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REDUCING ORAL HEALTH INEQUITIES IN UNDERSERVED POPULATIONS THROUGH SECONDARY PREVENTION AND EARLY DETECTION

Ph.D. Thesis

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"Progress is impossible without change, and those who cannot change their minds cannot change anything."

George Bernard Shaw

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1. LIST OF ABBREVIATIONS

AGNB	Aerobic Gram-Negative Bacilli
CHW	Community Health Worker
CI	Confidence Interval
COE	Clinical Oral Examination
MD	Mean Difference
NPV	Negative Predictive Value
OHCP	Oral Healthcare Prevention Program
OHIP-14	Oral Health Impact Profile–14
OHRQoL	Oral Health-Related Quality of Life
OHTS	Oral Health Transition Scale
OL	Oral lesion
OMS	Oral Medicine Specialist
OPMD	Oral Potentially Malignant Disease
PPV	Positive Predictive Value
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-analyses
ROC	Receiver Operating Characteristic
RR	Risk Ratio
SD	Standard Deviation
SMD	Standardized Mean Difference
TD	Teledentistry

2. STUDENT PROFILE

2.1. Vision and mission statement, specific goals

My vision is to advance digital oral medicine by establishing teledentistry as a reliable, patient-centered bridge between oral healthcare and medical care, ensuring early diagnosis, prevention, and access to oral health services for underserved and medically compromised populations.

My mission is to use teledentistry tools in primary dental care to enable early and accurate detection of potentially malignant oral disorders. I aim to integrate oral health promotion programs into post-stroke rehabilitation pathways and support interdisciplinary collaboration between dental and medical professionals.

2.2. Scientometrics

Number of all publications:	6
Cumulative IF:	21,3
Av IF/publication:	3,6
Ranking (SCImago):	D1:1, Q1:5
Number of publications related to the subject of the thesis:	2
Cumulative IF:	8,3
Av IF/publication:	4,1
Ranking (Sci Mago):	D1:1, Q1:1
Number of citations on Google Scholar:	133
Number of citations on MTMT (independent):	79
H-index:	5

The student's detailed bibliography is on pages 71-72.

2.3. Future plans

My future research aims to integrate teledentistry-based diagnostic tools into oral healthcare pathways for underserved populations. Building on my current work, I intend to expand digital screening and remote consultation models to improve early detection of oral mucosal lesions in settings with limited access to specialists. In the long term, I aim to translate these findings into structured screening and referral protocols. Through research, education, and interdisciplinary collaboration, my goal is to contribute to earlier diagnosis, improved prevention, and reduced oral health inequalities.

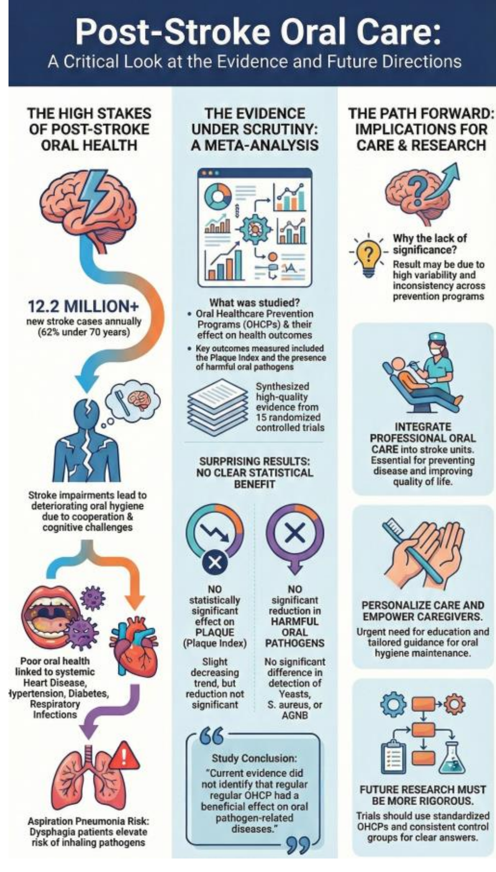
3. SUMMARY OF THE THESIS

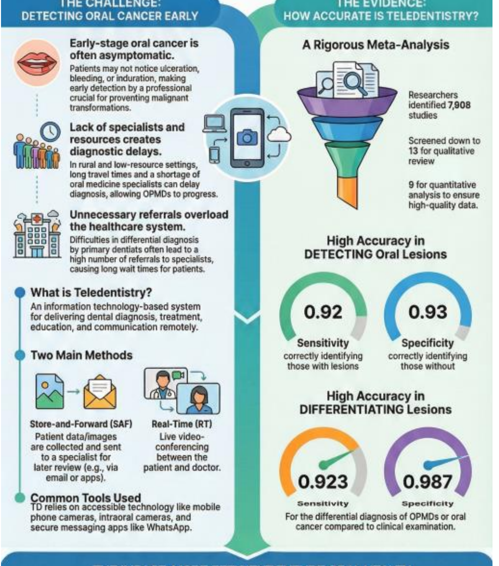
Oral health plays a critical yet often underrecognized role in systemic health, quality of life, and long-term outcomes in medically compromised populations. Oral potentially malignant disorders (OPMDs) and poor oral health status among post-stroke inpatients represent two clinically distinct but conceptually interconnected challenges, both characterized by limited access to specialized oral healthcare and delayed diagnosis or intervention.

This PhD thesis investigates the application of teledentistry (TD) as an innovative, scalable solution in oral medicine, focusing on (1) the remote identification and diagnostic support of OPMD, and (2) the development and implementation of oral healthcare prevention programs (OHCP) for post-stroke inpatients during rehabilitation. By leveraging digital tools, standardized clinical imaging, and interdisciplinary collaboration, the research aims to improve early detection of OPMDs and enhance oral health awareness, self-care capacity, and preventive practices in stroke-affected individuals.

The thesis adopts a multidisciplinary approach combining oral medicine, TD, rehabilitation medicine, and public health. Outcomes demonstrate that TD-supported oral care models can reduce diagnostic delays, improve continuity of care, and improve oral and general health outcomes in underserved populations. Ultimately, this work seeks to support the integration of digital oral healthcare pathways into routine medical and rehabilitative settings.

4. GRAPHICAL ABSTRACT





5. INTRODUCTION

5.1. Underserved Population

Underserved populations are groups that face functional, cognitive, or socioeconomic barriers to accessing healthcare services. Within these populations, oral health is increasingly recognized as an essential component of overall health. These populations—including individuals living with neurological impairments such as stroke survivors—exhibit a disproportionately high burden of oral diseases compared with the general population, ranging from poor oral hygiene and periodontal disease to OPMDs (1). Despite the well-established bidirectional relationship between oral and systemic health (2, 3), oral healthcare remains insufficiently integrated into mainstream medical and rehabilitative care pathways (4, 5), exacerbating health inequalities. Global evidence demonstrates that underserved groups experience a higher burden of oral diseases, reduced access to dental care, and delayed diagnosis of oral pathologies, contributing to avoidable morbidity and impaired quality of life (6-8).

Poor oral health has been strongly associated with systemic conditions such as cardiovascular disease, respiratory infections, and stroke, underscoring the bidirectional relationship between oral and general health (2, 9, 10).

Proactive interventions are necessary to prevent the progression of diseases that are particularly prevalent in underserved or physically compromised groups.

5.2. Diagnosis of Oral Lesions

Early detection of oral mucosal lesions, including OPMDs and oral cancer, remains a significant clinical challenge and is highly dependent on access to oral medicine specialists' (OMS) expertise. The diagnosis of these lesions is complicated by their often asymptomatic presentation, heterogeneous clinical appearance, and frequent resemblance to benign oral conditions, which can result in misinterpretation or delayed recognition in non-specialist settings (11). These diagnostic challenges disproportionately affect underserved populations, particularly individuals with physical, cognitive, or functional impairments and those living in underserved or geographically remote regions, where limited access to specialist care further delays timely assessment and referral.

TD has emerged as a promising digital health strategy to address access-to-care barriers by enabling remote oral examinations, specialist consultations, and triage via image-based, real-time communication technologies. By facilitating the transfer of clinical information and visual data to OMS, TD has the potential to support more accurate diagnosis and earlier identification of clinically significant lesions in populations that would otherwise face delayed or missed care. High-quality evidence demonstrates that TD can achieve high diagnostic accuracy for the detection and differential diagnosis of oral lesions (OL) when compared with conventional clinical oral examination (COE) (12).

5.1. Oral Healthcare of Post-Stroke Patients

Stroke survivors represent an underserved group in this context. Post-stroke impairments such as motor dysfunction, cognitive decline, dysphagia, and reduced self-care capacity significantly compromise daily oral hygiene practices, leading to rapid deterioration in oral health status. Accumulating evidence links poor oral hygiene in post-stroke patients to increased colonization by oral opportunistic pathogens and elevated risks of aspiration pneumonia, prolonged hospitalization, and reduced quality of life (4, 13, 14). Although OHCPs are advocated during rehabilitation, their implementation is inconsistent, resource-dependent, and often constrained by workforce shortages and a lack of dental expertise in non-dental settings.

5.2. Problem Statement and Importance

The primary problem addressed in this thesis is the persistent barrier to effective oral disease prevention, timely dental care, and early diagnosis among underserved populations. These groups contribute to a rapid decline in oral hygiene. This issue is of particular clinical and public health relevance, as delays in the detection of OLs are associated with disease progression and an increased risk of oral cancer (15). In contrast, poor oral health in post-stroke populations has been linked to serious systemic complications, including aspiration pneumonia (16) and increased cardiovascular risk (17).

5.3. Impact of Results

This research aims to inform and guide the research process by demonstrating how TD can be systematically integrated into OHCP, thereby reducing health inequalities, preventing systemic complications, and supporting more efficient and equitable healthcare delivery. The results may support interdisciplinary collaboration, inform clinical guidelines, and contribute to the development of public health strategies. Ultimately, the findings could improve patient outcomes, optimize healthcare resources, and strengthen the role of oral medicine within integrated healthcare systems.

6. OBJECTIVES

6.1. Study I. – Teledentistry in the Diagnosis of Oral Lesions

The objective of this project is to evaluate the diagnostic accuracy and clinical utility of TD in the detection and differential diagnosis of OL, with particular emphasis on OPMD. The project aims to compare TD-based assessments with conventional COE in terms of sensitivity, specificity, and referral decision-making. Additionally, it seeks to explore how TD can support early diagnosis, optimize referral pathways, and improve access to OMS for populations facing geographical barriers.

6.2. Study II. – Effect of OHCP on Oral Hygiene and Oral Opportunistic Pathogens in Post-Stroke Patients

The objective of this project is to assess the effectiveness of OHCP in maintaining oral hygiene and reducing oral health–related risks among post-stroke patients during rehabilitation. The project aims to synthesize available evidence on the impact of structured oral healthcare interventions on oral health indices, oral opportunistic pathogens, and oral health–related quality of life. Furthermore, it aims to identify gaps in current rehabilitation practices and inform the development of integrated, patient-centered oral healthcare strategies tailored to the needs of individuals with stroke-related impairments.

7. METHODS

7.1. Study I. – Teledentistry in the Diagnosis of Oral Lesions

7.1.1. Methodology and Protocol

The conduct and reporting of this systematic review and meta-analysis adhered to the PRISMA 2020 guidelines (18) outlined in the Cochrane Handbook (19). The study protocol was registered prospectively with PROSPERO (registration number: CRD42021282645), and all methodological procedures were implemented as specified in the registered protocol.

7.1.2. Eligibility Criteria

Study eligibility was defined using the PICO framework. The population (P) comprised adult patients with suspected OL. The imaging (I) included TD-based examinations that incorporated various imaging modalities. The comparator (C) was a conventional COE or a histopathological assessment via biopsy. The primary outcomes (O) of interest were diagnostic accuracy measures, including sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Regarding study design, observational studies were considered eligible for inclusion.

7.1.3. Information Sources and Search Strategy

The systematic literature search was conducted on 25 October 2021 across the following electronic databases: MEDLINE (via PubMed), Embase, and the Cochrane Central Register of Controlled Trials (CENTRAL). No search filters were applied. Only studies published in the English language were considered eligible. Additionally, the reference lists of all included articles were manually reviewed to identify further relevant studies. Non-original publications, including reviews, editorials, letters, and commentaries, as well as grey literature, were excluded. In vitro and animal studies were also excluded from the review.

We used the following search query: (telemedicine OR teledentistry OR telehealth OR telediagnosis OR telecons* OR ehealth OR smartphone OR phone OR remote OR app) AND (oral lesion OR premalignant OR manifestation OR diagnos* OR detect*) AND (dentist OR dental OR oral)

7.1.4. Study Selection and Data Extraction

Study selection was conducted independently by two authors. After removing duplicate records using reference management software (EndNote X9, Clarivate Analytics), the authors independently screened titles and abstracts, followed by full-text assessment of potentially eligible studies. Any disagreements arising during the selection process were resolved through consultation with a third independent author. The level of agreement between reviewers was evaluated using Cohen's kappa statistic.

Data extraction was performed independently by two authors using a predefined data collection form. Any discrepancies in the extracted data were resolved through discussion and, when necessary, consultation with a third independent author.

The following information was extracted from each included study: first author, year of publication, study design, country of origin, characteristics of the study population, mean age, assessed risk factors, sample size, definition of the target condition, professional background of the individual conducting the telediagnosis, type of imaging or photography device used, description of the teledentistry tool, and the applied reference standard.

7.1.5. Risk of Bias and Quality of Evidence Assessment

Risk of bias was assessed in accordance with the Cochrane Handbook for Systematic Reviews of Diagnostic Test Accuracy (20) using the QUADAS-2 tool (21). The assessment was independently conducted by two authors, with any disagreements resolved through consultation with a third independent author.

The certainty of evidence was evaluated in accordance with the recommendations of the Grades of Recommendation, Assessment, Development and Evaluation (GRADE) workgroup (22). Outcomes were assessed independently by two authors, and any disagreements were resolved through consultation with a third independent author. GRADE evidence profiles for the investigated outcomes were generated using the GRADEpro GDT software (23).

7.1.6. Data Synthesis and Analysis

Two-by-two contingency tables were extracted from the included studies, comprising true positive, false positive, false negative, and true negative values. In studies reporting

diagnostic assessments from multiple remote experts, data from a single expert were randomly selected for the primary analysis. Including both examiners as independent data points would have led to double-counting the same patients and underestimated uncertainty. To assess the robustness of the findings, sensitivity analyses were conducted using contingency tables derived from the previously non-selected experts.

The bivariate random-effects model, as described by Chu and Cole and Reitsma et al., was applied to evaluate the diagnostic accuracy of OPMD and OC detection. (24, 25). This modelling approach accounts for the inherent correlation between sensitivity and specificity. Sensitivity and specificity estimates from the included studies, along with their pooled summary estimates, were visualized on a receiver operating characteristic (ROC) plot, accompanied by the corresponding 95% confidence and prediction intervals. In these visualizations, the size of the ellipsoids represents the relative weight of each study, calculated according to the method proposed by Burke et al. (26). For the analysis of OL detection, where only three eligible studies were available, the bivariate model could not be reliably fitted. Therefore, separate univariate random-effects analyses of sensitivity and specificity were conducted using a generalized mixed-effects approach (27). In addition to assessing the prediction region, between-study heterogeneity was quantified using the I^2 statistic and its corresponding confidence interval, derived from the univariate analyses. Statistical analyses were conducted using the web-based tool described by Freeman et al. (28) and the meta package of the R statistical software (29). All analyses were performed in accordance with methodological recommendations by Harrer et al. (30).

7.2. Study II. – Effect of OHCP on Oral Hygiene and Oral Opportunistic Pathogens in Post-Stroke Patients

7.2.1. Methodology and Protocol

This study was conducted and reported in accordance with the PRISMA 2020 guidelines (18) and the methodological recommendations outlined in the Cochrane Handbook (20). The study protocol was prospectively registered in the PROSPERO database (registration number: CRD42022346788).

7.2.2. Eligibility Criteria

We defined study eligibility according to the PICO framework. The population (P) comprised adult post-stroke patients undergoing rehabilitation. The intervention (I) consisted of an OHCP designed to improve oral hygiene. The comparator (C) included the absence of a specific OHCP or the provision of routine oral care. The primary outcomes (O) of interest were measures of oral health status, including the Oral Hygiene Index, Periodontal Screening and Recording/Community Periodontal Index of Treatment Need, Plaque Index, and Gingival (Bleeding) Index. Secondary outcomes included the presence of oral opportunistic pathogens, specifically yeasts, Staphylococcus aureus, and aerobic Gram-negative bacilli (AGNB), as well as oral health-related quality of life (OHRQoL) measurements.

Only randomized controlled trials were considered eligible for inclusion. Observational studies, non-original publications, non-peer-reviewed articles, and in vitro and animal studies were excluded from the analysis.

7.2.3. Information Sources and Search Strategy

The initial systematic literature search was conducted on 22 February 2021. The search strategy was subsequently updated on 29 November 2022, including revisions to the search query. Both searches were performed across the following electronic databases: MEDLINE (via PubMed), Embase, and the Cochrane Central Register of Controlled Trials (CENTRAL).**Error! Reference source not found.Error! Reference source not found.** *Table 1* presents the original and the updated search queries. No search filters were applied.

Table 1 Original and Updated Search Query

Original	**Updated**
(oral and (health* OR hygiene OR care)) AND stroke AND (ohrqol OR quality of life OR DMFT index OR cpitn OR ohs OR plaque index OR gingival index OR toothbrush* OR rinse OR mouthwash OR education)	(oral or mouth) and (health* OR hygien* OR care) AND (stroke or stroke* or brain infarct* or ’cerebrovascular accident’) AND random*

7.2.4. Study Selection and Data Extraction

For duplicate removal, the reference management software EndNote X9 (Clarivate Analytics) was used. Two authors independently screened titles and abstracts, followed by full-text assessment of potentially eligible studies. Inter-reviewer agreement was quantified using Cohen's kappa statistic. Any disagreements were resolved through consultation with a third independent author. Additionally, citation chasing was performed after the completion of the full-text selection to identify further relevant studies.

Data extraction was performed independently by two authors using a predefined data collection form. Any discrepancies were resolved through discussion.

The following data were extracted from each included study: first author, year of publication, study setting, randomization and blinding procedures, characteristics of the study population, age, sample size, sex distribution, inclusion and exclusion criteria, characteristics of the OHCP, details of the control condition, timing of the intervention, oral health indices, measures of functional dependency, and other stroke-related variables. Where outcomes were reported at multiple time points, short-term assessments were grouped for analysis. For quantitative outcomes, sample size, mean values, and corresponding standard deviations were extracted.

7.2.5. Risk of Bias and Quality of Evidence Assessment

Risk of bias was assessed in accordance with the Cochrane Handbook (20) using the revised Cochrane risk-of-bias tool for randomized trials (ROB-2) (31). The assessment was conducted independently by two authors, and any disagreements were resolved through consultation with a third independent author.

The certainty of evidence was evaluated in accordance with the recommendations of the GRADE workgroup (22). Outcome endpoints were assessed independently by two authors, and a third independent author resolved any disagreements. GRADE evidence profiles for the outcomes of interest were generated using the GRADEpro Guideline Development Tool (23).

7.2.6. Data Synthesis and Analysis

Change from baseline was defined as the primary outcome of interest for all analyses. Effect sizes were pooled using a random-effects model. For continuous outcomes, the difference in means (MD) with its 95% confidence interval (CI) was used as the measure of effect size. Study-level MDs were calculated using reported sample sizes, means, and standard deviations (SDs). When changes from baseline were assessed, the standardized mean difference (SMD) was used as the effect size due to between-study heterogeneity. The mean change from baseline was calculated as the difference between the follow-up and baseline means. To obtain conservative variance estimates, baseline and follow-up SDs were summed within each study arm. These change scores and corresponding SDs were subsequently used to calculate pooled effect estimates and 95% CIs for differences between groups.

For outcomes measured on different scales, including the plaque index, SMDs with 95% CIs were calculated using Hedges' g as the standardized effect measure (32). Study-level and pooled SMDs were derived from reported sample sizes, means, and SDs for each study.

For binary outcomes, including the presence of Candida spp., Staphylococcus aureus, and AGNB, baseline and follow-up data were extracted as the number of events and the total group sample size. Effect sizes were expressed as risk ratios (RRs) with 95% CIs, calculated as the risk of the event of interest in the intervention group divided by the corresponding risk in the control group. Results were considered statistically significant when the pooled 95% CI did not include the null value.

Between-study heterogeneity was estimated using restricted maximum likelihood to calculate the between-study heterogeneity (τ^2), a method recommended for its favourable statistical properties (33, 34). The Q-profile method (35) was applied to derive 95% confidence intervals for τ^2. Relative heterogeneity was further quantified using the I^2 statistic proposed by Higgins and Thompson, along with its corresponding 95% CI (36). Given the limited number of studies included in the meta-analyses, estimates of heterogeneity were interpreted with caution. To obtain more reliable CIs in the presence of small study numbers, the Hartung–Knapp–Sidik–Jonkman method (37-39) was applied

in preference to the Wald approach (40). Where at least three studies were available, 95% prediction intervals were also reported.

All statistical analyses were conducted using R statistical software (29) with the meta package.

8. RESULTS

8.1. Study I. – Teledentistry in the Diagnosis of Oral Lesions

8.1.1. Study Search and Selection

A total of 7,608 records were identified through the systematic literature search, of which 14 studies met the eligibility criteria and were included in the qualitative synthesis (12, 41-53). Of these, 10 studies provided sufficient data for inclusion in the quantitative synthesis (12, 41-43, 45, 46, 49-51, 53). The study selection process and inter-reviewer agreement, as assessed by Cohen's kappa statistic, are presented in the PRISMA flowchart (*Figure 1*).

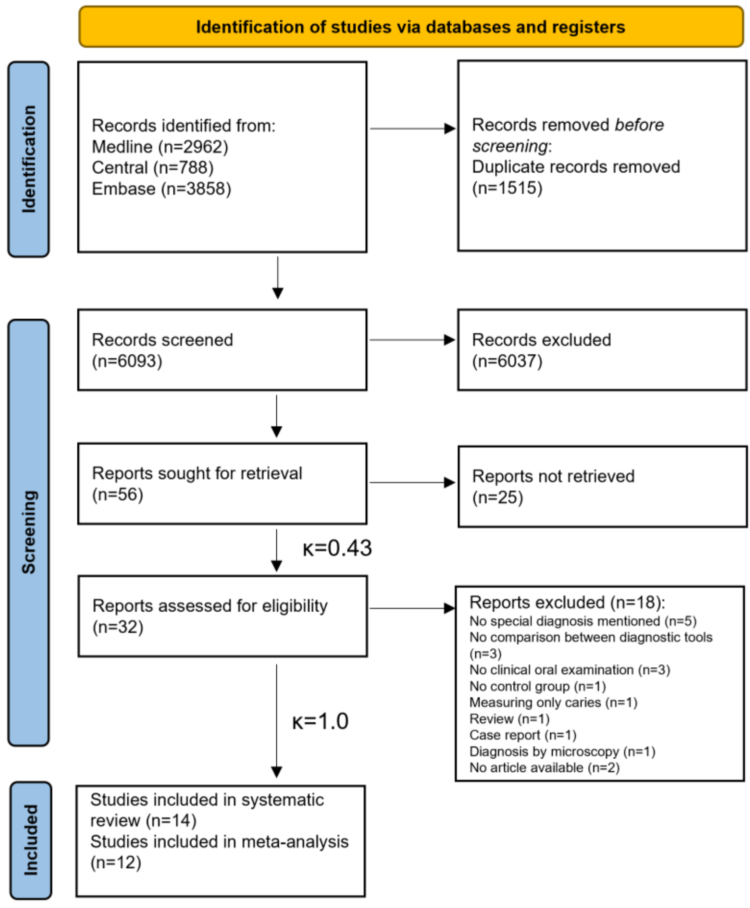


Figure 1. PRISMA 2020 Flowchart Representing the Study Selection Process (18)

8.1.2. Baseline characteristics

The baseline characteristics of the studies included in the qualitative synthesis are summarized in *Table 2*.

Table 2. Basic Characteristics of the Included Articles

Author (year)	Study Site	Study Design	Nº of participants	Mean Age (years)	Inclusion criteria	Exclusion criteria	Risk factor surveyed	Target condition definition	Index test			Reference standard
									Person conducting a remote diagnosis	Type of photography tool	Description of the TD tool	
Birur† (2015)	India	Cohort	3440	18-85	Targeted group from 2 rural villages, opportunistic group from oral surgeon's screening	N/A	Smoking tobacco, chewing betel leaf/gutka, regular use of alcohol	N/A	Not applicable	Mobile phone	Sana application was designed that is integrated with OpenMRS (medical record system)	Not applicable
Birur (2019)	India	Cross-sectional	3445	18-57	Workers of a pipeline factory	N/A	High risk of tobacco use	WHO	Remote specialist using mHealth	Mobile phone	Mobile phone-based questionnaire and photos of oral cavity	Screening by onsite specialist
Gomes (2017)	Brazil	Prospective	55	60-80+	>40 years old, smoking	N/A	Smoking, alcohol consumption, oral/ pharyngeal cancer in family	Grouped lesions (9)	2 trained examiners (>3years of experience)	Mobile phone	Newly developed app: videos of oral cavity and in-app data	Examiners with experience in oral diagnosis
Flores (2022)	Brazil	Cross-sectional	100	51,3	Patients referred to one of the 3 included oral medicine centers	N/A	N/A	Exact lesion diagnosis	Remote dentist	Mobile phone (at least 10megapixel resolution) or camera	Mobile phone application that includes patient data, and characteristics of the lesion and photos of the lesion	Expert professor

Fonseca† (2021)	Brazil	Cross-sectional	113	52	>5years of age with oral lesion	Difficulties with mouth opening	N/A	Final diagnosis, listed	Oral medicine and oral pathology professors (15 years of experience)	iPhone 5, 8mp camera	Photos were e-mailed with clinical implication to evaluators	COE or biopsy
Haron (2017)	Malaysia	Cross-sectional	8	N/A	8 targeted lesions, 8 normal or variant of normal	Not applicable	Not applicable	OPMD/ non-OPMD/ normal	Oral medicine specialist	5-13MP mobile phone camera	Photos taken by mobile phone, retrieved later for review	COE by oral medicine specialist
Haron (2021)	Malaysia	Prospective	355	53,9	Adults >18 years old referred by primary dentist	N/A	Alcohol consumption, smoking, betel-chewing	Presence of lesion/ normal variant, pre-determined table	Off-site specialist	13 MP mobile phone	Using MeMoSa application	COE by oral medicine or oral surgery specialist
Namakian† (2012)	USA	Observational	29	47	Patients of Special Care Clinic: intellectual disability, cerebral palsy, Down syndrome, autism, seizures, HIV, liver disease, neurologic disorders, stroke, schizophrenia	If the patient was not able to cooperate for records collection (at least intraoral and extraoral photos)	N/A	Community-based treatment or referral to dentist	Study dentists	Intraoral camera, point-and-shoot camera	COE followed by an evaluation questionnaire, after 3 3-week washout period a virtual examination was conducted	Study dentists

Perdoncini (2021)	Brazil	Cross-sectional	33	53	>18 years old patients referred to the clinic with oral lesion	Symptoms but no oral sign	N/A	Diagnosis per lesion	OMS	iPhone SE	The dentist sent the photos to specialist via WhatsApp, and a video call was initialized	OMS
Petruzzi (2016)	Italy	Cross-sectional	96	N/A	Referred patients by general dentists/oral hygienist/physician OR patient	N/A	N/A	Traumatic, infective, preneoplastic/neoplastic, autoimmune, not diagnosable	OMS	Mobile phone	Photos sent via WhatsApp, and after clinical examination was made. Biopsy was made where needed.	OMS
Tesfalul (2016)	USA	Observational	23	45,5	Referred adult patients with complicated oral lesion, receiving care via the mobile oral telemedicine system	<18 years, incomplete telemedicine consultation, failure to obtain consent	N/A	Cancer, infection, fracture, benign mass, dermatologic conditions, other	Specialist	HTC myTouch mobile phone	Mobile telemedicine application including image-sharing and clinical data	COE conducted by dentist
Torres-Pereira (2008)	Brazil	Cross-sectional	25	N/A	People with oral lesion	People without oral lesion	N/A	Predefined list of terms	OMS (10 years of experience)	FUJI S7000 digital camera	Images sent via email, with an electronic form containing patient's data	COE by OMS or biopsy when needed
Torres-Pereira (2013)	Brazil	Cross-sectional	60	N/A	People with oral lesion	N/A	N/A	Predefined list of terms	OMS	Canon EOS 300 Rebel digital camera	Images sent via email, with an electronic form containing patient's data	Biopsy

Vinayagamoorthy† (2018)	India	Cross-sectional	131	37,34	Patients included from oral screening programs	Having problem with comprehension, limited mouth opening	Medical and habit history	Normal/ abnormal, exact lesion diagnosis	Trained and calibrated examiner	Samsung mobile phone	Set of 5 photos were taken, then sent to the specialist via WhatsApp	Trained and calibrated examiner

† Study Included Only in the Systematic Review. COE=Clinical Oral Examination; N/A=Not Available; OMS=Oral Medicine Specialist; TD=Teledentistry

8.1.3. Primary Outcomes

8.1.3.1. Oral Lesion Detection with Teledentistry Tools

The pooled analysis of three studies (41, 43, 44), comprising 3,783 participants, demonstrated that TD tools are a reliable alternative to face-to-face dental visits for detecting OLs. The pooled sensitivity was 0.92 (95% CI: 0.59–0.99) and the pooled specificity was 0.93 (95% CI: 0.17–1.00) (*Figure 2*). Substantial heterogeneity was observed across the included studies, with I^2 values of 84% ($p < 0.01$) for sensitivity and 98% ($p < 0.01$) for specificity. Owing to the limited number of eligible studies, fitting a bivariate random-effects model was not feasible for this outcome.

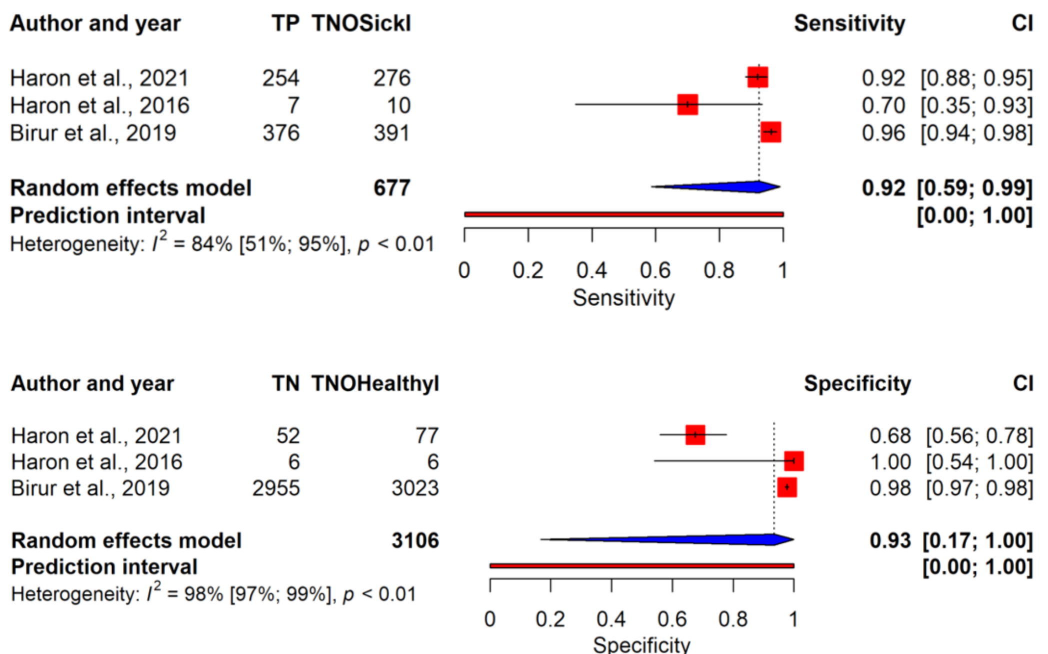


Figure 2. Forest Plot Representing High Sensitivity and Specificity of Diagnosing the Presence of Oral Lesions with Telendentistry Tools. TP=True Positive; TN=True Negative; CI=Confidence Interval

8.1.3.2. Diagnosing Oral Premalignant Lesions or Oral Cancer

As the exact numbers of true positive, true negative, false positive, and false negative cases were not reported in all included studies, a predefined diagnostic classification table

was applied to address this limitation, as summarized in *Table 3*. Using this approach, available data were assessed to diagnose OPMD or OC.

Table 3 Predefined Classification Table

Group I: Cancer/ Oral Potentially Malignant Disorder (OPMD)	
Oral potentially malignant disorder	
	Non-healing ulceration
	Erythroplakia
	Erythroleukoplakia
	Leukoplakia (homogenous/non-homogenous)
	Oral submucous fibrosis
	Smokeless tobacco keratosis
	Palatal lesions associated with reverse smoking
	Discoid lupus erythematosus
	Actinic keratosis (lip only)-cheilitis actinica
	Condensing ostitis
Malignant lesions	
	Suspicious of oral cancer
	Oral squamous cell carcinoma
	Solitary pigmented macule (on palate and gingiva)
Group II: Benign Lesions	
Benign conditions of the tongue	
	Erythema migrans/ Geographic tongue
	Median rhomboid glossitis
	Fissured tongue
	Black hairy tongue
	Fimbriated fold of the tongue
Inflamatory	
	Herpes labialis
	Oral Candidiasis
	Paracoccidioidomycosis
	Aphthous stomatitis
	Osteomyelitis
	Osteoradionecrosis
	Sialolithiasis
Benign tumours/tumour-like lesions	
	Lipoma
	Pyogenic granuloma
	Drug-induced gingival fibromatosis
	Peripheral giant cell granuloma
	Fibroma
	Haemangioma
	Papilloma
	Mucocele
	Ranula
	Fibrous hyperplasia (inflammatory)
	Papillary hyperplasia (inflammatory)
	Necrotizing sialometaplasia
Other mucosal lesions	
	Denture stomatitis
	Traumatic ulcer
	Neutropenic ulcer
	Hyperkeratosis (frictional keratosis)

	Smoker's palate
	Periodontal abscess
	Residual cyst
	Retentional cyst
	Amalgam tattoo
	Neurofibromatosis
	Nicotinic stomatitis
	Reactive hyperkeratosis
	Primary herpes stomatitis
	Bone spicule
	Burning mouth syndrome
	Peutz-Jeghers syndrome
Others (related to benign/reactive)	
	Lichen planus
	Erythema multiforme
	Lupus erythematosus
	Pemphigus vulgaris
	Reconstructed tissue
	Surgical defect for areas that are not reconstructed
Group III: Normal anatomic variant/developmental abnormalities	
Normal anatomic variant	
	Linea alba
	Leukodema
	Racial pigmentation/melanosis
	Anatomical gingival fibromatosis
	Diffuse pigmentation of gingiva and other parts
	Varicosities
Developmental anomalies	
	Fordyce granules
	Congenital lip pits
	Palatal/mandibular torus
	Ankyloglossia/tongue tie
	Cleft lip/cleft palate
	Exostosis
	Sublingual gland eminence
	Naevus

The pooled analysis of nine studies (12, 41-43, 46, 49-51, 53) demonstrated high diagnostic accuracy of TD for the differential diagnosis of OLs, with a pooled sensitivity of 0.926 (95% CI: 0.818–0.972) and a pooled specificity of 0.987 (95% CI: 0.947–0.997), as shown in *Figure 3* and *Figure 4*. Between-study heterogeneity was low, as indicated by moderate prediction region size and I^2 values of 0% for both sensitivity ($p = 0.66$) and specificity ($p = 1.00$).

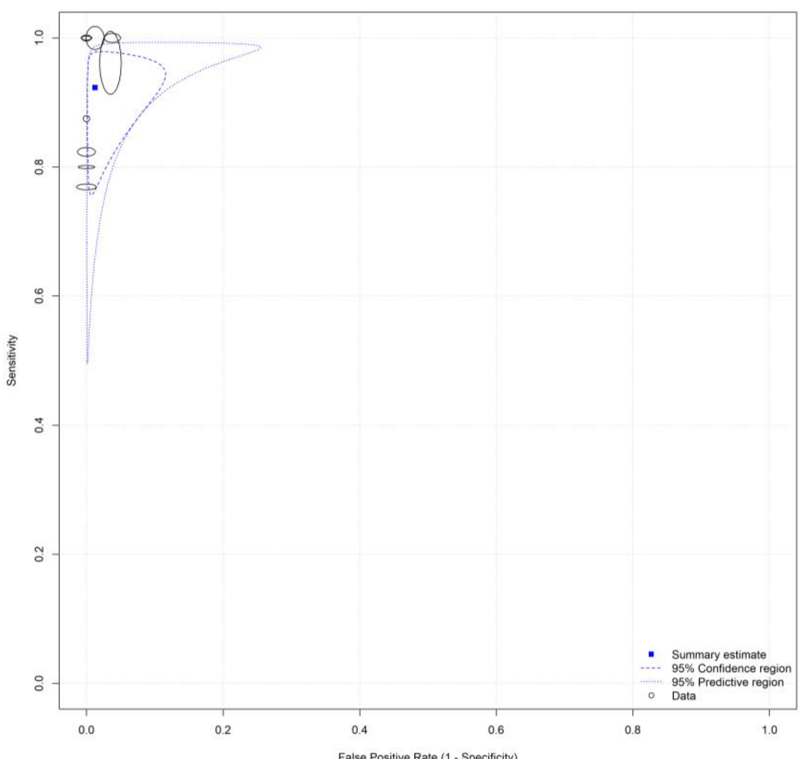


Figure 3 Sensitivity and False Positive Rates of Diagnosing Oral Premalignant or Malignant Lesions with Telendentistry Tools.

The low false-positive rate and the relatively small ROC curves for the 95% confidence region and 95% predictive region highlight that teledentistry tools can reliably support the differential diagnosis of oral lesions, encouraging trust among healthcare professionals and researchers.

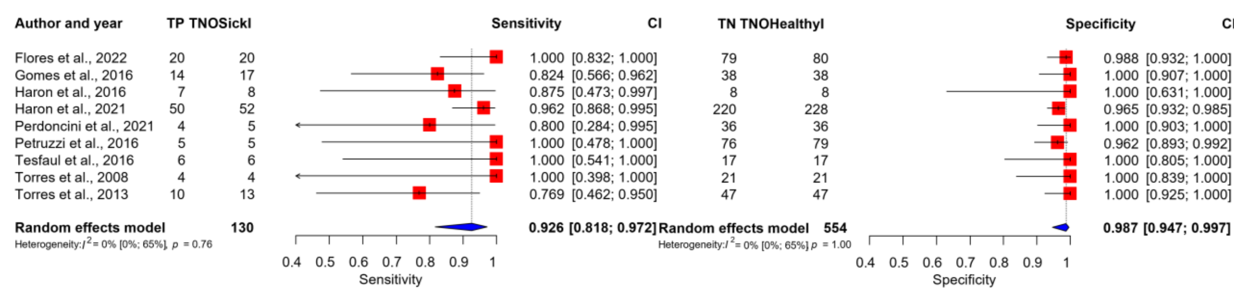


Figure 4 Forest Plots Showing High Sensitivity and Specificity of Diagnosing Oral Premalignant or Malignant Lesions with Telendentistry Tools. TP=True Positive; TN=True Negative; CI=Confidence Interval

Sensitivity analyses yielded pooled estimates of 0.95 (95% CI: 0.86–0.99) and 0.98 (95% CI: 0.93–1.00) for sensitivity and specificity, respectively. See details in *Figure 5*. These findings were consistent with those of the primary analysis, confirming the results and indicating that the diagnostic accuracy was not dependent on the individual examiner's level of expertise.

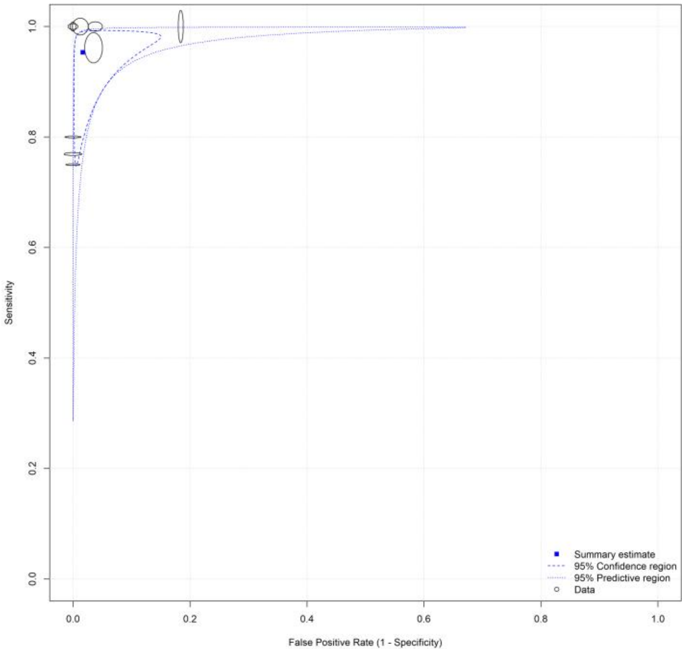


Figure 5 Sensitivity Running for Diagnosing Oral Premalignant or Malignant Lesions with Telendentistry Tools

8.1.4. Secondary Outcomes

8.1.4.1. Time Effectiveness

Due to substantial heterogeneity in the reporting of time-related outcomes, a quantitative synthesis of time-effectiveness was not possible. Nevertheless, several individual studies provided descriptive data relevant to this outcome. Namakian et al. reported a shorter mean examination time for virtual assessments (mean: 2.83 minutes; SD: 1.0) compared with in-person examinations (mean: 4.2 minutes; SD: 1.6) (48). Perdoncini et al. documented a mean patient transportation time of 58.3 minutes (SD: 52.9), indicating that a considerable proportion of participants were recruited from rural areas. (49). In the same study, the average duration of COE was 10.44 minutes (SD: 2.88). Additionally, Petruzzi

et al. reported an average travel distance of 70 km (SD: 78 km) for patients using a WhatsApp-based TD platform (42).

8.1.4.2. Screening Person

Birur et al. demonstrated that trained healthcare workers were able to detect OPMD with a PPV of 45% (45). In addition, their evaluation of community health workers (CHWs) in identifying OL revealed high agreement with on-site specialists, as indicated by a Cohen's kappa of 0.92. These findings suggest that, beyond dentists, appropriately trained CHWs may play a valuable role in the initial detection of OLs.

8.1.4.3. Referral Decision

Referral decision-making was evaluated in four studies (41, 43, 47, 48). However, considerable variability in referral policies was observed across the included articles. Fonseca et al. reported that, on average, 35.4% of examined patients could be managed within primary dental care without referral to specialist services (47). In contrast, Haron et al. demonstrated a high level of agreement in referral decisions when using a predefined referral list of types of OLs, reporting a Cohen's kappa value of 0.892 (95% CI: 0.843–0.940) (43). These findings highlight the potential of structured referral criteria – such as a predefined referral list– to improve consistency in TD-supported triage.

8.1.4.4. Technical Setting

The technical settings of TD applications varied substantially among the included studies. Haron et al. identified a positive correlation between higher mobile phone camera resolution and diagnostic agreement in lesion categorization, with reported accuracy ranging from 0.515 to 0.881 (41). Improved image quality contributed not only to enhanced lesion detection (sensitivity: 0.813; specificity: 1.00) but also to more accurate diagnosis (sensitivity: 0.93; specificity: 1.00), emphasizing the value of high-quality images in supporting effective TD practices and fostering confidence among clinicians and researchers.

Perdoncini et al. evaluated real-time video consultations with OMS and reported that 91% of the transmitted images were of good quality, while Internet connectivity was stable in 58% of cases (49).

In two studies (12, 51), professional cameras were used to simulate primary dental care settings, with images transmitted to OMS via email, thereby minimizing the impact of Internet connectivity issues.

Several studies have explored the feasibility of population-based screening using photographs on freely available messaging applications (42, 49, 52). In these settings, images were submitted by dentists, dental hygienists, and patients. Vinayagamoorthy et al. assessed the use of WhatsApp for remote screening. They reported high diagnostic sensitivity (0.981 and 0.987 for two independent examiners) and specificity (0.72 and 0.64 for two independent examiners) for exact lesion identification, supporting the feasibility of low-cost digital platforms for OL screening (52).

8.1.5. Risk of Bias Assessment

Risk of bias was assessed using the QUADAS-2 tool, and the results are summarized in *Figure 6*. Overall, most domains across the included studies were judged to be at low risk of bias. However, concerns were identified in the patient selection domain in two studies. In one study (47), the use of inappropriate exclusion criteria resulted in the inclusion of only participants with predefined risk factors, potentially limiting the generalizability of the findings. In another study (41), participant selection was based on the presence or absence of OL, OPMD, or OC, which may have introduced selection bias.

The index test domain was rated as having an unclear risk of bias in studies where the same examiner performed both the COE (index test) and the TD assessment, despite the use of a fixed, predefined washout period (47, 48, 50).

Due to the limited number of included studies, assessment of publication bias using the method proposed by Deeks et al. was not feasible (54).

Study	RISK OF BIAS				APPLICABILITY CONCERNS		
	PATIENT SELECTION	INDEX TEST	REFERENCE STANDARD	FLOW AND TIMING	PATIENT SELECTION	INDEX TEST	REFERENCE STANDARD
Birur 2015-FHW	?	☺	☹	☹	☺	☺	☹
Birur 2015-OC spec	?	☺	☺	?	☺	☺	☺
Birur 2019	☺	☺	☺	☺	☺	☺	☺
Fonseca 2021	☹	?	☺	?	☺	☺	☺
Haron 2017	☹	☺	☺	☺	☺	☺	☺
Haron 2021	☺	☺	?	☺	☺	☺	☺
Gomes 2017	☺	☺	☺	☺	☺	☺	☺
Namakian 2012	?	?	☺	☺	☺	?	☺
Perdoncini 2021	☺	☺	☺	?	☺	☺	☺
Petruzzi 2016	☺	☺	☺	☺	☺	☺	☺
Tesfalul 2016	☺	?	?	?	☺	☺	?
Torres-Pereira 2008	☺	☺	☺	☺	☺	☺	☺
Torres-Pereira 2013	☺	☺	☺	☺	☺	☺	☺
Vinayagamoorthy 2019	☹	☺	☺	☺	☺	☺	☺

☺ Low Risk ☹ High Risk ? Unclear Risk

Figure 6 Risk of Bias Assessment Using QUADAS-2 Tool for All of the Included Studies. Article Names in Bold Are Included in the Quantitative Analysis

8.1.6. Quality of Evidence

The certainty of evidence for diagnostic accuracy outcomes was assessed using the GRADE approach (22) and is summarized in *Table 4* and

Table 5.

Assessment of OL presence or absence indicates low certainty of evidence. Although the included studies were cross-sectional diagnostic accuracy studies with no serious concerns regarding risk of bias, indirectness, or inconsistency, the certainty was downgraded primarily due to serious imprecision and a strong suspicion of publication bias. This is reflected in the wide ranges observed for false-positive and false-negative estimates across studies.

In contrast, the differential diagnosis of OPMD demonstrates a moderate certainty of evidence. In this analysis, no serious concerns were identified across most GRADE domains. Despite persistent concerns about publication bias, the greater number of included studies and narrower confidence intervals for true-positive and true-negative estimates led to a higher overall certainty rating than for lesion presence detection.

Table 4 Certainty of Evidence Table for Oral Lesion Detection

Outcome	**№ of studies, № of patients)**	**Study design**	**Factors that may decrease the certainty of evidence**				**Effect per 100 patients tested**	**Test accuracy Clinical Oral Examination**
			Risk of bias	**Indirectness, inconsistency**	**Imprecision**	**Publication bias**	**pre-test probability of 10%**	
True positives (patients with oral lesions)	3 studies 677 patients	cross-sectional (cohort type accuracy study)	not serious	not serious	serious	Publication bias is strongly suspected	9 (6 to 10)	⊕⊕◯◯ Low
False negatives (patients incorrectly classified as not having an oral lesion)							1 (0 to 4)	
True negatives (patients without oral lesions)	3 studies 3106 patients	cross-sectional (cohort type accuracy study)	not serious	not serious	serious	Publication bias is strongly suspected	84 (15 to 90)	⊕⊕◯◯ Low
False positives (patients incorrectly classified as having an oral lesion)							6 (0 to 75)	

Table 5 Certainty of Evidence Table for Differential Diagnosis of Oral Lesions

Outcome	№ of studies (№ of patients)	Study design	Factors that may decrease the certainty of evidence			Effect per 100 patients tested			Test accuracy Clinical Oral Examination
			Risk of bias	Indirectness, inconsistency, imprecision	Publication bias	pre-test probability of 17.12%	pre-test probability of 0%	pre-test probability of 0%	
True positives (patients with oral premalignant/malignant lesions)	8 studies 110 patients	cross-sectional (cohort type accuracy study)	not serious	not serious	Publication bias is strongly suspected	15 (14 to 16)	0 (0 to 0)	0 (0 to 0)	⊕⊕⊕◯ Moderate
False negatives (patients incorrectly classified as not having an oral premalignant/malignant lesion)						2 (1 to 3)	0 (0 to 0)	0 (0 to 0)	
True negatives (patients without oral premalignant/malignant lesions)	8 studies 474 patients	cross-sectional (cohort type accuracy study)	not serious	not serious	Publication bias is strongly suspected	82 (77 to 83)	99 (93 to 100)	99 (93 to 100)	⊕⊕⊕◯ Moderate
False positives (patients incorrectly classified as having an oral premalignant/malignant lesion)						1 (0 to 6)	1 (0 to 7)	1 (0 to 7)	

8.2. Study II. – Effect of OHCP on Oral Hygiene and Oral Opportunistic Pathogens in Post-Stroke Patients

8.2.1. Study Search and Selection

A total of 7,608 records were identified through the systematic literature search. Following the selection process, 15 studies (13, 55-67) met the eligibility criteria and were included in the quantitative synthesis. The study selection process and inter-reviewer agreement, as assessed by Cohen's kappa statistic, are presented in *Figure 7*. In addition, citation chasing yielded 565 further records; however, none met the inclusion criteria.

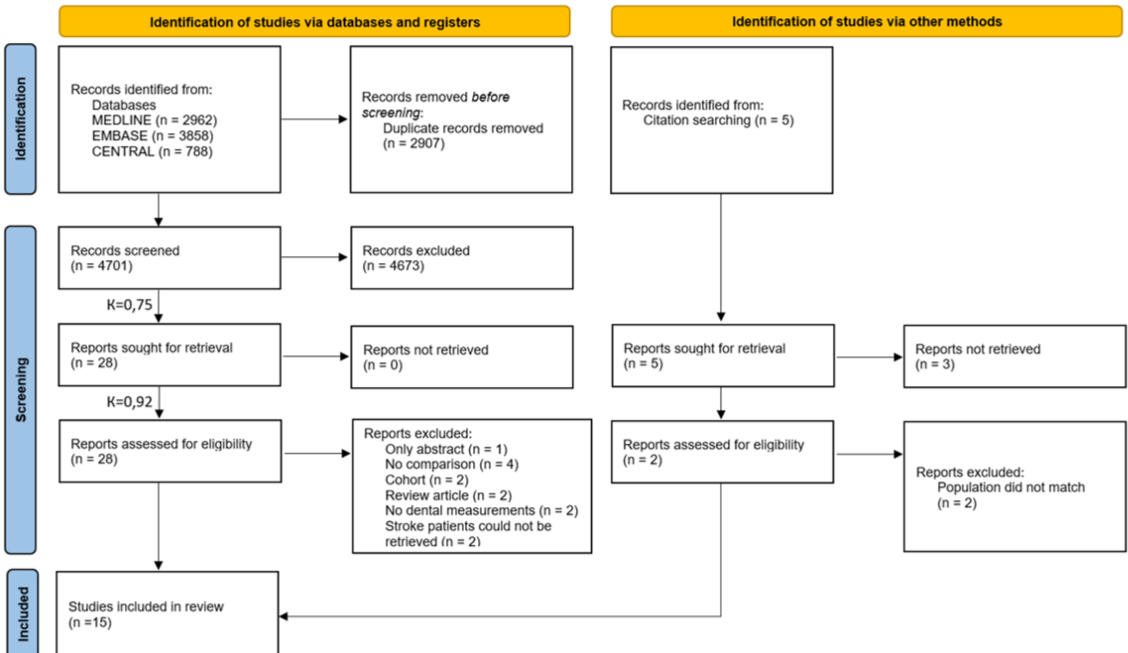


Figure 7 The Selection Process Using the PRISMA 2020 flowchart

8.2.2. Baseline Characteristics

The baseline characteristics of the included studies can be seen at *Table 6*.

Table 6 Baseline Characteristics of the Included Studies

Author (year)	Nº of participants	Age in years	Gender	Inclusion	Exclusion	Oral health promotion program	Control	Timing	Dental measurements	Comments
AbMalik (2017)	86	mean: 53,52 (13,81)	52 male, 34 female	Hospitalized stroke patients, MBI*<70, medically stable, under rehabilitation, no antibiotics, dentated	N/A	Daily powered tooth brushing with 1% CHX gel	Daily manual tooth brushing with commercial toothpaste	Baseline, 3 months, 6 months	Oral clinical assessment, microbiological sample (yeast, S.Aureus, AGNB)	
AbMalik (2018)	86	>40years	52 male, 34 female	Hospitalized stroke patients, MBI*<70, medically stable, under rehabilitation, no antibiotics, dentated	N/A	Daily powered tooth brushing with 1% CHX gel	Daily manual tooth brushing with commercial toothpaste	Baseline, 3 months, 6 months	PI (Sillness-Löe)	
Brady (2020)	105	median: 76 (63-83)	N/A	People with incapacity	No	Nurses participated in a 90-minute online OHC training course that provided information on OHC and a tutorial on OHC assessment and care. Staff had access to all necessary equipment, products, and specialist dental services	N/A	16 months	Dental plaque, denture plaque, OHRQoL	

Chen (2019)	66	N/A	43 male, 23 female	Nasogastric tube insertion, dysphagia, first-time stroke, Chinese language	History of dysphagia (oral cancer or head-neck cancer), more than 6 months of swallowing treatment	30 minutes before swallowing, training 3 times a week, using dental floss/interdental brush, Bass-method tooth brushing, fluoride toothpaste	Usual care (tooth brushing or sponge stick cleaning) twice a day	Baseline, 2 weeks, 3 weeks	OHAT	
Chipps (2014)	51	mean: I: 62,54 (13,5) C:63,74 (15,6)	C: 65,5% male, I: 52,2% male	>18years, English language, primary diagnosis of stroke, admitted directly from an acute care facility, dysphagia	Current pneumonia, infection of the oral cavity, hematological disorder, medically restricted fluid intake, allergy to study products, pregnant/nursing, history of MRSA	Oral care twice a day: battery tooth brushing, tongue brushing, flossing, mouth rinse, and lip care	Usual oral care: tooth brushing, mouth rinse, lip balm (with standard hospital oral care products)	Baseline, day 5, day 10	Revised-THROAT, S.aureus	dysphagia, tube feeding included

Dai (2017a)	94	mean: 66,6 (10,8)	57 male, 37 female	Admitted within six months, BI <70, not edentulous, Mini-Mental State Examination MMSE >18, able to follow a one-step command, no nasogastric feeding tubes	N/A	Powered toothbrush, 0.2% chlorhexidine mouth rinse, toothpaste, oral hygiene instructions for 3 months	Manual toothbrush, toothpaste, oral hygiene instruction for 3 months	Baseline, 3 months, 6 months	PI (Silness-Löe), GBI, dental caries, periodontal health, oral mucosa conditions, dental prosthesis status (WHO), height of calculus (mm), Lobene Extrinsic Tooth Stain Index	
Dai (2017b) only systematic review	95	mean: 66,6 (10,8)	58 male, 37 female	Admitted within six months, BI <70, not edentulous, Mini-Mental State Examination MMSE >18, able to follow a one-step command, no nasogastric feeding tubes	N/A	Powered toothbrush, 0.2% chlorhexidine mouth rinse, toothpaste, oral hygiene instructions for 3 months	Manual toothbrush, toothpaste, oral hygiene instruction for 3 months	Baseline, 3 months, 6 months	OHRQoL (OHIP-14; GOHAI, OHTS)	
Dai (2018)	96	mean: 66,6 (10,8)	59 male, 37 female	Admitted within six months, BI <70, not edentulous, Mini-Mental State Examination MMSE >18, able to follow a one-step command, no nasogastric feeding tubes	N/A	Powered toothbrush, 0.2% chlorhexidine mouth rinse, toothpaste, oral hygiene instructions for 3 months	Manual toothbrush, toothpaste, oral hygiene instruction for 3 months	Baseline, 3 months, 6 months	Microbiological sample (yeast, S.Aureus, AGNB)	3 people took antibiotics due to urethritis

Gosney (2006)	203	16-96	106 male, 97 female	1st stroke	Patients receiving antibiotics, steroid medication, previous stroke	Orabase: 2% (w/v) colistin, 2% (w/v) polymyxin E, and 2% (w/v) amphotericin B. A 500 mg dose of gel was applied topically to the mucous membranes of the mouth four times daily	Placebo	day 0, 8, 15	AGNB	
Kim (2014)	56	mean: I: 57,38 (14,22) C: 56,05 (14,55)	27 male, 29 female	Stroke patient admitted to ICU, first stroke, 6+ teeth, no sign of infection	N/A	Tooth brushing with an interdental brush and tongue cleaner, and cleaning with chlorhexidine	N/A	Stabilization of vital signs following admission to the ICU, before discharge from the ICU	Silness-Löe PI, GI, CAL, DMFT, tooth mobility index (Lindhe's Grading), colonization (Candida)	PI, GI: 6 teeth
Kim (2016)	62	N/A	19 male, 43 female	Patients with stroke who were admitted to the rehabilitation center	≤5 teeth, poor cognitive function, relying only on the caregiver to brush teeth	Removing supragingival calculus with an ultrasonic scaler, tooth brushing education for patient and caregiver, application of disclosing solution, hygienist removed plaque using a toothbrush, an interdental brush, tongue cleaner (every 3-4 days)	Removal of supragingival calculus with ultrasonic scaler, tooth brushing education (once)	Depends on outcome	DMFT, tooth mobility, PI, calculus index, papillary bleeding index, CPI, modified O'Leary index	PI, CI, PBI, CPI: 6 teeth

Lam (2014)	102 (81)	69.9 (SD 10.9)	51 male, 30 female	BI <70, age ≥50 years, admission to the stroke rehabilitation ward up to 7 days earlier	Patient with mild stroke, edentulism, communication difficulties, presence of nasogastric tube	1) Oral Hygiene Instructions+CHX; 2) OHI, CHX, assisted tooth brushing with an electric toothbrush	OHI, involving professional instruction on maintaining good oral hygiene using an electric toothbrush	Baseline, 3 weeks (hospital discharge)	caries status, denture status, number of teeth, CPI, PI, GBI, OHIP-14, OHTS	
Lam (2013a)	102 (81)	69.9 (SD 10.9)	51 male, 30 female	BI <70, age ≥50 years, admission to the stroke rehabilitation ward up to 7 days earlier	Patient with mild stroke, edentulism, communication difficulties, presence of nasogastric tube	1) Oral Hygiene Instructions+CHX; 2) OHI, CHX, assisted tooth brushing with an electric toothbrush	OHI, involving professional instruction on maintaining good oral hygiene using an electric toothbrush	Baseline, 3 weeks (hospital discharge)	S.aureus, yeast, AGNB, denture status, dental plaque, gingival bleeding, DMFT	
Lam (2013b)	102 (81)	69.9 (SD 10.9)	51 male, 30 female	BI <70, age ≥50 years, admission to the stroke rehabilitation ward up to 7 days earlier	Patient with mild stroke, edentulism, communication difficulties, presence of nasogastric tube	1) Oral Hygiene Instructions+CHX; 2) OHI, CHX, assisted tooth brushing with an electric toothbrush	OHI, involving professional instruction on maintaining good oral hygiene using an electric toothbrush	Baseline, 3 weeks (hospital discharge)	PI (Silness-Löe), GBI, caries status, denture status, number of teeth, CPI, OHIP-14, OHTS	PI, GBI 6 site/tooth

Yu (2016)	89	53-76 (64.7± 5.5)	78 male, 52 female	Released 3 months, considered stable by their physicians, no antibiotics in the previous 4 weeks; no periodontal treatment in the last 3 months, minimum 20 teeth in the oral cavity, and having a probing depth greater than 4 mm in no more than two of the Ramfjord teeth	N/A	"Oral hygiene instructions and demonstrations to each participant. Dental plaque, gingivitis, periodontitis, and soft-bristle toothbrushes were explained in plain language. Participants were told to have their teeth brushed twice a day, once in the morning and once at night."	After baseline examination, an educational oral hygiene video was shown to care recipients and caregivers. Modified Bass brushing technique was shown	Baseline, 1,2,3 months	PI, GI	

AGNB: aerobic Gram negative bacilli; BI: Barthel-Index; CHX: chlorhexidine; CPI: Community Periodontal Index; DMFT: Decayed-Missing- Filled Teeth; FOIS: Functional Oral Intake Scale; GOHAI: General Oral Health Assessment Index; MASA: Mann Assessment of Swallowing Ability; MBI: Mean Barthel Index; MMSE: Mini Mental State Examination; MN-SF: Mini-Nutritional-Short Form; mRS: modified Rankin Scale; N/A=Not Available; OHAT: Oral Health Assessment Tool; OHIP-14: The Oral Health Impact Profle-14; OHRQoL: Oral Health Related Quality of Life; OHTS: Oral Health Transition Scale; PI: plaque index; SF-12: 12-item Short Form Health Survey

8.2.3. Primary Outcomes

8.2.3.1. Plaque Index

Based on the five included studies (13, 56, 62, 64, 68), a short-term decreasing trend in plaque index (PI) was observed following OHCP, although the effect did not reach statistical significance (SMD: −2.77; 95% CI: −6.60, 1.06). In the 3-month subgroup and at the 6-month follow-up, no significant reductions were identified (SMD: −4.93; 95% CI: −21.10, 11.24 and SMD: −0.26; 95% CI: −0.79, 0.28), respectively (*Figure 8*). Substantial between-study heterogeneity was observed at both the 1-month and 3-month time points, with τ^2 values of 2.17 and 41.75, respectively.

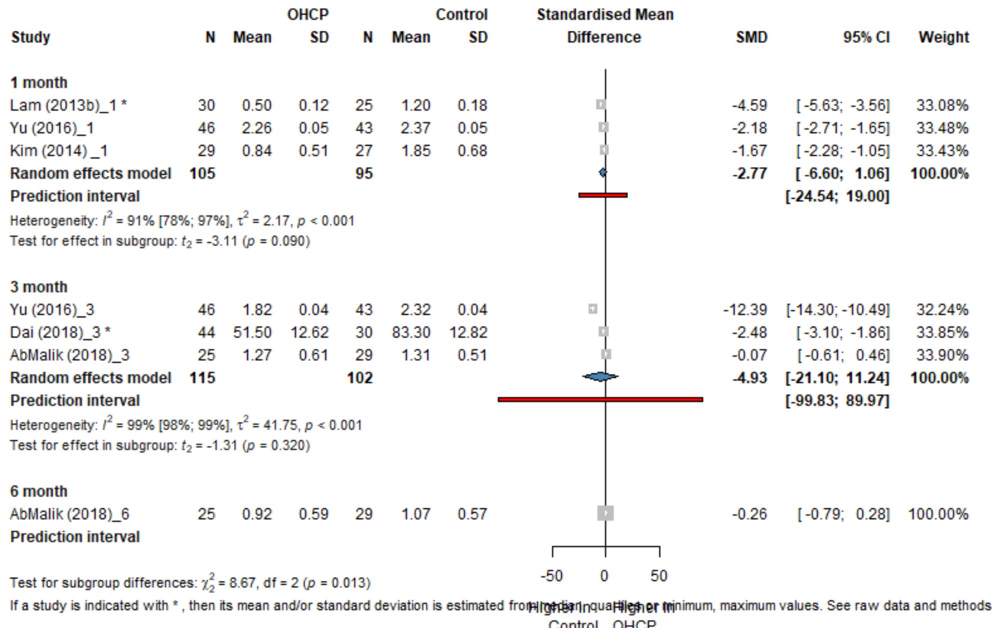


Figure 8 Forest Plot of Studies Showing SMD of Plaque Index at 1-month, 3-month, and 6-month Time Points. SD=Standardized Difference; SMD=Standardized Mean Difference; CI=Confidence Interval

A decreasing trend in the plaque index was observed at the 1-month time point; however, this change did not reach statistical significance. No significant changes in plaque index were detected at subsequent follow-up time points.

8.2.3.2. Gingival Index, Gingival Bleeding Index

Two studies assessed the gingival index at short-term (3 weeks and 3 months) (64, 68). In addition, two studies evaluated the gingival bleeding index at three follow-up intervals (3 weeks, 3 months, and 6 months) (62, 67). Visual illustrations of the outcomes are shown in *Figure 9* and *Figure 10*.

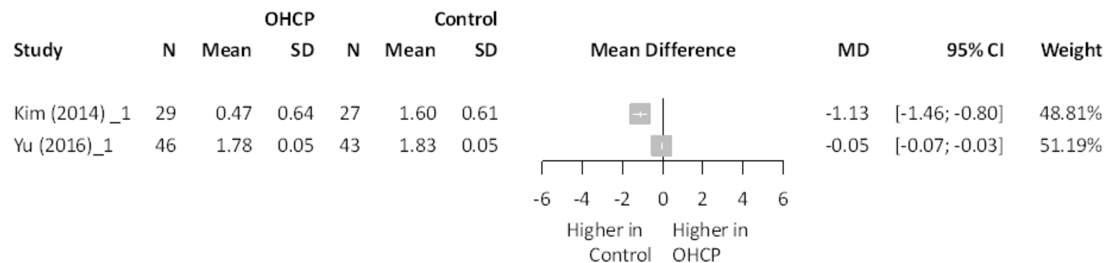


Figure 9 Forest Plot Showing Gingival Index at less than 1 month. OHCP=Oral Healthcare Prevention Program; SD=Standard Deviation; MD=Mean Difference; CI=Confidence Interval

There is no tendency to assess.

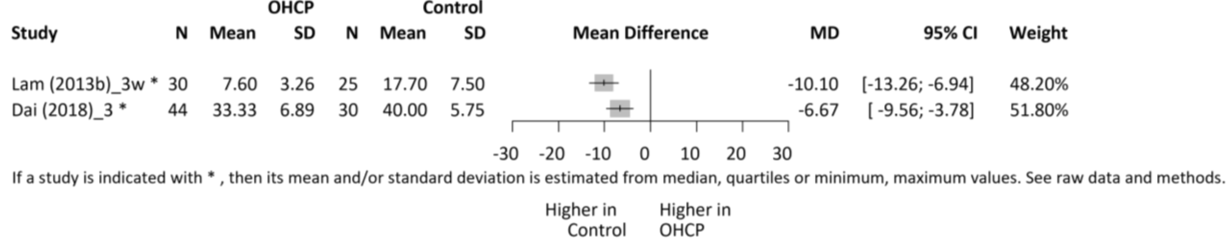


Figure 10 Forest Plot Showing Gingival Bleeding Index at 3 weeks (67) and 3 months (62) timepoints. OHCP=Oral Healthcare Prevention Program; SD=Standard Deviation; MD=Mean Difference; CI=Confidence Interval

A tendency is visible, favouring the control group.

8.2.4. Secondary Outcomes

8.2.4.1. Oral Opportunistic Pathogens

The risk of detecting oral opportunistic pathogens was evaluated across three subgroups: yeasts, *Staphylococcus aureus*, and AGNB.

The presence of *Candida* species in the oral cavity (>10^2 CFU/mL) was assessed in four studies (13, 55, 62, 64) at short-term follow-up (mean duration: 2.2–3 weeks) and at 3- and 6-month time points. OHCP did not result in a statistically significant reduction in

Candida detection at either the short-term or 3-month follow-up when compared with the control group (RR: 1.06; 95% CI: 0.20–5.69 and RR: 0.98; 95% CI: 0.33–2.93, respectively) (*Figure 11*).

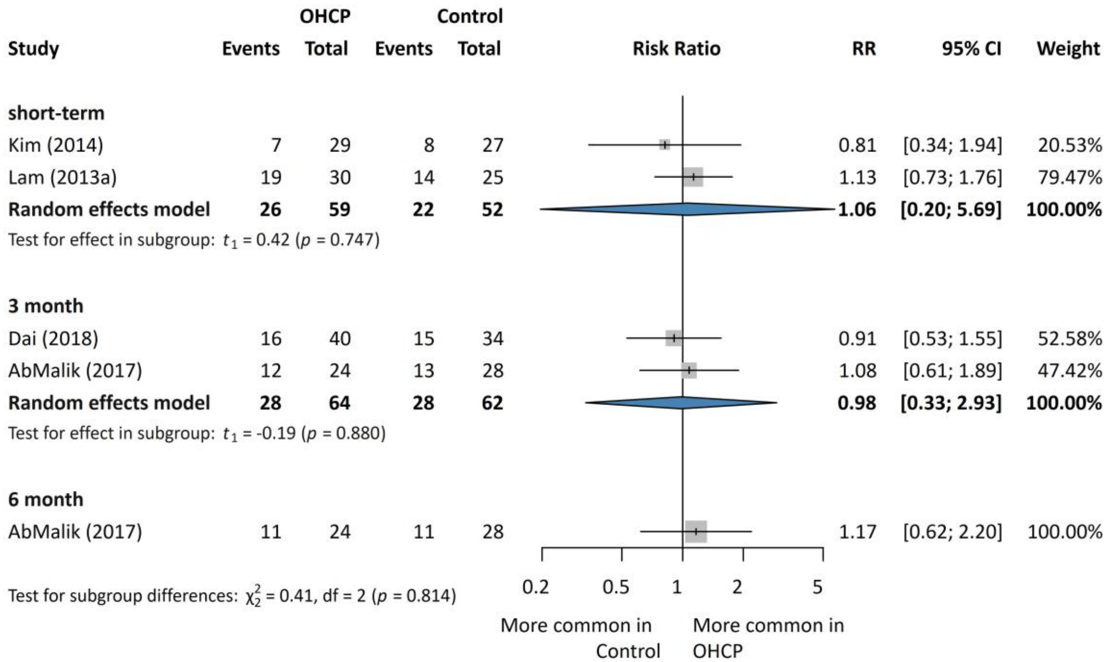


Figure 11 Forest Plot demonstrating the Risk of Presence of Candida Species at Different Timepoints. OHCP=Oral Healthcare Prevention Program; RR=Risk Ratio; CI= Confidence Interval

The forest plot shows no significant difference in risks between the intervention and control groups.

For *Staphylococcus aureus*, four studies (13, 55, 59, 62) reported microbiological assessments conducted at short-term (10 days or 3 weeks), 3-month, and 6-month follow-up intervals. No statistically significant differences were observed between the intervention and control groups at either short- or long-term evaluations (RR: 0.89; 95% CI: 0.07–11.99 and RR: 0.74; 95% CI: 0.01–42.01, respectively) (*Figure 12*).

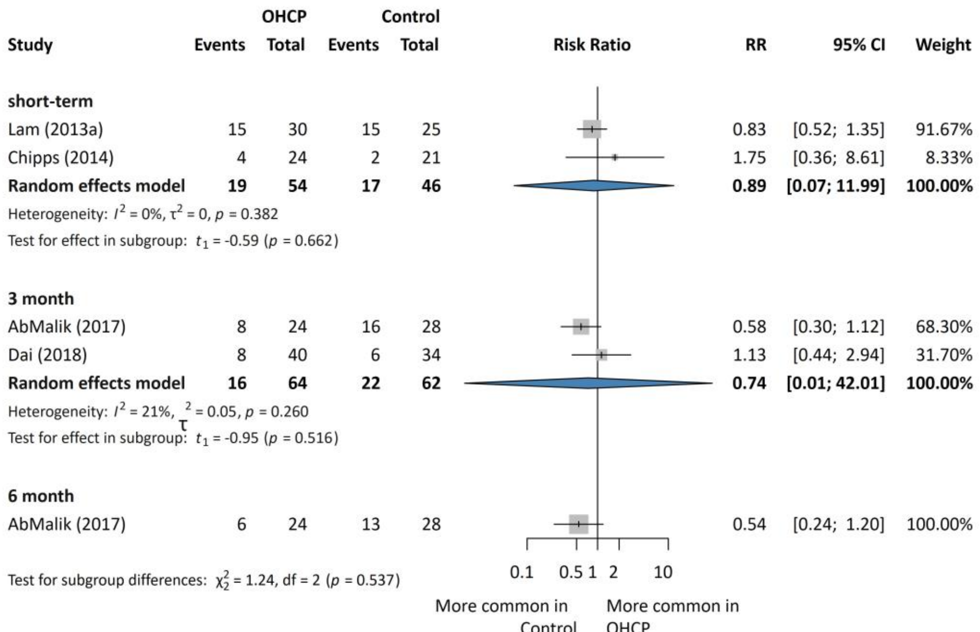


Figure 12 Forest Plot demonstrating the Risk of Presence of S. aureus at Different Timepoints. OHCP=Oral Healthcare Prevention Program; RR=Risk Ratio; CI= Confidence Interval

The short-term and long-term evaluations show no statistically significant risk.

Similarly, four studies evaluated the presence of AGNB at follow-up time points of 2–3 weeks, 3 months, and 6 months. The pooled results did not demonstrate a significant reduction in AGNB detection associated with OHCP at either short- or longer-term assessments (RR: 0.77; 95% CI: 0.00–888.18 and RR: 1.04; 95% CI: 0.34–3.16, respectively) (*Figure 13*).

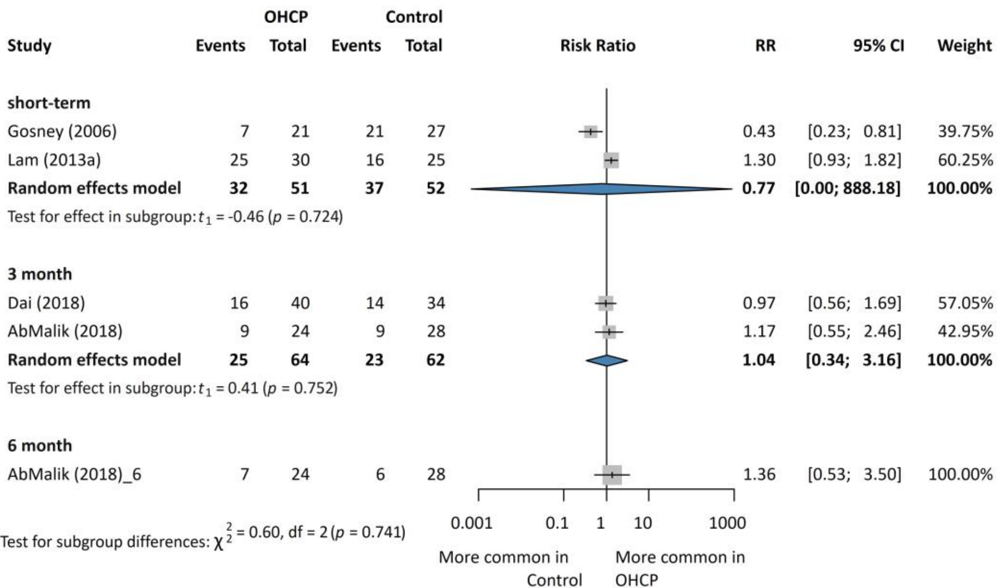


Figure 13 Forest Plot demonstrating the Risk of Presence of Aerobic Gram-Negative Bacilli at Different Timepoints. OHCP=Oral Healthcare Prevention Program; RR=Risk Ratio; CI= Confidence Interval

The statistical analysis did not show a statistically significant risk.

8.2.4.2. Oral Health-Related Quality of Life

OHRQoL was assessed in two studies (61, 66) using two validated instruments: the Oral Health Impact Profile–14 (OHIP-14) (69) and the Oral Health Transition Scale (OHTS) (70). Assessments were conducted at follow-up time points of 3 weeks, 3 months, and 6 months.

Using the OHIP-14, Lam et al. reported a statistically significant reduction in median OHIP-14 scores at the 3-week follow-up compared with baseline (median: 4.0; range: 1.0–9.0 vs. median: 7.0; range: 2.0–14.0; $p = 0.014$) (66). At the 3-month time point, Dai et al. observed a significant improvement in OHRQoL among participants receiving the OHCP ($p < 0.01$) (61). In contrast, no significant change was detected in the control group ($p > 0.05$).

Assessment using the OHTS revealed a significant reduction in total scores at the 3-week follow-up (61). Similarly, at 3 months, a statistically significant decrease in OHTS scores was observed in the intervention group ($p < 0.01$) (61), indicating an improvement in participants' perceived oral health status after the intervention.

8.2.5. Risk of Bias Assessment

Summaries of the risk of bias assessments are presented in *Figure 14* for oral health measurements, *Figure 15* for oral opportunistic pathogens, and *Figure16* for OHRQoL. While assessments of oral health measurements raised concerns about a high risk of bias due to deviations from the intervention and outcome measurement, and missing outcome data, evaluations of oral opportunistic pathogens and OHRQoL were generally deemed to be at low risk of bias.

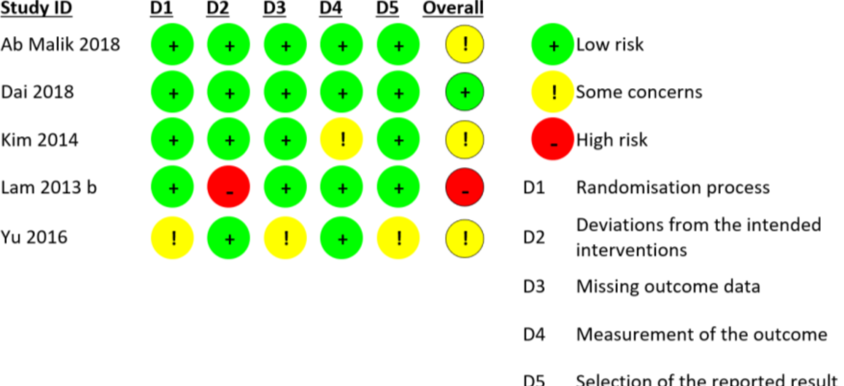


Figure 14 Risk of Bias Assessment of Included Studies Reporting Oral Health Measurements

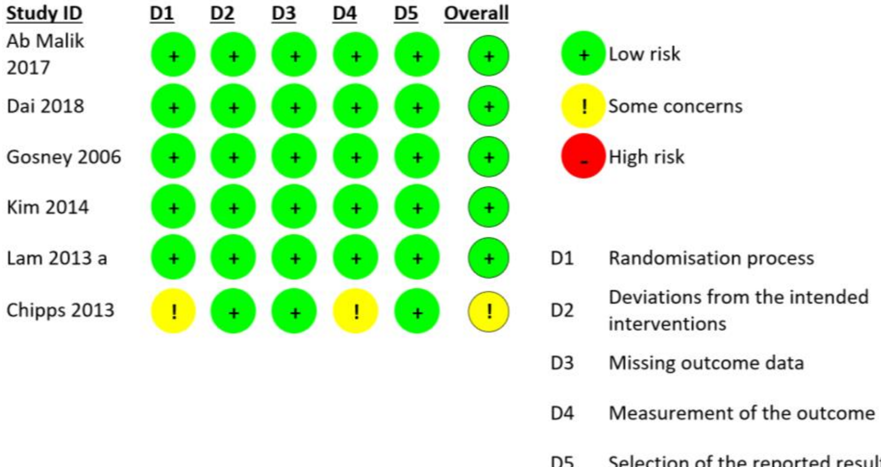


Figure 15 Risk of Bias Assessment of Included Studies Reporting Oral Opportunistic Pathogens

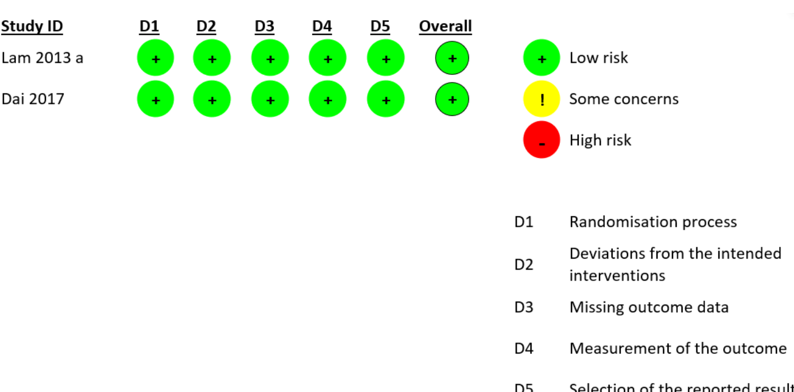


Figure16 Risk of Bias Assessment of Included Studies Reporting OHRQoL

8.2.6. Quality of Evidence

The certainty of evidence for the evaluated outcomes is summarized in *Table 7*. Overall, the certainty of evidence was rated as low for most outcomes due to imprecision, reflected by wide confidence intervals and small sample sizes across the included studies. In addition, limitations in study design and methodological heterogeneity raised concerns about risk of bias across several outcomes. As a result, overall confidence in the estimated effects is limited, indicating that further well-designed studies with larger sample sizes are likely to improve the certainty of the evidence significantly and may change the observed effect estimates.

Table 7 Certainty of Evidence for Included Outcomes

Outcomes	**Anticipated absolute effects* (95% CI)**		**Relative effect (95% CI)**	**№ of participants (studies)**	**Certainty of the evidence (GRADE)**
	Risk with usual oral healthcare	**Risk with oral healthcare prevention program**			
Plaque Index (PI) Scale from: 0 to 1 Follow-up: mean 1 month	-	SMD **2.77 SD lower** (6.6 lower to 1.06 higher)	-	200 (3 RCTs)	⨁◯◯◯ Very low
Plaque Index (PI) Scale from: 0 to 1 Follow-up: mean 3 months	-	SMD **4.93 SD lower** (21.1 lower to 11.24 higher)	-	217 (3 RCTs)	⨁⨁◯◯ Low
Yeast follow-up: mean 2 weeks	42 per 100	**45 per 100** (8 to 100)	**RR 1.06** (0.20 to 5.69)	111 (2 RCTs)	⨁⨁◯◯ Low
Yeasts follow-up: mean 3 months	45 per 100	**44 per 100** (15 to 100)	**RR 0.98** (0.33 to 2.93)	126 (2 RCTs)	⨁⨁◯◯ Low
Staphylococcus aureus follow-up: mean 2 weeks	37 per 100	**33 per 100** (3 to 100)	**RR 0.89** (0.07 to 11.99)	100 (2 RCTs)	⨁◯◯◯ Very low
Staphylococcus Aureus follow-up: mean 3 months	35 per 100	**26 per 100** (0 to 100)	**RR 0.74** (0.01 to 42.01)	126 (2 RCTs)	⨁⨁◯◯ Low
AGNB follow-up: mean 2 weeks	71 per 100	**55 per 100** (0 to 100)	**RR 0.77** (0.00 to 888.80)	103 (2 RCTs)	⨁⨁◯◯ Low
AGNB follow-up: mean 3 months	37 per 100	**39 per 100** (13 to 100)	**RR 1.04** (0.34 to 3.16)	126 (2 RCTs)	⨁⨁◯◯ Low

9. DISCUSSION

9.1. Summary of Findings

This doctoral research addressed two interrelated challenges in oral healthcare delivery for underserved populations: limited access to timely specialist diagnosis of OLs and inadequate preventive oral care among functionally underserved individuals, particularly post-stroke patients. Together, the findings underscore that structural barriers—rather than lack of clinical need—remain the principal drivers of oral health inequities. That digitally supported and task-shifted models of care may offer viable pathways toward more equitable service provision.

9.1.1. Teledentistry in the Diagnosis of Oral Lesions

The diagnostic meta-analysis demonstrated that TD achieves high sensitivity and specificity for the detection and differential diagnosis of OLs, including OPMD and OC. These findings are particularly relevant for populations residing in rural or underserved areas, where access to OMS is often delayed or absent. Delayed diagnosis is a well-established determinant of poorer OC outcomes, contributing to advanced-stage presentation and increased mortality. By enabling remote triage, image-based assessment, and referral prioritization, TD has the potential to substantially reduce diagnostic delays and mitigate geographic and socioeconomic disparities in OC care. Notably, the high diagnostic performance across different examiners suggests that TD can support task-sharing models involving trained non-dental CHW, a strategy especially relevant in low-resource or overstretched healthcare systems.

9.1.2. Effect of OHCP on Oral Hygiene and Oral Opportunistic Pathogens in Post-Stroke Patients

In contrast, OHCP in post-stroke patients revealed no statistically significant improvements in objective oral health indices or reductions in oral opportunistic pathogens. These findings should not be interpreted as evidence against prevention, but rather as reflections of methodological limitations, heterogeneity in interventions, and insufficient statistical power.

Post-stroke patients represent a distinctly underserved group, often affected by motor impairment, cognitive deficits, dysphagia, and dependence on caregivers, all of which compromise their ability to maintain oral hygiene independently.

Notably, despite limited objective improvements, patient-reported outcomes related to OHRQoL showed favorable trends in studies incorporating structured oral health education and assistance. This suggests that even when measurable clinical changes are modest, oral health interventions may still confer significant benefits in terms of comfort, dignity, and perceived well-being—outcomes that are especially important in underserved populations. These findings align with a growing recognition that OHRQoL measures should be prioritized alongside clinical endpoints in rehabilitation and community dentistry research.

9.2. International Comparison

9.2.1. Teledentistry in the Diagnosis of Oral Lesions

Internationally, the role of TD in improving access to oral healthcare specialists for underserved populations has gained increasing attention as health systems seek scalable solutions to persistent inequities (71). TD models have been implemented in diverse settings—from rural and remote communities with limited specialist availability to school-based screening programs in urban regions—demonstrating comparable diagnostic accuracy to conventional in-person care while reducing travel burden and expanding the reach of preventive services (72). Systematic evidence suggests that TD may serve as a cost-effective alternative for remote screening and triage across a range of oral conditions, including caries and periodontal disease, without significant differences in clinical outcomes compared with traditional approaches, especially where workforce shortages limit service availability (73, 74).

Comprehensive overviews of systematic reviews further highlight that TD can improve access, patient communication, and care experiences, while underscoring that equity and data privacy-related outcomes remain under-researched and warrant focused investigation (73).

In the specific context of OL detection, region-specific studies have reported promising diagnostic performance. For example, in Latin America, early investigations suggest that

store-and-forward and real-time teleconsultation strategies, often augmented with artificial intelligence, may achieve diagnostic accuracy comparable to face-to-face clinical evaluations for OPMD, while alleviating geographic and specialist shortages that disproportionately affect underserved populations (75). In high-income regions, such as North America and Europe, TD has been deployed effectively during public health emergencies (e.g., the COVID-19 pandemic), facilitating continuity of care in rural and remote areas where traditional access was disrupted. However, clinician uptake and infrastructure barriers persist (76). Despite these advances, structural, technological, and policy barriers—including reimbursement systems, digital literacy, and connectivity—continue to limit the broader adoption of TD in many low- and middle-income settings.

9.2.1. Effect of OHCP on Oral Hygiene and Oral Opportunistic Pathogens in Post-Stroke Patients

Regarding oral healthcare in post-stroke rehabilitation, international evidence indicates that structured oral care protocols are still inadequately integrated into stroke care pathways worldwide. Cross-national studies consistently report that stroke survivors have poorer oral health outcomes—such as higher caries prevalence and periodontal disease—compared with matched controls, reflecting similar disparities in hospitalization, rehabilitation, and community care settings worldwide (77, 78). Qualitative research from diverse health systems highlights common barriers, including disrupted daily oral hygiene routines, limited professional training in oral care among multidisciplinary teams, and reduced dental service utilization following stroke (79).

Although formal OHCPs for stroke survivors are still nascent in most countries, emerging evidence supports their potential to mitigate declines in oral health through structured hygiene protocols and interdisciplinary collaboration, particularly when integrated into broader rehabilitation frameworks. The lack of strong, consistent clinical evidence underscores a global need for methodologically rigorous trials that evaluate not only clinical endpoints but also implementation outcomes in varied health system contexts.

Taken together, the two bodies of evidence highlight a critical asymmetry: while diagnostic access can be substantially improved through digital innovation, preventive oral healthcare for underserved populations remains under-integrated into mainstream

medical and rehabilitation services. This gap is particularly concerning given the established associations between poor oral health, aspiration pneumonia, cardiovascular disease, and overall mortality in stroke survivors. Integrating oral health into post-stroke care pathways—potentially supported by TD consultations, caregiver training, and dental hygienist involvement—represents a significant opportunity to reduce avoidable complications and long-term health inequalities.

From a health systems perspective, these findings support a shift toward community-based, digitally enabled, and interprofessional models of oral healthcare. Such approaches are well-aligned with the World Health Organization's Global Strategy on Oral Health (80), which emphasizes universal access, prevention, and the integration of oral health into primary care. Future research should therefore focus not only on clinical efficacy but also on implementation science, cost-effectiveness, and scalability, particularly in underserved settings.

9.3. Strengths

9.3.1. Teledentistry in the Diagnosis of Oral Lesions

A significant strength of this study lies in its rigorous methodological design, which includes adherence to the PRISMA 2020 guidelines, prospective protocol registration, and the use of validated tools for risk-of-bias assessment and evaluation of certainty of evidence. The inclusion of diagnostic accuracy meta-analyses enabled quantitative synthesis of sensitivity and specificity, providing estimates of TD's performance in detecting OLs. The study also incorporated sensitivity analyses, which demonstrated that diagnostic accuracy was not dependent on the examiner's level of expertise, supporting the feasibility of task-shifting models involving trained non-specialists. Furthermore, the focus on underserved populations and real-world settings enhances the clinical relevance and potential applicability of the findings.

9.3.2. Effect of OHCP on Oral Hygiene and Oral Opportunistic Pathogens in Post-Stroke Patients

This study provides a comprehensive synthesis of randomized controlled trials evaluating OHCP in a highly underserved and often neglected population. The use of a rigorous Cochrane-based methodology, including ROB-2 for risk-of-bias assessment and GRADE

for evaluating certainty of evidence, strengthens the credibility of the findings. The inclusion of multiple outcome domains, encompassing oral health indices, microbiological measures, and OHRQoL, offers a multidimensional perspective on the potential impact of preventive interventions. Additionally, the focus on change-from-baseline outcomes and conservative statistical approaches enhances the robustness of effect estimation.

9.4. Limitations

9.4.1. Teledentistry in the Diagnosis of Oral Lesions

Despite the strengths, several limitations should be acknowledged. The number of eligible studies was relatively small, particularly for specific outcomes, which limited the feasibility of fitting bivariate diagnostic models and constrained the assessment of publication bias. Substantial heterogeneity was observed in some analyses, reflecting variability in study populations, TD modalities, imaging quality, and reference standards. In addition, the incomplete reporting of diagnostic contingency data in some studies necessitated assumptions and the derivation of indirect data, which may have introduced uncertainty. Finally, most included studies were conducted in controlled or pilot settings, which may limit the generalizability of the findings to large-scale, routine healthcare systems.

9.4.1. Effect of OHCP on Oral Hygiene and Oral Opportunistic Pathogens in Post-Stroke Patients

The primary limitation of this study is the low certainty of evidence across most outcomes, primarily driven by small sample sizes due to the limited number of included articles, imprecision, and substantial heterogeneity between studies. Variability in intervention content, duration, intensity, and implementation settings hindered meaningful comparison and pooling of results. Outcome measures were inconsistently reported, and follow-up periods varied considerably, limiting the ability to detect sustained effects over time. Furthermore, while patient-reported outcomes showed some improvement, objective clinical and microbiological outcomes did not demonstrate consistent benefits, underscoring potential limitations in intervention fidelity. These

factors collectively restrict the strength of causal inferences and highlight the need for more standardized, adequately powered trials.

10. CONCLUSIONS

This doctoral research addressed critical gaps in oral healthcare delivery for underserved populations by examining two complementary domains: the diagnostic performance of TD in detecting OLs and the effectiveness of OHCP in post-stroke patients. Together, these investigations provide a comprehensive perspective on how access-related barriers, rather than clinical complexity alone, contribute to the persistence of oral health inequalities. The findings highlight the need for innovative, system-level approaches that integrate digital technologies and preventive strategies into routine care pathways for underserved populations.

The diagnostic meta-analysis demonstrated that teledentistry is a reliable and accurate tool for detecting and differentiating OLs, including OPMD and OC. High pooled sensitivity and specificity indicate that TD can effectively support early diagnosis and appropriate referral, particularly in settings where access to specialist care is limited. These results underscore the potential of TD to reduce diagnostic delays and mitigate geographic, socioeconomic, and functional barriers to oral healthcare. Importantly, the demonstrated feasibility of involving trained non-dental health care workers in the diagnostic process suggests that task-sharing models may further enhance reach and scalability in underserved communities.

In contrast, the evidence regarding OHCP in post-stroke patients revealed limited and inconsistent effects on objective oral health indices and oral opportunistic pathogens, with overall low certainty of evidence. While these findings reflect substantial methodological heterogeneity and small sample sizes, they also emphasize the challenges of implementing and evaluating preventive oral healthcare in populations with complex functional and cognitive impairments. Nevertheless, improvements observed in patient-reported OHRQoL suggest that even modest preventive interventions may yield meaningful benefits in comfort, dignity, and perceived well-being—outcomes particularly relevant in rehabilitation and long-term care settings.

Overall, this thesis emphasizes the need to integrate oral healthcare more fully into primary care, rehabilitation, and community health systems, particularly for populations at a heightened risk of exclusion from conventional dental services. TD emerges as a promising enabler of equitable access to diagnostics. At the same time, the limited

evidence base for preventive interventions in post-stroke care underscores an urgent need for well-designed, adequately powered randomized trials. Future research should prioritize standardized outcome measures, interdisciplinary collaboration, and implementation-focused evaluation to ensure that oral healthcare innovations translate into sustainable improvements in health equity and clinical outcomes for underserved populations.

11. IMPLICATIONS FOR PRACTICE

The findings of this doctoral research have several important implications for clinical practice, particularly in the delivery of oral healthcare to underserved populations. First, the demonstrated diagnostic accuracy of TD supports its integration into routine oral healthcare pathways as a complementary tool to conventional face-to-face examinations. In settings where access to OMS is limited—such as rural areas, long-term care facilities, and rehabilitation units—teledentistry can facilitate early detection, triage, and referral of OLs, thereby reducing diagnostic delays and improving equity in access to care.

Second, the results suggest that TD-enabled models may support task-sharing approaches involving trained non-dental healthcare professionals, including community healthcare workers, nurses, and rehabilitation staff. By equipping these professionals with standardized training and digital tools for image capture and referral, oral health screening can be seamlessly integrated into existing healthcare encounters, particularly for populations with limited mobility or high care dependency. Such approaches may alleviate workforce constraints and extend specialist expertise beyond traditional dental settings without compromising diagnostic quality.

Third, the limited and inconsistent effects of OHCP in post-stroke patients highlight the need for more structured and interdisciplinary approaches to oral care in rehabilitation practice. Oral health should be recognized as a core component of post-stroke care, with clearly defined responsibilities for oral hygiene support, caregiver education, and routine monitoring. While current evidence does not demonstrate significant improvements in objective clinical outcomes, observed benefits in OHRQoL suggest that preventive interventions can still enhance patient comfort and dignity, thereby reinforcing their clinical relevance.

Ultimately, these findings underscore the importance of integrating digital health solutions with preventive care strategies, rather than implementing them in isolation. Combining TD-based oral health assessment with structured OHCP protocols may enable more comprehensive, patient-centered care for underserved populations. For successful implementation, clinical practice should be supported by clear referral pathways, standardized documentation, and adequate training, alongside institutional and policy-level support to ensure sustainability. Collectively, these practice-oriented implications

underscore the potential of digitally enabled, prevention-focused oral healthcare models to reduce inequities and improve outcomes in underserved populations.

12. IMPLICATIONS FOR RESEARCH

12.1. Methodology and Study Design

The consistently low certainty of evidence highlights the need for more rigorously designed, adequately powered trials with standardized outcome measures and clearly defined control conditions.

The findings of the present research highlight several methodological considerations. Firstly, there is a clear need for larger, adequately powered randomized controlled trials with standardized intervention protocols and outcome measures. In both TD diagnostics and OHCP, heterogeneity in study design, intervention intensity, follow-up duration, and outcome reporting limited the comparability and interpretability of results. Future studies should adopt harmonized definitions for outcomes such as OL classification, oral health indices, and microbiological thresholds to facilitate meaningful synthesis and meta-analysis.

Secondly, future diagnostic accuracy studies should ensure complete and transparent reporting of contingency table data (true positives, false positives, false negatives, and true negatives), enabling bivariate meta-analytical approaches. The use of standardized reference standards and blinded assessment procedures should be prioritized to minimize bias. In addition, longitudinal study designs are warranted to evaluate not only diagnostic performance at a single time point but also the impact of TD-supported diagnosis on downstream outcomes, including time to treatment, disease stage at diagnosis, and patient survival.

Thirdly, research evaluating OHCP in post-stroke patients should incorporate mixed-methods approaches that combine objective clinical measures with patient-reported outcomes and caregiver perspectives. Given the complexity of post-stroke impairments, the fidelity and adherence of interventions should be systematically assessed and reported. Implementation-relevant outcomes—such as feasibility, acceptability, and resource requirements—should be embedded into study designs to enhance applicability. Furthermore, control conditions should be clearly defined and reflect standard care practices to allow valid comparative inference.

12.2. New Areas

Beyond methodological refinement, this thesis's results point to several emerging research areas. One priority area is integrating TD into preventive oral healthcare pathways for underserved populations, particularly post-stroke patients. Future studies should investigate hybrid care models that incorporate remote assessment, caregiver-supported oral hygiene, and periodic professional intervention, evaluating their effectiveness, scalability, and cost- and time-effectiveness across various healthcare systems.

Another promising research direction involves task-shifting and workforce innovation. Investigating the training requirements, diagnostic performance, and ethical implications of involving non-dental healthcare professionals—such as nurses, CHWs, and rehabilitation staff—in oral health screening and monitoring represents a critical area for future inquiry. These studies should also examine how digital tools can support competency, decision-making, and referral accuracy in non-specialist settings.

Finally, research should increasingly adopt an equity-focused lens to examine how socioeconomic status, geographic location, digital literacy, and disability intersect to influence access to oral healthcare. Evaluating TD and preventive interventions in low-resource and marginalized populations will be essential to ensure that digital health innovations do not inadvertently widen existing disparities. Incorporating health economics, policy analysis, and implementation science frameworks will further support the translation of research findings into sustainable, system-level improvements in oral healthcare delivery.

13. IMPLICATIONS FOR POLICY MAKERS

The findings of this doctoral research have significant implications for policymakers responsible for designing health systems, integrating services, and implementing equity-oriented reforms. Both studies highlight that oral health remains structurally marginalized within mainstream healthcare systems, despite its well-documented impact on systemic health outcomes. Policymakers should recognize oral healthcare as an essential component of general health, particularly for underserved populations such as stroke survivors and individuals with limited access to specialist care. Integrating oral health into national non-communicable disease strategies, rehabilitation frameworks, and universal health coverage schemes would represent a critical step toward reducing preventable morbidity and health inequalities.

The demonstrated diagnostic accuracy of remote OL assessment underscores the need for supportive regulatory and reimbursement frameworks that enable alternative care pathways (TD) beyond traditional face-to-face dentistry. Policymakers should consider establishing formal referral and triage protocols to enable oral screening within primary care, rehabilitation, and community health settings, supported by digital consultation where appropriate.

The findings from the post-stroke OHCP study further suggest that preventive oral care is not sufficiently integrated into rehabilitation pathways. Policymakers should mandate the inclusion of oral health assessment and support within stroke unit standards, rehabilitation guidelines, and long-term care regulations. This may include defining professional responsibilities for oral care, supporting interprofessional collaboration, and ensuring access to trained oral health personnel, such as dental hygienists, within institutional care settings.

Aligning oral health policy with broader public health goals—such as healthy ageing, disability inclusion, and post-acute care quality—will be essential to ensure that oral healthcare is no longer treated as an isolated service, but as an integral part of comprehensive, patient-centered healthcare systems.

14. FUTURE PERSPECTIVES

Building on the findings of this doctoral work, a key future direction is the conduct of a well-designed clinical trial comparing an OHCP with standard care in a stroke rehabilitation setting. Such a trial would aim to address the methodological limitations identified in the existing literature by implementing a standardized, clearly defined intervention and control condition, with sufficient sample size and follow-up duration. By adopting harmonized outcome measures and rigorous methodology, this trial could provide higher-certainty evidence regarding the clinical and patient-centered benefits of structured oral healthcare during post-stroke rehabilitation.

The results of such a clinical trial could serve as a critical foundation for integrating oral healthcare into routine post-stroke rehabilitation pathways. Embedding oral health assessment and preventive care into daily rehabilitation practice would support a more holistic, patient-centered approach, addressing an area that is currently underrepresented in standard stroke care protocols. Importantly, including OHRQoL outcomes would ensure that patient perspectives and functional well-being are adequately captured, complementing traditional clinical endpoints. This evidence could directly inform the development of institutional guidelines and interdisciplinary care models involving rehabilitation professionals, nursing staff, caregivers, and oral health practitioners.

In parallel, further investigation into the role of TD in oral medicine represents a promising avenue for future research. Building on existing evidence of diagnostic accuracy, future studies should explore how TD can be integrated into clinical workflows to support early detection, triage, and follow-up of OLs in underserved populations. Particular emphasis should be placed on evaluating feasibility, acceptability, and diagnostic reliability in real-world rehabilitation and community care settings, as well as on defining clear referral pathways between non-dental healthcare providers and OMS.

Ultimately, combining structured OHCP with digitally supported oral medicine services may offer a scalable and equitable model for improving oral health outcomes in post-stroke and other underserved populations.

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