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Original Article

Oral soft tissue diagnosis as a novel teledentistry framework for the post-pandemic era: A systematic review

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Abstract *Background/purpose:* Teledentistry has emerged as a promising alternative to conventional care. This systematic review aims to assess the effectiveness of teledentistry in diagnosing and managing oral soft tissue diseases compared to traditional consultations, explores clinical outcomes, technological challenges, and implications for future research and policy, and digitally advanced countries.
Materials and methods: A review registered in Prospero with CRD42024626432 used CINAHL, Embase, ProQuest, and ScienceDirect databases following PRISMA 2020 guidelines. Eligibility

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was based on population, intervention, comparison, outcome, and study design (PICOS) with inclusion and exclusion criteria, focusing on rural populations, teledentistry interventions for oral soft tissue conditions, comparative models, and clinical outcomes. Bias risk was assessed using the Risk of Bias Tool for Nonrandomized Studies.
Results: Fourteen eligible studies were included. Most demonstrated improved diagnostic accuracy of oral soft tissue lesions, patient satisfaction, and follow-up compliance in teledentistry-supported care. Modern platform diagnostics were commonly used. The comparative analyses showed that teledentistry was at least equivalent to traditional consultations.
Conclusion: Teledentistry shows strong potential as a cost-effective, accessible solution for managing oral soft tissue conditions. Its integration into mainstream healthcare could bridge disparities in oral health service delivery in underserved regions.

Introduction

Digital health technologies have transformed healthcare delivery, making teledentistry a key component of modern oral health care.[1—3] Teledentistry encompasses digital communication technologies such as live video, remote imaging, and store-and-forward systems to facilitate dental care, education, consultation, diagnosis, and treatment at a distance.[4—6] During the COVID-19 pandemic, teledentistry gained unprecedented momentum, filling gaps in dental care when face-to-face visits were limited or impossible.[3,7] Its applications have since expanded, demonstrating particular utility in managing oral soft tissue conditions requiring early diagnosis and continuous monitoring to prevent progression into more serious pathologies.[8—10]

Oral soft tissues, including the mucosa, gingiva, lips, tongue, and oropharyngeal areas, play vital roles in maintaining oral and systemic health.[11—13] These tissues serve as physical and immunological barriers against microbial invasion and are critical to essential functions such as speech, mastication, and swallowing.[14] Lesions affecting these tissues, from benign inflammatory to potentially malignant disorders, often require timely and precise diagnosis for effective management.[15,16] Teledentistry enables clinicians to remotely assess such conditions through high-resolution imaging and video consultations, with studies reporting satisfactory diagnostic concordance with conventional clinical examinations.[17,18] Furthermore, teledentistry supports longitudinal patient engagement and follow-up, a critical aspect in managing chronic or recurring soft tissue conditions.[19,20]

Despite its growing integration into dental care systems, especially in the post-pandemic landscape, the evidence base regarding teledentistry's effectiveness in oral soft tissue disease management remains fragmented.[21,22] Variability in study design, diagnostic protocols, population demographics, and healthcare infrastructure presents challenges to drawing generalized conclusions.[23,24] Access to teledentistry is uneven across regions, especially in developing countries and rural areas like parts of Asian nations. These disparities highlight the need for a comprehensive review of current literature to assess teledentistry's clinical efficacy, feasibility, and limitations in these contexts.

This systematic review evaluates the effectiveness of teledentistry in diagnosing and managing oral soft tissue diseases compared to traditional consultations. Focusing on studies in post-COVID-19 settings, it identifies clinical benefits, technological limitations, and patient outcomes. The goal is to provide an evidence-based foundation for future research, optimize digital oral healthcare strategies, and support policies for equitable access to services through teledentistry, particularly for advanced tech countries like Taiwan.

Material and methods

Search strategy and eligibility criteria

This systematic review follows the preferred reporting items for systematic reviews and meta-analyses (PRISMA) 2020 guidelines.[25,26] This review has been registered with PROSPERO and may be cited using the registration number CRD42024626432. The review questions were designed according to the population, intervention, comparator, outcome, and study (PICOS) framework. The population was defined as the underserved populations in any geographic region. Intervention was defined as the consultation method that uses teledentistry. The comparator was the conventional face-to-face dental care or direct consultation. The outcomes were defined as improving oral soft tissue health outcomes. The study design was described as a comparative cohort and observational study.

This study was conducted on November 11th, 2024, utilizing several electronic databases, including CINAHL, Embase, ProQuest, and ScienceDirect. The search terms used in each database were in Medical Subject Headings (MeSH). The Boolean operators "AND" and "OR" were utilized for search items shown in Table 1. We applied an inclusive search strategy without any filters. We excluded non-original contributions, such as editorials, letters, and comments. Moreover, our analysis did not consider studies based on in vitro methods and animal research.

Table 1 Database search strategy.

Databases	Keywords	Results
CINAHL	(((teledentistry) OR (remote consultation) OR (telemedicine)) AND ((oral soft tissue) OR (mouth mucosa)))	236
Embase	(((teledentistry) OR (teleconsultation) OR (telemedicine)) AND ((oral AND soft AND tissue) OR (mouth AND mucosa)))	56
Science direct	(((teledentistry) OR (remote consultation) OR (telemedicine)) AND ((oral soft tissue) OR (mouth mucosa)))	92
Proquest	(((teledentistry) OR (remote consultation) OR (telemedicine)) AND ((oral soft tissue) OR (mouth mucosa)))	317

Study selection

The study selection process was conducted by two independent reviewers, Israyani (I) and Christine Anastasia Rovani (C.A.R.), in accordance with PRISMA 2020 guidelines. After removing duplicate entries using Rayyan (new. Rayyan.ai), both reviewers independently screened titles, abstracts, and full texts in a blinded manner. Any disagreements between the reviewers during screening or full-text eligibility assessment were resolved through discussion. If consensus could not be reached, a third reviewer, Chung-Ming Liu (C-M.L.), served as the adjudicator to make the final decision. This dual-reviewer process ensured methodological rigor and minimized the risk of selection bias. Eligible studies focused on populations with limited access to oral care, specifically those with oral soft tissue diseases. Interventions included modern teledentistry applications. Comparative studies assessing teledentistry against conventional care. Outcomes of interest spanned early diagnosis of oral soft tissue lesions for patients during teledentistry. Study designs featured cohort studies, longitudinal research, and qualitative or mixed-method studies on implementation barriers. Studies involving only urban or rural populations, outdated technology, non-comparative analyses, irrelevant outcomes, theoretical papers, case reports, and those lacking methodological rigor were excluded.

Data collection and harmonization

Data extraction was performed independently by two reviewers (I. and C.A.R.) using a standardized data extraction form. Data included publication characteristics, population demographics, types of oral lesions, teledentistry platforms used, diagnostic approaches, and outcome measures. In cases of discrepancies between the two reviewers, consensus was sought through discussion. If consensus could not be achieved, the third reviewer (C-M.L.) was consulted to resolve the disagreement. This dual data extraction approach further enhanced the validity and reliability of the review findings. The extracted data included paper titles, authors, publication years, research locations, and study details population, including age and gender, software used, type of device used, study design, comparative method, intervention, outcome measured, and diagnosis of oral disease were established.

Risk of bias and quality evaluations

In this study, authors I. and C.A.R. evaluated bias risk and quality using the risk of bias in non-randomised studies of interventions version 2 (ROBINS-I V2) tool.[27,28] This tool assesses bias risk in nonrandomized systematic reviews, which evaluates bias across seven specific domains: (1) bias due to confounding (D1), (2) bias in classification of interventions (D2), (3) bias in selection of participants into the study or analysis (D3), (4) bias due to deviations from intended interventions (D4), (5) bias due to missing data (D5), (6) bias in measurement of the outcome (D6), and (7) bias in selection of the reported result (D7). If multiple assessors are involved, preliminary considerations and assessment plans should be agreed upon to ensure consistency. Each assessor then independently evaluates the studies, particularly focusing on confounding factors and domain-specific risks of bias.

Due to the significant heterogeneity in study designs, intervention types, diagnostic modalities, and outcome measures, a quantitative meta-analysis was not feasible. Therefore, we employed a structured narrative synthesis approach in accordance with the SWiM (Synthesis Without Meta-analysis) reporting guidelines. This method enabled us to summarize and compare findings across diverse contexts while maintaining methodological transparency.

Results

As shown in Fig. 1, all 701 records were identified through four electronic databases (CINAHL, Embase, ScienceDirect, and ProQuest). After removing 17 duplicates, 684 records were screened. Of these, 653 articles were excluded due to various reasons, including irrelevant background ($n = 381$), non-human samples ($n = 81$), non-original research ($n = 137$), different outcomes including no oral soft tissue diagnoses ($n = 68$), and unsuitable study design ($n = 44$). Out of the 31 full texts sought for retrieval, seven could not be accessed due to a lack of a PDF. A third examiner (C-M. L.) evaluated discrepancies and included 14 studies that were deemed eligible and included in the final review.[29–42]

Table 2 summarizes the characteristics of studies on teledentistry and remote oral health assessments, demonstrating considerable methodological and clinical diversity. Sample sizes ranged from small validation studies (e.g., Steinmeier et al. with 10 patients) to large-scale surveys (e. g., Meisha et al. with 3443 participants) and retrospective image analyses (e.g., Rabinovici-Coh et al. with 2398 images from 1470 patients). The studies employed various designs, including cross-sectional, prospective observational, retrospective, and randomized clinical trials. They were conducted across Japan, Thailand, Indonesia, Italy, Brazil, Switzerland, Saudi Arabia, India, Qatar, Israel,

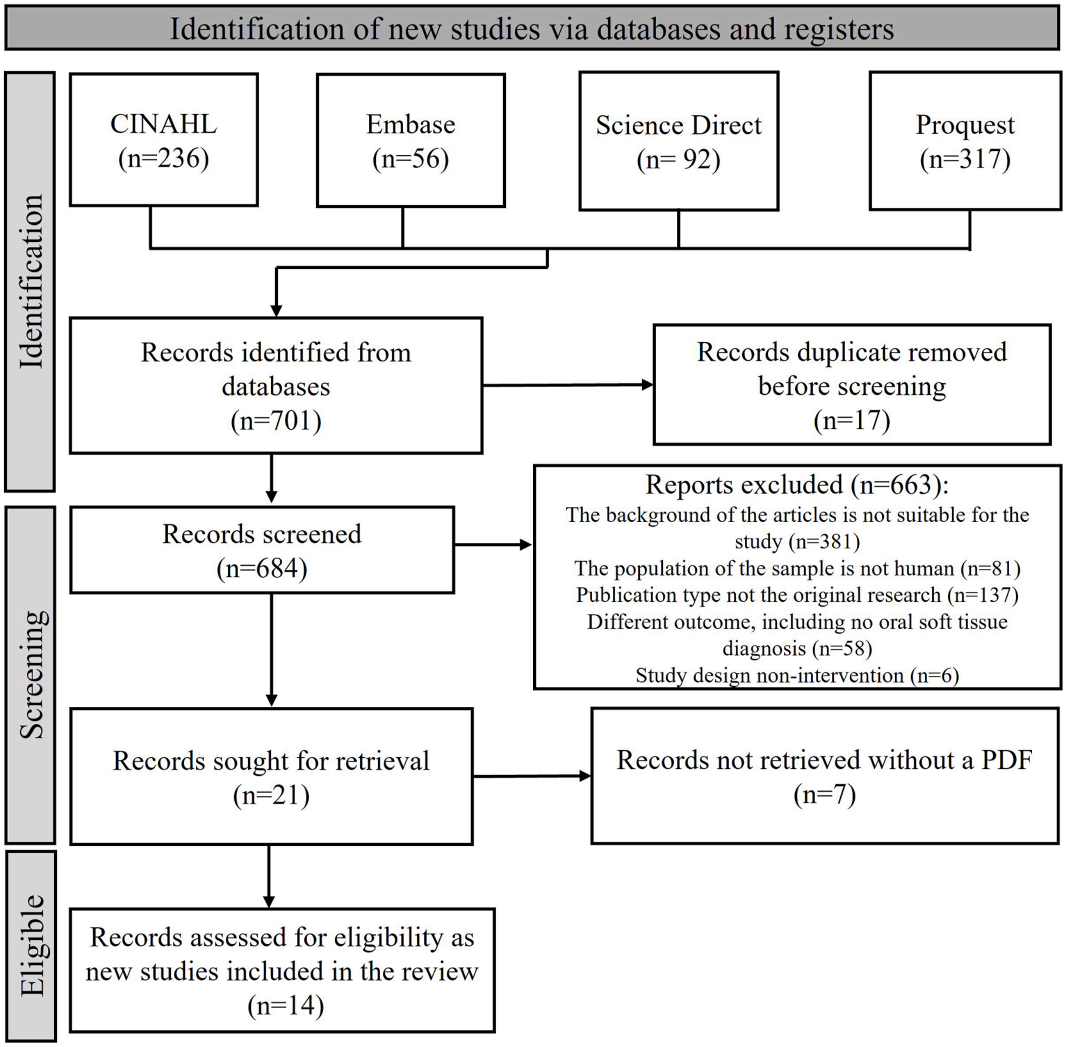

Figure 1 Preferred reporting items for systematic review and meta-analyses (PRISMA) 2020 flow diagram illustrating the selection process of studies included in the systematic review.

Canada, and Chile. Commonly assessed oral conditions included tongue coating, gingival inflammation, precancerous and cancerous lesions (e.g., leukoplakia, OSCC, erythroplakia), infections, ulcers, and periodontal diseases. Some studies focused on teledentistry tools' technological or diagnostic performance, while others explored user accessibility, public attitudes, and clinical applications. Despite differences in approach, the findings consistently highlight teledentistry's potential in detecting various oral pathologies, supporting remote diagnostics, and improving access to oral health care.

Table 3 summarizes studies on teledentistry and remote oral health assessments. Ako et al. found video evaluations on mobile devices to be reliable, aligning closely with in-person assessments in long-term care. Vetchaporn et al. validated an intraoral imaging device that improves the sensitivity and specificity of screenings for malignant disorders. Sidabutar et al. evaluated a teledentistry app, proving effective in expanding access to oral health services, particularly for chronic pulpitis and gingivitis. Barca et al. confirmed telemedicine's feasibility in maxillofacial consultations during COVID-19, noting high satisfaction and successful remote biopsies. Fonseca et al. found smartphone-based oral lesion imaging achieved 97 % diagnostic accuracy, comparable to face-to-face evaluations. Steinmeier et al. examined intraoral scanning, reporting high diagnostic agreement but moderate sensitivity for periodontal assessments. Meisha et al. analyzed care-seeking behaviors during COVID-19, revealing a preference for teleconsultation and disparities in emergency care. Bhushan et al. reviewed telemedicine protocols for facio-odontogenic pain, emphasizing its role in reducing in-person interactions. Paixão et al. showed teleconsulting data focused on diagnosing infections and biopsies. Ali et al. reported audio-only teledentistry having strong agreement with diagnoses, though pulpitis and periodontitis had slightly lower reliability. Rabinovici-coh et al. trained deep learning models to detect oral squamous cell carcinoma, achieving high accuracy with an AUC of 0.96. Lin et al. established guidelines for intraoral photography, enhancing image quality for remote screenings. Dornellas et al. validated a pediatric teletriage tool, supporting early

Table 2 Summary of the characteristics of eligible studies included in the systematic review.

First author	Year of publication	Country	Study design	Sample size	Oral soft tissue lesion type	Ref
Ako et al.	2024	Japan	Cross-sectional observational study	60 (no control or intervention groups mentioned)	Tongue coating and gingival swelling	29
Vetchaporn et al.	2021	Thailand	Prospective observational study	34 patients (no control or intervention group mentioned)	Oral lichen planus Leukoplakia Discoid lupus erythematosus Squamous cell carcinoma Verruca Vulgaris Hyperkeratosis Mild epithelial dysplasia (premalignant)	30
Sidabutar et al.	2024	Indonesia	Cross-sectional observational study	The paper does not explicitly state the sample size or separate control and intervention groups	Gingivitis	31
Barca et al.	2020	Italy	Single-site, stratified, prospective observational study	Total sample size: 90 patients - Group A: 63 patients (A1: 54 patients, A2: 9 patients) - Group B: 27 patients (B1: 12 patients, B2: 15 patients)	Precancerous lesions, MRONJ, oral cancer, odontogenic abscesses, and TMJ dislocation.	32
Fonseca et al.	2020	Brazil	Observational study focused on diagnostic accuracy, non-randomized, non-controlled	The sample size is 113 cases. There is no control or intervention group mentioned in the study.	Inflammatory fibrous hyperplasia, pyogenic granuloma, oral lichen planus, mucocele, hemangioma, papilloma, leukoplakia, actinic cheilitis, periodontal abscess, candidiasis, and oral squamous cell carcinoma.	33
Steinmeier et al.	2020	Switzerland	Cross-sectional validation study, observational, single-site, non-randomized, non-blinded, non-	Sample size: 10 patients - Control group: Not mentioned - Intervention group: Not mentioned	Gingivitis and periodontitis	34

			controlled			
Meisha et al.	2021	Kingdom of Saudi Arabia	Cross-sectional observational study, non-randomized, web-based survey, non-probability snowball sampling technique	Total invited: 4372 - Total responded: 3443 - No control or intervention groups mentioned	Cellulitis	35
Bhushan et al.	2021	India	Not mentioned	The paper does not provide information on sample size or control and intervention groups	Mouth ulcers (aphthous ulcers) and oral Herpes infection	36
Paixão	2024	Brazil	Retrospective observational study	The sample size is 3920 teleconsulting sessions. There are no control or intervention groups mentioned in the paper.	Infections (fungal, viral, bacterial), biopsies, and soft tissue tumors (e.g., fibrous hyperplasia).	37
Ali et al.	2022	Qatar	Cross-sectional retrospective observational study	Total calls: 1239 - Excluded due to incomplete records: 398 - Referred for face-to-face care: 250 - Showed up at referral point: 223 - Final sample size for AD study: 191	Ulcer	38
Rabinovici-coh et al.	2024	Israel	Retrospective, multi-site, stratified	Total sample size: 1470 patients - Total images: 2398 - Images from TZMC: 1382 (from 586 patients) - Images from the internet: 1016 (from 884 patients) - Normal mucosa: 103 images - Benign lesions: 1494 images - Mimic-cancer lesions: 260 images - OSCC tumors: 541 images	OSCC, erythroplakia, traumatic ulcers, TUGSE, keratoacanthoma	39
Lin et al.	2021	British Columbia, Canada	Not mentioned	Not mentioned (the paper does not provide specific information on	Leukoplakia, erythroplakia, erythroleukoplakia, and	40

(*continued on next page*)

Table 2 (*continued*)

First author	Year of publication	Country	Study design	Sample size	Oral soft tissue lesion type	Ref
				sample size or control and intervention groups)	dysplasia.	
Dornellas et al.	2024	Brazil	Randomized, controlled, noninferiority, blinded (examiners), before-and-after study nested within a randomized clinical trial	Validation phase: 140 participants - Clinical trial: - G1 (teleconsultation only): 130 participants - G2 (teleconsultation plus face-to-face consultation): 130 participants	Perforated or oral mucosa ulceration	41
Beltrán et al.	2022	Antofagasta, metropolitana, maule, bío-bío, araucanía	Pilot study, multi-site, non-randomized, non-controlled, implementation study	Sample size: 135 patients - Control group: Not mentioned - Intervention group: 135 patients (all participants received teledentistry service)	Reactive lesions (fibroma, frictional keratosis, mucocele), infectious lesions (subprosthetic stomatitis, median rhomboid glossitis, chronic periodontitis), vascular lesions (vascular malformation), pigmented lesions (amalgam tattoo, smoking-related melanosis), potentially malignant lesions (leukoplakia, erythroplakia, lichen planus)	42

oral health interventions. Beltrán et al. demonstrated that a semi-presential teledentistry platform effectively delivered urgent care for elderly patients while minimizing infection risks. These studies highlight advancements in digital dentistry, improving diagnostic precision, accessibility, and patient outcomes.

The risk of bias assessment using the ROBINS-I V2 is presented in Fig. 2. Most included studies showed a high risk of bias in domains D1 and D2, indicating unclear research questions and inappropriate data collection methods. Some studies also showed moderate concerns in D3 and D7, related to the tools used for data collection and the link between data and interpretation. In contrast, domains such as D4, D5, and D6 generally had a low risk of bias, suggesting better data integration, appropriate sampling, and discussion of study limitations. A few studies had unclear or missing information, marked by black "X" symbols. While the studies provide helpful information, many have methodological limitations, and their findings should be interpreted cautiously. Improving study quality in future research is recommended.

Discussion

This systematic review comprehensively evaluates the current landscape of teledentistry and remote oral health assessments, emphasizing methodological heterogeneity and a wide range of clinical applications. A total of 14 eligible studies were included, encompassing various study designs and geographic locations, which underscore teledentistry's global relevance and adaptability. Our analysis of eligible studies indicates that teledentistry can reliably identify oral mucosal lesions, including potentially malignant disorders, using remote imaging and teleconsultation platforms.[43—45]

The findings indicate that digital tools, such as video-based assessments, intraoral imaging technologies, and artificial intelligence (AI)-assisted diagnostics, consistently demonstrate high reliability in detecting oral pathologies. For instance, Ako et al. confirmed the feasibility of mobile-based assessments in geriatric care settings.[29] At the same time, Vetchaporn et al. validated an intraoral imaging system with enhanced sensitivity for screening potentially malignant disorders.[30] Similarly, Fonseca et al. reported diagnostic accuracy of smartphone-captured oral lesion images comparable to conventional face-to-face evaluations.[33] During the COVID-19 pandemic, telemedicine was pivotal in facilitating remote maxillofacial consultations, as illustrated by Barca et al. Furthermore, AI-based models developed by Rabinovici-Coh et al. demonstrated strong performance in detecting oral squamous cell carcinoma, highlighting the promise of automated diagnostic tools.[32,39] Additional contributions by Sidabutar et al. and Beltrán et al. emphasize the utility of teledentistry in expanding access to oral healthcare, particularly among underserved and remote populations.[31,42]

Notably, the integration of teledentistry was most effective in healthcare systems with adequately established digital infrastructure and professional training.[21] Countries and regions with supportive health policies have demonstrated the successful implementation of teledentistry programs, particularly in rural and remote communities.[46,47] These programs utilized store-and-forward technology and real-time video conferencing to assess soft tissue abnormalities, improving continuity of care and follow-up.[47,48] However, challenges such as variable internet connectivity, lack of standardized protocols for teleconsultations, and differences in clinician experience still limit the full potential of teledentistry. Studies reported issues with image quality and data privacy in some cases, which may affect diagnostic reliability and patient trust.[49,50]

Patient satisfaction and acceptance emerged as pivotal components of successful teledentistry services. Several studies in the review reported high satisfaction rates among patients using teledentistry for oral soft tissue consultations, especially when it reduced travel time, cost, and waiting periods.[51—53] Furthermore, teledentistry enabled better engagement for individuals with mobility impairments or those living in geographically isolated regions. Despite these advantages, some patients expressed concerns regarding the impersonality of virtual consultations and limited access to digital devices or internet connectivity.[54,55] These findings emphasize the importance of user-centered design and digital literacy programs to optimize teledentistry implementation.

Although several studies implied that teledentistry may reduce the cost burden by minimizing the need for in-person consultations, travel expenses, and time off work, particularly for rural and elderly populations, few of the included studies conducted formal cost-effectiveness analyses. For example, Sidabutar et al. noted improved access among low-income groups using a custom teledentistry platform, yet no direct economic evaluation was reported.[31] Barca et al. and Beltrán et al. also referenced reduced logistical barriers, but without quantified cost savings.[32,42] Thus, while teledentistry is frequently cited as a more affordable alternative, this conclusion currently rests on anecdotal or observational evidence rather than robust economic modelling.

From a clinical perspective, the reviewed studies suggest that teledentistry enhances the management of oral soft tissue lesions through rapid triage, appropriate referrals, and collaborative care among dental specialists. Several models demonstrated that teledentistry could be effectively integrated into oral healthcare frameworks, promoting interdisciplinary collaboration and reducing the burden on tertiary care centers.[20,56] Moreover, in the post-pandemic era, where digital transformation in healthcare continues to accelerate, teledentistry represents a sustainable and scalable solution for improving oral health outcomes.[56,57]

However, limitations such as inconsistent image quality, restricted internet bandwidth in rural regions, and the predominance of cross-sectional designs constrain these digital solutions' broader implementation and long-term validation. Future studies should prioritize multi-center randomized controlled trials (RCTs) with standardized protocols to advance the field, to strengthen methodological rigor, and improve generalizability across diverse populations. Furthermore, comprehensive cost-effectiveness analyses are warranted to evaluate teledentistry systems'

Table 3 Data extracted from the studies evaluated.

First author	Software used	Methods	Result summary	Ref
Ako et al.	SPSS-28	Cross-sectional study on 60 elderly in long-term care. OHAT is used for in-person (OHAT-B) and video (OHAT—V1—V3) assessments. Intraoral videos were recorded via an iPhone 14. Three dentists performed video evaluations. Reliability was analyzed using SPSS.	The study found that oral health assessments using video recordings of the oral cavity taken with a mobile electronic device showed high reliability and substantial agreement with in-person assessments, suggesting the possibility of remote oral health assessment for older adults in long-term care facilities.	29
Vetchaporn et al.	Inskam, line application	A diagnostic device combining autofluorescence and white light was developed and tested on 34 OPMD patients. Validated via clinical and histopathological comparison. Images from 17 intraoral sites were captured and sent through a smartphone app for remote diagnosis. Compared the combination method vs. autofluorescence alone.	The intraoral camera with fluorescent aids, combined with autofluorescence and LED white light, demonstrated high validity and reliability for screening oral potentially malignant disorders in teledentistry, with improved sensitivity, specificity, PPV, and NPV compared to autofluorescence alone.	30
Sidabutar et al.	drgbeta.com application	Cross-sectional study using researcher-developed teledentistry app (drgbeta.com). Data collected via chat, photo sharing, and in-app surveys from health students in East Nusa Tenggara. Twelve dentists were involved; 3 actively participated. Informed consent was obtained; data credit was given as compensation.	The drgbeta.com teledentistry application increases access to oral health services, particularly for those with low incomes, and provides educational benefits, with chronic pulpitis and gingivitis being the most frequently consulted cases.	31
Barca et al.	Graphpad	Conducted at the maxillofacial surgery unit, "magna graecia" university. Two groups: Follow-up and urgent cases. Video consultations via smartphone. Data: Demographics, photos, consultation times, feedback. COVID-19 screening and satisfaction surveys included. Analyzed with GraphPad.	The study demonstrated the effectiveness of telemedicine in managing maxillofacial surgical pathologies during the COVID-19 pandemic, with high satisfaction rates among patients and doctors, and successful remote consultations and biopsies for 90 patients.	32
Fonseca et al.	Google docs, dropbox	Oral lesion images captured using an 8-megapixel smartphone with flash; no editing applied. Encrypted images were analyzed remotely by three experienced evaluators. Diagnostic input and feedback were collected via google docs.	Telediagnosis of oral lesions using smartphone photography showed high diagnostic accuracy, with at least one evaluator correct in 97 % of cases, comparable to face-to-face diagnosis.	33
Steinmeier et al.	3shape communicate, version 4.0.1; microsoft excel; r; ggplot2	Cross-sectional validation study with 10 patients. IOS (Trios), full-mouth exams, and radiographs obtained. Ten dentists performed remote and radiograph-assisted assessments.	The study found that intraoral scans (IOS) were effective for detecting dental findings but less accurate for assessing periodontal conditions, with agreement between remote and clinical	34

		The agreement was analyzed descriptively (100 observations/parameter) using Excel and R studio.	diagnoses ranging from 78 % to 95 % for dental conditions and moderate sensitivity and specificity for gingivitis and periodontitis.	
Meisha et al.	IBM SPSS-24	Cross-sectional web-based survey (apr—Jun 2020) in Saudi Arabia; adults ≥18 years, excluding dental workers. Snowball sampling; data via anonymous QuestionPro survey. Topics: Emergency, urgent, routine dental care. Logistic regression used; analysis in SPSS.	The study found that during the COVID-19 pandemic in Saudi Arabia, participants were more willing to seek emergency dental care for life-threatening conditions but less so for conditions like facial cellulitis, with a preference for teleconsultation and significant social disparities in healthcare-seeking behavior.	35
Bhushan et al.	Not mentioned	Review of telemedicine regulations and protocols per government, NITI aayog, and board of governors guidelines. "Type seven Elements for telemedicine consultation" and COVID-19 procedural recommendations from the government and the DCI are included.	Telemedicine is a valuable tool in managing facio-odontogenic pain during the COVID-19 pandemic by reducing interpersonal interactions for pre- and post-operative visits.	36
Paixão et al.	SPSS-22	Secondary data from asynchronous teleconsulting (minas gerais, Jul 2015—Jul 2017) was analyzed for dental specialty and question type. A third reviewer resolves disagreements. Questions are classified as diagnostic or general. Descriptive analysis using SPSS v22.0.	The study found that most teleconsulting sessions in oral medicine focused on diagnosing conditions like infections and biopsies, while pharmacology questions centered on general approaches such as prescriptions and anesthetics, highlighting a need for more academic training in these areas.	37
Ali et al.	SPSS-22	Retrospective analysis of audio-only teledentistry triage (mar—Aug 2020); compared remote vs. in-person diagnoses using Cohen's weighted kappa. Data collected via a standardized form. Photo senders excluded. Statistical analysis performed with SPSS.	The study found a significantly excellent pair-wise agreement between synchronous audioconferencing teledentistry and clinical face-to-face diagnoses, with kappa values indicating high reliability. However, conditions like pulpitis and periodontitis showed slightly lower agreement levels.	38
Rabinovici-coh et al.	Fusemedml, scikit-learn, pytorch, pytorch lightning	Retrospective study of 1470 patients using smartphone clinical images. Deep learning models (CNN-ResNet18, OCNN-ResNet50) were trained for OSCC and suspicious lesion detection. Dataset from TZMC and online sources. Metadata fusion, pretrained weights, and ensemble methods applied. Data stratified by lesion location.	The study demonstrates the efficacy of deep learning methods in predicting OSCC and suspicious cases, achieving high accuracy with AUC values of 0.96 for OSCC prediction and enhanced accuracy for specific lesion locations.	39
Lin et al.	Not mentioned	Developed recommendations for capturing interpretable intraoral photographs, emphasizing ideal lighting, mirror positioning, camera angle, and tissue retraction. Utilized simple tools such as smartphone cameras and	The paper proposes recommendations for intraoral photography in oral mucosal screening, adaptable to smartphone or point-and-shoot cameras, to standardize image quality and facilitate remote triage and follow-	40

(*continued on next page*)

Table 3 (*continued*)

First author	Software used	Methods	Result summary	Ref
		cheek retractors. Provided guidelines applicable to clinical and home settings, enabling patients to take self-photographs for follow-up under adequate lighting conditions. Specific intraoral site instructions were detailed in tables for standardized photo capture.	up of oral lesions, improving clinical care and knowledge sharing.	
Dornellas et al.	Medcalc, jamovi, rstudio	This before-and-after study in a randomized clinical trial validates the QuesT-Odontoped questionnaire for teletriage. 260 children were randomized into G1 (teleconsultation) and G2 (teleconsultation plus face-to-face consultation). Pain and quality-of-life scales were assessed at 7, 14, 12, and 24 months. Statistical analyses included mann–Whitney, Student's t-test, and Poisson regression. Teletriage was conducted via the NuTes-FOUSP platform. Ethical approval and data protection protocols were followed.	Not mentioned (the paper is a study protocol and does not include results)	41
Beltrán et al.	R-project, 4.0.3 version	Implement a mobile dental clinic and teledentistry platform in five regions of Chile, ensuring strict biosafety protocols. Develop a web-based platform and mobile app for medical and dental data. SENAMA-Chile social workers enrolled patients and classified treatment needs through dental care triage. Electronic consultations with specialists were carried out. A general dentist and assistant gathered data, using the R-project statistical analysis.	The study demonstrated that a "semi-presential" teledentistry platform implemented in a mobile dental clinic effectively provided urgent and priority dental care to 135 elderly patients in Chile during the COVID-19 pandemic, reducing contagion risk and enhancing early diagnosis of oral pathologies.	42

SPSS = statistical package for the social sciences; OHAT = oral health assessment tool; OHAT-B = oral health assessment tool – baseline (used in-person); OHAT V1–V3 = oral health assessment tool versions 1 to 3 (used via video assessments); OPMD = oral potentially malignant disorder; LED = light emitting diode; PPV = positive predictive value; NPV = negative predictive value; COVID-19 = coronavirus disease 2019; IOS = intra oral scanner; R studio = an integrated development environment (IDE) for R (R is a statistical programming language); IBM-SPSS = international business machines – statistical package for the social sciences; NITI = National Institution for Transforming India; DCI = Dental Council of India; CNN-ResNet18 = convolutional neural network with residual network 18 layers; OCNN-ResNet50 = optimized convolutional neural network with residual network 50 layers; OSCC = oral squamous cell carcinoma; TZMC = Tzafon Medical Center; AUC = area under the curve; G1 = group 1; G2 = group 2; NuTes-FOUSP = núcleo de teleodontologia e telessaúde da faculdade de odontologia da universidade de São Paulo (telehealth and teledentistry center, school of dentistry, university of São Paulo); R-project = an open-source programming language and environment for statistical computing and graphics (commonly referred to simply as "R"); SENAMA-Chile = servicio nacional del adulto mayor, Chile (national service for the elderly, Chile).

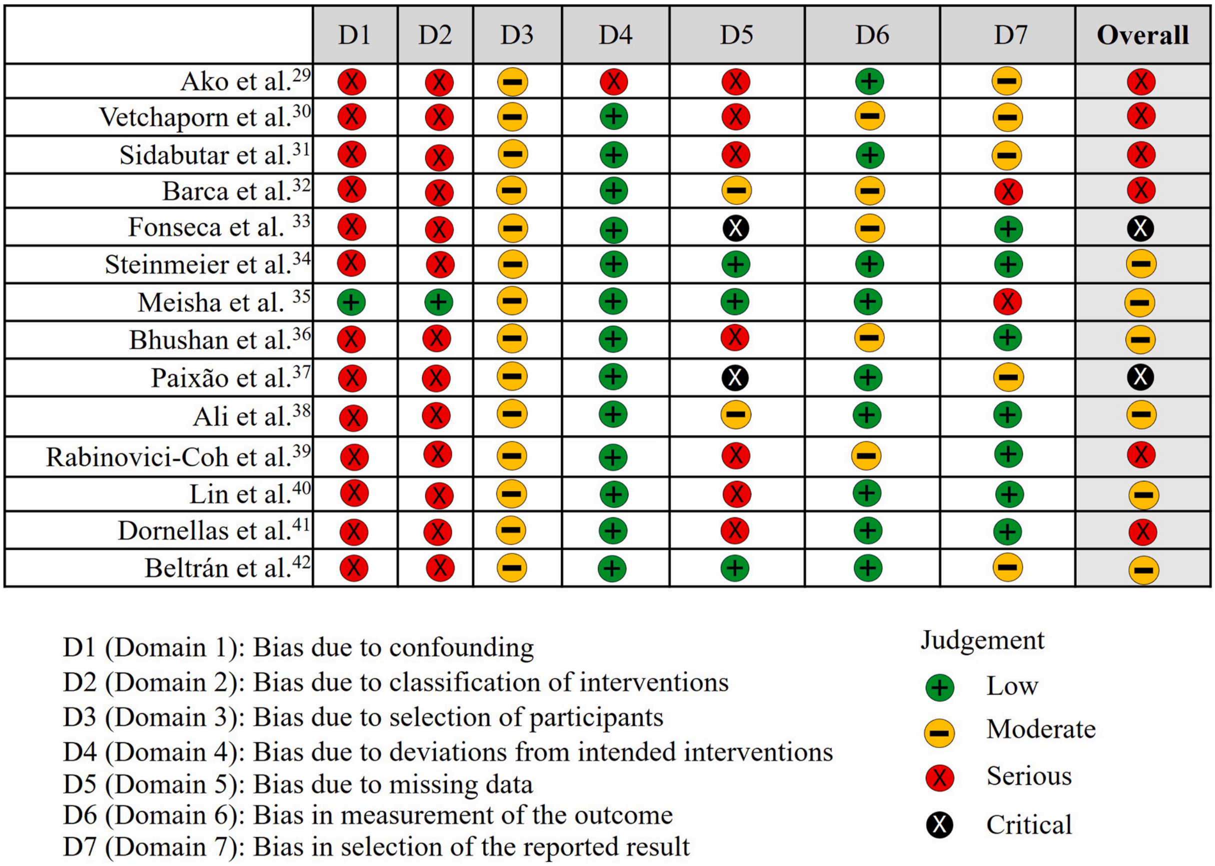

Figure 2 Summary of the risk of bias item for each included study using risk of bias in non-randomised studies of interventions version 2 (ROBINS-I V2).

economic viability and scalability in routine clinical practice. Addressing these gaps will be instrumental in refining the integration of teledentistry into contemporary dental healthcare delivery. While this review synthesized evidence across 14 studies, no meta-analysis was conducted. This decision was driven by the high degree of clinical and methodological heterogeneity among the included studies ranging from different diagnostic technologies and oral lesion types to variability in study designs and patient populations. Although the lack of meta-analysis limits the statistical strength of the conclusions, the structured narrative approach allowed for a comprehensive evaluation of key themes, diagnostic performance, and contextual implementation factors.

This review highlights teledentistry's transformative role in oral health care, especially in enhancing diagnostics and access for underserved populations. Advanced technologies like mobile imaging and artificial intelligence show promising diagnostic reliability. However, study quality and design heterogeneity challenge definitive conclusions. Future large-scale studies are essential to validate these findings, inform clinical guidelines, and ensure teledentistry's sustainable implementation in various healthcare settings. Future research should prioritize comprehensive economic evaluations and cost-effectiveness analyses of teledentistry platforms, particularly in diverse healthcare settings, to substantiate its financial sustainability and inform policymaking.

Declaration of competing interest

All the authors declare that they had no conflict of interest during the preparation of this paper.

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