation of AI-enabled tele-dentistry systems as additional diagnostic tools in the future. Economic analysis is required to prove cost-potentialness in various settings. Research regarding the effect of teledentistry on healthcare professional capacity building in the early detection of oral lesions is highly recommended, since this is one of the areas where much less information can be found. Moreover, separate investigations concerning various oral lesions are necessary for the determination of diagnostic efficacy.

CONCLUSION

As compared to the previous systematic reviews conducted, which were primarily concentrated on teledentistry in general applications, the present systematic review was mainly based on teledentistry applications for early detection of oral lesions in different settings, whether in developing or developed countries like the US and Saudi Arabia. As shown in our analysis, teledentistry applications, both asynchronous and synchronous, are potential means for the early detection of oral lesions. In most of the studies analyzed, κ values above 0.80 were noted, indicating considerable agreement between teledentistry and face-to-face consultations. Nevertheless, interpretation of these results must be carefully done, considering their varying methodological quality and biases associated with them. One of the notable strengths of using teledentistry for diagnosing oral lesions is that it greatly improves access to oral health care services. The use of teledentistry systems minimizes unnecessary referrals and ensures better optimization of healthcare resources. Also, this technology helps to detect precancerous or cancerous lesions at an earlier stage. Other advantages of teledentistry include increased compliance of patients to post-visit care and enhanced diagnostic capacity of healthcare practitioners owing to expert consultations. There are certain issues associated with the implementation of this approach despite its benefits. Firstly, image quality is a vital issue that may affect the accuracy of diagnosis. The inability to conduct thorough clinical examination including palpation hampers the evaluation of certain features of lesions. Some areas have limited access to technology. Moreover, insufficient expertise and lack of guidelines impede the use of the system. The potential future of teledentistry is

certainly noteworthy. The integration of teledentistry into artificial intelligence will enhance the accuracy and efficiency of diagnoses. The implementation in government-based health organizations will make teledentistry more feasible. Moreover, teledentistry offers its own strengths, which can contribute to enhanced accessibility to specialists for rural and underserved communities. It is crucial to create guidelines and regulations that will ensure the provision of high-quality services using teledentistry. Finally, teledentistry should be incorporated into the dental educational program.

AUTHOR CONTRIBUTION STATEMENT

Miura A. Kuswara: Conceptualization, data collection, analysis, and manuscript writing.
Merita Arini: Supervision and review.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors used AI-assisted tools for language editing purposes only. All intellectual content remains the responsibility of the authors.

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BIBLIOGRAPHY

1. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin.* 2018;68(6):394–424. <https://doi.org/10.3322/caac.21492>
2. Vigaros E, Warnakulasuriya S, Piau A, Giraudeau N, Maret D. Early detection of oral malignancies may involve the development of tele-expertise in dentistry. *Oral Oncol.* 2022;130:105904. <https://doi.org/10.1016/j.oraloncology.2022.105904>
3. Estai M, Kanagasingham Y, Mehdizadeh M, Vignarajan J, Norman R, Huang B, et al. Teledentistry as a novel pathway to improve dental health in school children: a research protocol for a randomised controlled trial. *BMC Oral Health.* 2020;20(1):11. <https://doi.org/10.1186/s12903-019-0992-1>
4. Vinayagamoorthy K, Acharya S, Kumar M, Pentapati KC, Acharya S. Efficacy of a remote screening model for oral potentially malignant disorders using a free messaging application: A diagnostic test for accuracy study. *Aust J Rural Health.* 2019;27(2):170–176. <https://doi.org/10.1111/ajr.12496>
5. Birur PN, Sunny SP, Jena S, Kandasarma U, Raghavan S, Ramaswamy B, et al. Mobile health application for remote oral cancer surveillance. *J Am Dent Assoc.* 2015;146(12):886–894. <https://doi.org/10.1016/j.adaj.2015.05.020>
6. Akeel S, Almazroa S, Ali SA, Alhindi NA, Alhamed S, Felemban OM, et al. Assessing Tele-Oral Medicine in Saudi Arabia: A Cross-Sectional Study on Specialists' Experiences and Potentialness in Oral Healthcare. *Healthcare.* 2023;11(23):3089. <https://doi.org/10.3390/healthcare11233089>
7. Cardozo I, Silva VC da, Perdoncini NN, Torres-Pereira CC. Telehealth in Oral Medicine: report of an experience from public health care in a southern Brazilian state. *Braz Oral Res.* 2022;36:e031. <https://doi.org/10.1590/1807-3107bor-2022.vol36.0031>

8. Fonseca BB, Perdoncini NN, da Silva VC, Gueiros LAM, Carrard VC, Lemos CA, et al. Telediagnosis of oral lesions using smartphone photography. *Oral Dis.* 2022;28(6):1573–1579. <https://doi.org/10.1111/odi.13972>
9. Gomes MS, Bonan PRF, Ferreira VYN, de Lucena Pereira L, Correia RJC, da Silva Teixeira HB, et al. Development of a mobile application for oral cancer screening. *Technol Health Care.* 2017;25(2):187–195. <https://doi.org/10.3233/THC-161259>
10. Haron N, Zain RB, Ramanathan A, Abraham MT, Liew CS, Ng KG, et al. m-Health for Early Detection of Oral Cancer in Low- and Middle-Income Countries. *Telemed E Health.* 2020;26(3):278–285. <https://doi.org/10.1089/tmj.2018.0285>
11. Mitbander R, Brenes D, Coole JB, Kortum A, Vohra IS, Carns J, et al. Development and Evaluation of an Automated Multimodal Mobile Detection of Oral Cancer Imaging System to Aid in Risk-Based Management of Oral Mucosal Lesions. *Cancer Prev Res (Phila).* 2025;18(4):197–207. <https://doi.org/10.1158/1940-6207.CAPR-24-0253>
12. Nguyen J, Takesh T, Parsangi N, Song B, Liang R, Wilder-Smith P. Compliance with Specialist Referral for Increased Cancer Risk in Low-Resource Settings: In-Person vs. Telehealth Options. *Cancers (Basel).* 2023;15(10):2775. <https://doi.org/10.3390/cancers15102775>
13. Niknam F, Mardani M, Bastani P, Bashiri A, Ha D, Sookhakian A, et al. Assessing the usability and reliability of a web-based teledentistry tool for remote diagnosis of oral lesions: a cross-sectional study. *BMC Oral Health.* 2024;24(1):1094. <https://doi.org/10.1186/s12903-024-04696-7>
14. Northridge ME, Littlejohn T, Mohadjeri-Franck N, Gargano S, Troxel AB, Wu Y, et al. Feasibility and Acceptability of An Oral Pathology Asynchronous Tele-Mentoring Intervention: A Protocol. *J Public Health Res.* 2020;9(1):1777. <https://doi.org/10.4081/jphr.2020.1777>
15. Perdoncini NN, Schussel JL, Amenábar JM, Torres-Pereira CC. Use of smartphone video calls in the diagnosis of oral lesions. *J Am Dent Assoc.* 2021;152(2):127–135. <https://doi.org/10.1016/j.adaj.2020.10.013>
16. Morales-Gómez C, Ojeda-Uribe G, Adorno-Farías D, Maturana-Ramirez A, Espinoza-Santander I. Telediagnosis performance of specialists in oral medicine and general dental practitioner using images of oral mucosa lesions in Chile. *Med Oral Patol Oral Cir Bucal.* 2025;30(1):e49–e55. <https://doi.org/10.4317/medoral.26825>
17. Uhrin E, Domokos Z, Czumbel LM, Kóti T, Hegyi P, Hermann P, et al. Teledentistry: A Future Solution in the Diagnosis of Oral Lesions: Diagnostic Meta-Analysis and Systematic Review. *Telemed E Health.* 2023;29(11):1591–1600. <https://doi.org/10.1089/tmj.2022.0426>
18. Jampani ND, Nutalapati R, Dontula BSK, Boyapati R. Applications of teledentistry: A literature review and update. *J Int Soc Prev Community Dent.* 2011;1(2):37–44. <https://doi.org/10.4103/2231-0762.97695>
19. Al-Khalifa KS, AlSheikh R. Teledentistry awareness among dental professionals in Saudi Arabia. *PLoS One.* 2020;15(10):e0240825. <https://doi.org/10.1371/journal.pone.0240825>
20. Akeel S, Almazrooa S, Ali SA, Alhindi NA, Alhamed S, Felemban OM, et al. Assessing Tele-Oral Medicine in Saudi Arabia: A Cross-Sectional Study on Specialists' Experiences and Potentialness in Oral Healthcare. *Healthcare (Basel).* 2023;11(23):3089. <https://doi.org/10.3390/healthcare11233089>
21. Morales-Gómez C, Ojeda-Uribe G, Adorno-Farías D, Maturana-Ramirez A, Espinoza-Santander I. Telediagnosis performance of specialists in oral medicine and general dental practitioner using images of oral mucosa lesions in Chile. *Med Oral Patol Oral Cir Bucal.* 2025;30(1):e49–e55. <https://doi.org/10.4317/medoral.26825>
22. Al-Buhaisi D, Karami S, Gomaa N. The role of teledentistry in improving oral health outcomes and access to dental care: An umbrella review. *J Oral Rehabil.* 2024. <https://doi.org/10.1111/joor.13836>
23. Maqsood A, Sadiq MSK, Mirza D, Ahmed N, Lal A, Alam MK, et al. The Teledentistry, Impact, Current Trends, and Application in Dentistry: A Global Study. *Biomed Res Int.* 2021;2021:5437237. <https://doi.org/10.1155/2021/5437237>
24. Haron N, Zain RB, Nabillah WM, Saleh A, Kallarakkal TG, Ramanathan A, et al. Mobile Phone Imaging in Low Resource Settings for Early Detection of Oral Cancer and Concordance with Clinical Oral Examination. *Telemed E Health.* 2017;23(3):192–199. <https://doi.org/10.1089/tmj.2016.0128>

25. Niknam F, Mardani M, Bastani P, Bashiri A, Ha D, Sookhakian A, et al. Assessing the usability and reliability of a web-based teledentistry tool for remote diagnosis of oral lesions: a cross-sectional study. *BMC Oral Health*. 2024;24(1):1094. <https://doi.org/10.1186/s12903-024-04696-7>
26. Soegyanto AI, Wimardhani YS, Maharani DA, Tennant M. Indonesian Dentists' Perception of the Use of Teledentistry. *Int Dent J*. 2022;72(5):674–681. <https://doi.org/10.1016/j.identj.2022.04.001>
27. Arini M, Primastuti HI. Literature Review: Telemedicine Implementation in Developing Countries (Conference Paper). *Elsevier*. 2024;1013:505–514.
28. Nurhidayati N, Arini M, Mamat WHW. Readiness and Service Model Exploration for Chronic Kidney Disease Telemonitoring at Public Hospital in Bengkulu, Indonesia. *JMMR*. 2024;13(2).