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EFFECTIVENESS OF TELE-DENTISTRY AND MOBILE HEALTH APPLICATIONS IN IMPROVING ORAL HEALTH OUTCOMES: A SYSTEMATIC REVIEW

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Abstract

Digital technologies are increasingly used to support oral health care, but their clinical effectiveness remains uncertain. This systematic review evaluated the impact of teledentistry and mobile health (mHealth) applications on objective and patient-reported oral health outcomes. Electronic databases were searched up to November 2025 for human studies assessin teledentistry or mobile app–based interventions targeting oral health behaviours, diagnostic accuracy, or treatment outcomes. Ten original studies (mostly randomized controlled trials) and ten systematic reviews or meta-analyses were included. Mobile app interventions in orthodontic patients and older adults consistently improved plaque and gingival indices, tooth-brushing frequency and duration, and oral health knowledge compared with usual education alone. Several trials reported moderate to large short-term improvements in gingival inflammation and self-reported behaviours. Teledentistry models using smartphone photography and store-and-forward platforms demonstrated high diagnostic sensitivity and specificity for dental caries screening, and cluster randomized data suggested comparable preventive outcomes to traditional care with better access for underserved groups. However, some app-based trials showed no additional benefit over standard verbal instructions, and follow-up was usually short. Overall, teledentistry and mHealth applications appear to be effective adjuncts—rather than replacements—for conventional oral care. Heterogeneity of interventions and methodological limitations highlight the need for robust, long-term multicentre trials.

Keywords: Teledentistry; Mobile Health; Smartphone Applications; Oral Hygiene; Dental Caries; Orthodontics.

INTRODUCTION

Teledentistry and mobile health (mHealth) applications have emerged as promising tools to support prevention, diagnosis and follow-up in dentistry. Recent systematic reviews

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indicate that smartphone apps and other digital tools can positively influence tooth-brushing behaviour, plaque accumulation and gingival inflammation, particularly in adolescents undergoing orthodontic treatment (Toniazzo et al. 2019; Patil et al. 2021; Al-Moghrabi et al. 2022). Scoping reviews also show rapid growth in dental apps targeting education, appointment reminders, caries risk assessment and remote consultations (Pascadopoli et al. 2023; Väyrynen et al. 2023). Parallel advances in teledentistry suggest that extra-oral photography and videoconferencing can support accurate remote diagnosis of dental caries, periodontal conditions and treatment needs. A systematic review of systematic reviews concluded that teledentistry offers acceptable accuracy for caries detection and treatment planning, with sensitivity and specificity often exceeding 80% (Gurgel-Juarez et al. 2022). Other reviews highlighted its potential to expand access in rural or resource-limited settings, although evidence on long-term clinical outcomes is limited and heterogeneous (Fortich-Mesa et al. 2020; Kargozar & Jadidfard 2024). Despite this growing literature, previous syntheses have typically focused either on mHealth interventions in orthodontic or paediatric populations, or on teledentistry for diagnostic accuracy, rather than jointly considering both modalities and their impact on clinical oral health outcomes across age groups (Toniazzo et al. 2019; Patil et al. 2021; Pascadopoli et al. 2023). Moreover, most reviews include studies only up to 2019–2021 and do not fully incorporate recent randomized trials in older adults, geriatric caries telediagnosis or community-based teledentistry programmes (Väyrynen et al. 2023; Kargozar & Jadidfard 2024). Understanding whether these digital interventions produce meaningful improvements in plaque control, gingival health, caries outcomes and patient-reported measures is essential for clinicians and policymakers considering integration of digital tools into routine dental care. Social-media-based and e-learning interventions also show promise for oral health promotion, but the relative contribution of structured apps and formal teledentistry pathways remains unclear (Sharma et al. 2023; Kaneyasu et al. 2023). Therefore, the aim of this systematic review was to synthesize contemporary evidence on the effectiveness of teledentistry and mobile health applications in improving oral health outcomes. Specifically, we (1) summarized findings from original clinical and diagnostic studies evaluating these interventions, and (2) interpreted them in the context of existing systematic reviews and meta-analyses, in order to identify strengths, limitations and priorities for future research.

METHODS

This systematic review followed the PRISMA 2020 reporting guideline (Page et al. 2021). The protocol was not formally registered.

Eligibility Criteria

We included original human studies that: Evaluated a teledentistry or mobile health (mHealth) intervention (smartphone app, messaging platform, remote photograph-based assessment or video consultation) designed to improve oral health; Reported at least one clinical or patient-reported oral outcome (e.g., plaque indices, gingival indices, caries detection accuracy, decayed–missing–filled teeth, oral health knowledge, or quality-of-life

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measures); Used a comparative design (randomized or non-randomized controlled trials, controlled diagnostic studies, or cluster trials). Systematic reviews and meta-analyses were eligible for background and discussion if they synthesized digital interventions in dentistry, including mHealth, teledentistry, social-media or e-learning-based oral health promotion. Narrative reviews, opinion pieces and purely technical AI studies without clinical outcomes were excluded. Only English-language articles were considered.

Information Sources and Search Strategy

We searched MEDLINE, Scopus, Web of Science and Cochrane Library from inception to 21 November 2025, supplemented by manual screening of reference lists of relevant systematic reviews. Search terms combined controlled vocabulary and free text for teledentistry, tele-dentistry, telehealth, mobile health, mHealth, smartphone application, app, oral hygiene, dental caries, gingivitis and randomized controlled trial.

Study Selection and Data Extraction

Two reviewers independently screened titles and abstracts, retrieved potentially relevant full texts, and selected studies according to the eligibility criteria. Disagreements were resolved by discussion. For each original study we extracted: country and setting, population characteristics, sample size, study design, intervention details, comparator, follow-up duration, and main oral health outcomes and results. For systematic reviews we extracted scope, number and type of included studies, and main conclusions.

Risk of Bias Assessment

For randomized controlled trials, risk of bias was assessed using the Cochrane RoB 2 tool, considering randomization process, deviations from intended interventions, missing outcome data, measurement of outcomes and selective reporting. Diagnostic accuracy studies were judged with QUADAS-2, focusing on patient selection, index test, reference standard and flow. Risk-of-bias assessments informed the qualitative interpretation; no quantitative meta-analysis was undertaken because of heterogeneity in interventions, populations and outcomes.

RESULTS

Study Selection and Overview

The searches identified a large body of literature on digital dentistry; after screening, ten original studies met inclusion criteria for qualitative synthesis (six randomized controlled trials of smartphone applications, one community trial of an educational app in older adults, and three diagnostic or preventive teledentistry studies). These were interpreted alongside ten systematic reviews and meta-analyses. The included original studies were conducted in Saudi Arabia, Italy, the Netherlands, Iran, South Korea, other Asian countries and multi-country settings, reflecting both clinical orthodontic practices and community-dwelling older adults (Alkadhi et al. 2017; Zotti et al. 2016; Scheerman et al. 2020; Farhadifard et al. 2020; Ki et al. 2021; Lee et al. 2023; Borujeni et al. 2021; Estai et al. 2016; Pandey et al. 2023; Azimi et al. 2025).

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Table 1: Characteristics of the included studies

Citation	setting	Population and design	Digital intervention	Comparator	Follow-up	Main oral outcomes	Key findings
Alkadhi 2017	Saudi Arabia	44 patients with fixed appliances, two-arm RCT	Mobile app sending active oral-hygiene reminders three times daily	Verbal oral-hygiene instructions only	4 weeks	Ramfjord plaque index, gingival index	App group showed significant reductions in plaque and gingival indices versus baseline and control, indicating improved hygiene (Alkadhi et al. 2017).
Zotti 2016	Italy	60 adolescents with fixed appliances, RCT	Smartphone app for motivation and reminders	Standard instructions with analogue booklet	6 months	Plaque index, compliance measures	App users, particularly those with poorer baseline hygiene, showed larger plaque-index reductions and better compliance than controls (Zotti et al. 2016).
Scheerman 2020	Netherlands	171 adolescents and young adults, RCT	Behaviour-change-theory-based WhiteTeeth app promoting brushing and sugar-intake reduction	Usual care information leaflet	6 months	Dental plaque, tooth-brushing frequency, sugary snack intake	The app produced clinically relevant reductions in plaque and improvements in brushing frequency and reduced sugary drinks compared with control (Scheerman et al. 2020).
Farhadifard 2020	Iran	120 orthodontic patients, RCT	Brush DJ smartphone app used in addition to conventional instruction	Conventional oral-hygiene instruction alone	12 weeks	Plaque index, gingival index, brushing behaviour	Plaque and gingival indices improved over time in the app group but worsened in controls, between-group differences were highly significant, and brushing frequency correlated with app usage (Farhadifard et al. 2020).
Ki 2021	Community setting	Community-dwelling older adults, RCT	OHEMA mobile app plus in-person education	In-person education and pamphlets only	8–12 weeks	Plaque, tongue coating, oral-health and swallowing-related QoL	App-supported education improved plaque scores, tongue coating and oral-health-related quality of life compared with control (Ki et al. 2021).

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Lee 2023	Gerodontology clinic	Older adults, RCT	Oral-health education mobile application	Standard verbal instruction	3 months	Plaque index, gingival index, knowledge scores	Significant gains in knowledge and modest but significant improvements in plaque and gingival indices were observed in the app group, not in controls (Lee et al. 2023).
Borujeni 2021	Iran	Patients with fixed appliances, controlled trial	Telegram-based teledentistry: remote oral-hygiene education, reminders and photograph feedback	Conventional clinic visits without remote follow-up	First three follow-ups	Plaque index, gingival index, bleeding	Patients receiving teledentistry support showed lower plaque and gingival indices in early follow-up visits than those managed conventionally (Borujeni et al. 2021).
Estai 2016	Australia	100 regularly attending patients, diagnostic study	Smartphone-based teledentistry model with intraoral photos reviewed remotely	Face-to-face examination by senior dentist (reference standard)	Single assessment	Caries detection accuracy (sensitivity, specificity, kappa)	Remote photographic assessment achieved sensitivity around two-thirds and specificity near 97–98%, with substantial intra- and inter-rater reliability for caries screening (Estai et al. 2016).
Pandey 2023	India	Older adults, diagnostic accuracy study	Smartphone photographs for telediagnosis of dental caries	Chairside clinical examination	Single assessment	Sensitivity, specificity, predictive values for caries	Smartphone-based telediagnosis showed acceptable sensitivity and specificity compared with clinical examination, supporting its use for geriatric screening (Pandey et al. 2023).
Azimi 2025	Community, cluster trial	Participants in underserved areas, cluster RCT	Comprehensive teledentistry programme using remote consultations and digital education	Standard preventive oral-care programme delivered face-to-face	12 months	Caries experience, preventive service use, access metrics	Teledentistry produced caries and preventive-care outcomes comparable to traditional care while improving access and reducing travel barriers (Azimi et al. 2025).

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Effects of Mobile Health Applications on Oral Hygiene and Behaviours

Across orthodontic populations, four RCTs consistently showed that smartphone applications improved short-term oral-hygiene outcomes compared with usual instruction. In the Saudi trial by Alkadhi et al., three-times-daily reminder messages led to significant reductions in plaque and gingival indices over four weeks, whereas verbal instruction alone produced no meaningful change (Alkadhi et al. 2017). Similarly, Zotti et al. found that adolescents using an interactive app achieved larger plaque-index reductions and better adherence than those using a traditional booklet, with the greatest gains among participants who started with poorer hygiene (Zotti et al. 2016).

The Brush DJ trial extended these findings over 12 weeks: plaque and gingival indices improved steadily in the app group but increased in the control group, leading to highly significant between-group differences; self-reported brushing frequency and duration tracked app usage (Farhadifard et al. 2020). The WhiteTeeth RCT, grounded in behaviour-change theory, demonstrated that a more complex app combining reminders, self-monitoring and tailored feedback reduced plaque and sugar intake and increased brushing frequency up to six months (Scheerman et al. 2020).

Two trials in older adults suggested that mHealth interventions are also feasible and beneficial beyond orthodontic settings. In community-dwelling elders, the OHEMA app plus group education improved plaque and tongue-coating scores and enhanced oral-health and swallowing-related quality of life compared with education alone (Ki et al. 2021). An oral-health education app evaluated in a gerodontology clinic similarly increased knowledge and produced modest but significant improvements in plaque and gingival indices (Lee et al. 2023).

Collectively, these trials indicate that smartphone apps can strengthen conventional instruction by providing frequent prompts, multimedia education and self-monitoring features that translate into better plaque control and gingival health, at least in the short term. However, adherence to app usage often declines over time, and several related RCTs in the broader literature have reported neutral effects, highlighting the importance of engagement and behavioural design (Deleuse et al. 2020; Sembawa et al. 2025).

Effects of Teledentistry on Clinical Outcomes and Diagnostic Performance

Teledentistry interventions mainly focused on remote education and diagnostic screening. In orthodontic patients, Borujeni et al. showed that a Telegram-based follow-up system—where patients received remote hygiene advice, shared photographs and obtained feedback between visits—resulted in lower plaque and gingival indices at early follow-up appointments than standard clinic-only care (Borujeni et al. 2021). This suggests that asynchronous teledentistry can support behaviour maintenance between visits.

In community screening contexts, Estai et al. evaluated a smartphone-based teledentistry model in which mid-level dental providers assessed intraoral photographs uploaded via an encrypted app. Sensitivity for caries detection was moderate, with very high specificity

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and almost perfect intra-rater reliability (Estai et al. 2016). Pandey et al. reported similarly acceptable sensitivity and specificity for smartphone-based telediagnosis of caries in geriatric patients, supporting the feasibility of remote screening for older adults (Pandey et al. 2023).

Azimi et al. conducted a cluster randomized trial comparing a comprehensive teledentistry programme with conventional preventive care in underserved communities. The teledentistry arm used smartphone-enabled consultations, remote triage and digital education. Over 12 months, caries experience and preventive-care outcomes were comparable between groups, but patients in the teledentistry arm benefited from reduced travel, shorter waiting times and improved appointment adherence (Azimi et al. 2025).

Overall, these studies indicate that teledentistry can deliver diagnostic accuracy adequate for screening and can maintain oral health outcomes comparable to face-to-face care while improving access and convenience. However, most data relate to caries detection and early orthodontic follow-up; evidence on long-term periodontal or restorative outcomes remains scarce.

Risk of Bias and Heterogeneity

Most randomized trials adequately described random sequence generation and reported balanced baseline characteristics. However, allocation concealment and blinding were rarely detailed, introducing potential performance and detection bias, especially where outcomes were clinician-assessed. Self-reported behaviours (e.g., brushing frequency) are vulnerable to social desirability bias. Diagnostic studies used appropriate reference standards but sometimes recruited from single clinics, limiting generalizability.

Interventions varied widely in content (simple reminder apps versus theory-based multi-component apps versus full teledentistry programmes), duration (4 weeks to 12 months) and target groups (adolescents, older adults, mixed clinic samples). Outcomes included different plaque and gingival indices, diverse knowledge scales and varying caries measures, precluding quantitative pooling.

Despite these limitations, the direction of effect was generally consistent for plaque and gingival outcomes in app-based trials and for diagnostic performance in teledentistry studies, lending moderate confidence to the qualitative synthesis.

DISCUSSION

This systematic review found that teledentistry and mobile health applications can meaningfully improve oral health behaviours and surrogate clinical outcomes when used as adjuncts to conventional care. The findings from the ten original studies are broadly consistent with previous systematic reviews and meta-analyses of digital dental interventions.

Meta-analytic evidence suggests that mHealth interventions in dentistry produce small to moderate improvements in plaque and gingival indices, especially in orthodontic patients, though effect sizes vary with intervention intensity and study quality (Toniazzo et al. 2019;

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Al-Moghrabi et al. 2022). The app-based RCTs in our review largely mirrored this pattern: reminder-based and behaviour-change-oriented apps enhanced plaque control and gingival health beyond standard verbal or leaflet-based instruction (Alkadhi et al. 2017; Zotti et al. 2016; Scheerman et al. 2020; Farhadifard et al. 2020). These results align with scoping reviews describing smartphone apps as promising tools for oral health education and adherence support, particularly among technology-engaged adolescents and young adults (Pascadopoli et al. 2023; Väyrynen et al. 2023).

Importantly, this review extends previous syntheses by including newer data from older adults and community-based integrated-care settings. Trials of the OHEMA app and other gerodontology-focused applications demonstrate that older adults can successfully engage with mobile tools and derive benefits in plaque control, tongue coating and oral-health-related quality of life (Ki et al. 2021; Lee et al. 2023). These findings complement reviews highlighting the untapped potential of mHealth to support ageing populations and those with functional limitations (Chau et al. 2023).

Regarding teledentistry, our findings echo evidence-synthesis work showing that store-and-forward models based on intraoral photography offer high specificity and acceptable sensitivity for caries screening, with substantial reliability (Gurgel-Juarez et al. 2022; Kargozar & Jadidfard 2024). Previous systematic reviews have emphasized teledentistry's value in triage, referral and access expansion, particularly in rural and underserved communities (Fortich-Mesa et al. 2020; Fernández et al. 2021). The cluster trial by Azimi et al. supports these conclusions, showing that preventive outcomes under a tele-enabled model can match those of traditional care while reducing barriers to service use.

Nonetheless, digital dental interventions are not universally effective. Reviews of social-media-based and text-message interventions point to substantial heterogeneity, with several trials reporting neutral effects when engagement is low or interventions lack behaviour-change components (Sharma et al. 2023; Patil et al. 2021). Recent RCTs have similarly found that reminder apps without interactive features or gamification may not confer additional benefits beyond standard instruction (Deleuse et al. 2020; Sembawa et al. 2025). Collectively, these findings suggest that effectiveness is driven less by digitization itself and more by thoughtful intervention design grounded in behavioural science, personalization and sustained engagement.

Our review has limitations. The search was limited to English-language publications, and we did not perform a formal meta-analysis because of heterogeneity in interventions and outcomes. Many included trials had short follow-up, small sample sizes and limited reporting of allocation concealment or blinding, which may inflate effect estimates. Diagnostic teledentistry studies were often single-centre and may not fully represent real-world screening conditions.

Future research should prioritize multicentre, adequately powered randomized trials with longer follow-up, standardized outcome measures and economic evaluations. Comparative studies of different digital designs (simple reminders versus gamified, AI-

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assisted or integrated teleconsultation platforms) would help identify which features most effectively translate into sustained behavioural and clinical gains. Additionally, there is a need for evidence in low- and middle-income settings and among high-risk groups such as people with disabilities, institutionalized older adults and those with limited digital literacy.

CONCLUSION

Teledentistry and mobile health applications offer promising adjuncts to conventional dental care. Across ten original studies, smartphone apps generally improved plaque control, gingival health and oral-health knowledge, while teledentistry models achieved acceptable diagnostic accuracy and outcomes comparable to traditional care, with clear advantages in access and convenience. However, benefits are not universal and depend strongly on intervention design, user engagement and context. Current evidence supports integrating well-designed digital tools into preventive and orthodontic care pathways rather than replacing face-to-face dentistry. High-quality, longer-term trials and implementation studies are needed to define best practice and maximize patient benefit.

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