

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

Ph.D. Thesis Booklet

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2026

1. Introduction

1.1. Underserved Populations

Oral health is increasingly recognized as an integral component of general health, particularly among underserved populations facing functional, cognitive, or socioeconomic barriers to dental care.

Despite the well-established bidirectional relationship between oral and systemic health, oral healthcare remains insufficiently integrated into medical and rehabilitative care pathways, thereby exacerbating health inequalities.

Global evidence shows that underserved populations experience higher oral disease burden, limited access to dental services, and delayed diagnosis, leading to preventable morbidity and reduced quality of life. These findings highlight the need for proactive oral health interventions targeting underserved groups.

1.2. Diagnosis of Oral Lesions

Early detection of oral lesions (OLs), including oral potentially malignant disorders (OPMDs) and oral cancer (OC), remains clinically challenging and highly dependent on access to oral medicine specialists.

Diagnostic complexity arises from the asymptomatic presentation, heterogeneous clinical features, and frequent resemblance to benign conditions, which increases the risk of delayed or inaccurate diagnosis in non-specialist settings. These challenges disproportionately affect underserved populations, particularly those with physical or cognitive impairments and individuals living in geographically remote areas. Teledentistry (TD) has emerged as a promising approach to mitigate these access barriers by enabling remote assessment, specialist consultation, and triage.

1.3. Oral Healthcare in Post-Stroke Patients

Stroke survivors represent a particularly underserved population with respect to oral health. Post-stroke impairments, including motor dysfunction, cognitive decline, dysphagia, and reduced self-care capacity, significantly compromise oral hygiene and accelerate oral health deterioration. Poor oral health has been associated with increased colonization by oral opportunistic pathogens, higher risk of aspiration pneumonia, prolonged hospitalization, and reduced quality of life. Although oral healthcare prevention programs (OHCPs)

are recommended during rehabilitation, their implementation remains inconsistent and is often limited by resource constraints and a lack of dental and caregiver expertise.

1.4. Impact of Results

The findings of this research support the improvement of early detection, prevention, and continuity of oral healthcare for underserved populations by demonstrating the potential for integrating TD and OHCPs. The results may inform interdisciplinary collaboration, clinical guideline development, and public health strategies, ultimately strengthening the role of oral medicine within integrated healthcare systems and improving patient outcomes.

2. Objectives

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

This study aims to evaluate the diagnostic accuracy of TD in the detection and differential diagnosis of OLs, with a particular focus on OPMDs and OC.

2.2. Study II – Effect of Oral Healthcare

Prevention Programs in Post-Stroke Patients

This study aims to evaluate the effectiveness of OHCPs in maintaining oral hygiene and reducing oral health–related risks among post-stroke patients during rehabilitation. It synthesizes evidence on oral health indices, oral opportunistic pathogens, and oral health–related quality of life (OHRQoL).

3. Methods

Both studies were conducted as systematic reviews and meta-analyses in accordance with the PRISMA 2020 guidelines and the Cochrane Handbook. The study protocols were prospectively registered in PROSPERO (CRD42021282645 and CRD42022346788, respectively).

3.1. Search Strategy

A systematic literature search was conducted in MEDLINE (via PubMed), Embase, and the Cochrane Central Register of Controlled Trials for Studies I and II. No search filters were applied, and only English-language publications were included. Reference lists of eligible

studies were manually screened. Non-original publications, grey literature, and in vitro or animal studies were excluded.

3.2. Eligibility Criteria

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

Eligibility was defined using the PICO framework. The population (P) included adult patients with suspected OLs. The intervention (I) included TD-based examinations, while the comparator (C) was a conventional clinical oral examination or a histopathological assessment. Diagnostic accuracy measures—sensitivity, specificity, positive predictive value, and negative predictive value—were considered as outcomes (O).

3.2.2. Study II – Effect of Oral Healthcare Prevention Programs in Post-Stroke Patients

Study eligibility was defined using the PICO framework. The population (P) comprised adult post-stroke patients undergoing rehabilitation. The intervention (I) consisted of an OHCP, while the comparator (C) was routine oral

care or the absence of OHCP. Primary outcomes (O) included oral health indices. Secondary outcomes included the presence of oral opportunistic pathogens and OHRQoL. Only randomized controlled trials were included.

3.3. Study selection and data extraction

In both studies, the selection of articles and data extraction were conducted independently by two authors, with disagreements resolved by a third author. Inter-reviewer agreement was assessed using Cohen's kappa statistic.

Data extraction was performed independently by two authors using a predefined data collection form.

3.4. Quality Assessment

The risk of bias was assessed using the QUADAS-2 tool for Study I and the ROB-2 tool for Study II, in accordance with Cochrane recommendations. The certainty of evidence was evaluated using the GRADE approach, and evidence profiles were generated using GRADEpro GDT software. All assessments were performed independently by two reviewers, with consensus achieved through consultation.

3.5. Data synthesis and analysis

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

Diagnostic accuracy data were summarized using two-by-two contingency tables. Pooled sensitivity and specificity for the detection of the presence of OLs and diagnosis of OPMD and OC were estimated using a bivariate random-effects model. For outcomes with limited data, univariate random-effects analyses were applied. Between-study heterogeneity was assessed using the I^2 statistic. Statistical analyses were conducted using the meta package in R.

3.5.2. Study II – Effect of Oral Healthcare Prevention Programs in Post-Stroke Patients

The primary outcome was change from baseline. Effect sizes were pooled using random-effects models. Continuous outcomes were summarized using mean differences or standardized mean differences with 95% confidence intervals (CIs), applying conservative variance estimates. Binary outcomes were analyzed using risk ratios (RR) with 95% CIs.

Between-study heterogeneity was assessed using restricted maximum likelihood estimation and quantified using τ^2 and the I^2 statistic. All analyses were conducted using R with the meta package.

4. Results

4.1. Study I

A total of 7,608 records were identified, of which 14 studies met the eligibility criteria and were included in the qualitative synthesis. Ten studies provided sufficient data for inclusion in the quantitative synthesis.

4.1.1. Primary Outcomes

Oral Lesion Detection with Teledentistry Tools

The pooled analysis of three studies demonstrated that TD represents a reliable alternative to face-to-face dental visits for detecting OL. Sensitivity was 0.92 (95% CI: 0.59–0.99) and specificity was 0.93 (95% CI: 0.17–1.00). Substantial heterogeneity was observed for both sensitivity ($I^2 = 84\%$, $p < 0.01$) and specificity ($I^2 = 98\%$, $p < 0.01$).

Diagnosis of OPMD or OC

The analysis of nine studies demonstrated high diagnostic accuracy of TD for the differential diagnosis of OLs, with a sensitivity of 0.926 (95% CI: 0.818–0.972) and a specificity of 0.987 (95% CI: 0.947–0.997). Between-study heterogeneity was negligible ($I^2 = 0\%$ for both outcomes).

Sensitivity analyses yielded comparable results, with a sensitivity of 0.95 (95% CI: 0.86–0.99) and a specificity of 0.98 (95% CI: 0.93–1.00), confirming the robustness of the findings and indicating that diagnostic accuracy was not dependent on examiner expertise.

4.1.2. Secondary Outcomes

Time Effectiveness

Individual studies suggested shorter examination times for virtual assessments compared with in-person examinations, reduced travel requirements, and potential time savings, particularly for patients from rural areas.

Screening Person

One study demonstrated that trained healthcare workers could detect OPMD with a positive predictive value of

45%. High agreement was reported between community health workers and on-site specialists for OL detection (Cohen's kappa = 0.92), supporting the role of trained non-dental personnel in initial screening.

Referral Decision

Referral decision-making revealed variability in referral practices. Over one-third of patients could be managed within primary dental care, while there was high agreement in referral decisions when using a predefined referral list (Cohen's kappa = 0.892). These findings suggest that structured referral criteria may enhance consistency in TD-supported triage.

Technical Setting

Considerable variability was observed in the technical settings of TD applications. Higher image resolution was associated with improved diagnostic agreement, highlighting the importance of image quality. Real-time video consultations demonstrated generally good image quality but variable Internet stability. The use of professional cameras and email-based image transfer reduced reliance on stable internet connections. Several studies confirmed the feasibility of low-cost messaging

platforms for population-based screening, reporting high diagnostic sensitivity and acceptable specificity for lesion identification.

4.2. Study II – Effect of Oral Healthcare

Prevention Programs in Post-Stroke Patients

A total of 7,608 records were identified. Following study selection, 15 randomized controlled trials met the eligibility criteria and were included in the quantitative synthesis.

4.2.1. Primary Outcomes

Plaque Index

Based on five studies, a decreasing trend in plaque index was observed in the short-term following OHCPs; however, this effect did not reach statistical significance (SMD: -2.77 ; 95% CI: -6.60 to 1.06). No significant reductions were identified at the 3-month or 6-month follow-up time points (SMD: -4.93 ; 95% CI: -21.10 to 11.24 and SMD: -0.26 ; 95% CI: -0.79 to 0.28 , respectively). Substantial heterogeneity was observed at both short-term and 3-month assessments.

Gingival Index and Gingival Bleeding Index

Two studies assessed the gingival index at short-term and 3-month follow-up, while two studies evaluated the gingival bleeding index at 3-week, 3-month, and 6-month time points. Due to the limited data available, a quantitative synthesis was not performed.

4.2.2. Secondary Outcomes

Oral Opportunistic Pathogens

The effect of OHCPs on oral opportunistic pathogens was assessed for *Candida* species, *Staphylococcus aureus*, and aerobic Gram-negative bacilli. No statistically significant reductions were observed for any pathogen subgroup.

Oral Health–Related Quality of Life

OHRQoL was assessed in two studies using the Oral Health Impact Profile-14 and Oral Health Transition Scale instruments at follow-up time points of 3 weeks, 3 months, and 6 months. Both studies reported significant improvements among participants receiving OHCPs at both short-term and 3-month follow-ups, whereas no significant changes were observed in the control groups.

5. Conclusions

5.1. Study I – 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 underserved populations, where access to oral medicine specialists is frequently limited. By enabling remote triage, image-based assessment, and referral prioritization, TD has the potential to reduce diagnostic delays and mitigate geographic and socioeconomic disparities in OC care. The consistently high diagnostic performance across examiners further supports the feasibility of task-sharing models involving trained non-dental healthcare workers, which may be especially valuable in resource-limited settings.

5.2. Study II – Effect of Oral Healthcare Prevention Programs in Post-Stroke Patients

In contrast, the synthesis of evidence on OHCPs in post-stroke patients did not demonstrate statistically significant improvements in oral health indices or reductions in oral

opportunistic pathogens. These findings likely reflect methodological limitations, heterogeneity of interventions, and limited statistical power rather than ineffectiveness of prevention.

Stroke survivors represent a particularly underserved group, as motor, cognitive, and functional impairments substantially compromise independent oral hygiene.

Despite limited effects on clinical outcomes, improvements in OHRQoL were observed in studies incorporating structured OHCPs and support. This suggests that oral healthcare interventions may provide meaningful benefits in comfort, dignity, and perceived well-being, even when measurable clinical changes are modest. International comparisons similarly indicate that oral healthcare remains insufficiently integrated into post-stroke rehabilitation pathways worldwide, with common barriers including lack of standardized protocols, limited professional training, and reduced dental service utilization.

6. Bibliography

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