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Review

Use of Tele dentistry for Oral Health Education and Caries Risk Reduction in Rural Pediatric Populations: A Systematic Review

Raed Mohammed Alamoudi[1*], Abdulaziz Hamad Alharbi[2], Roaa Mubarak Zafer[3], Waad Khalid Aldaghriry[4], Albandari Ghazi Alrashidi[4], Waad Ibrahim Aladwani[5], Ali Hussain Alkhamis[6]

[1] *Department of Pediatric Dentistry, Al Thager Hospital, Jeddah, Saudi Arabia*
[2] *College of Dentistry, King Faisal University, Al-Ahsa, Saudi Arabia*
[3] *Department of Dentistry, Ministry of Health, Riyadh, Saudi Arabia*
[4] *College of Dentistry, Majmaah University, Majmaah, Saudi Arabia*
[5] *Department of Dentistry, Souq Aleaun Priamry Healthcare Center, Adham, Saudi Arabia*
[6] *Alfisal Primary Healthcare Center, Ministry of Health, Al-Ahsa, Saudi Arabia*

Correspondence should be addressed **Raed Mohammed Alamoudi**, Department of Pediatric Dentistry, Al Thager Hospital, Jeddah, Saudi Arabia, Email : raed.m.alamoudi@gmail.com

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Abstract

Teledentistry effectively enhances pediatric oral health by providing remote education, early caries detection through photos/video, and behavioral guidance, significantly improving access in underserved areas and reducing travel burdens for families. This systematic review aims to investigate the use of teledentistry for oral health education and caries risk reduction in rural pediatric populations. A systematic search of studies published in PubMed, Web of Science and Scopus was completed from the earliest available date until December 24, 2025, without geographic restriction. Major outcomes of interest included oral health education–related outcomes and caries-related outcomes. The target population was the pediatric population under 18 years who reside in rural, underserved, remote, or low-resource areas. The Newcastle-Ottawa Scale tool was used to assess the quality and risk of bias in non-randomized observational studies, and the quasi-experimental studies were assessed using the ROBINS-I tool. Ten studies were included in the systematic review. The reviewed evidence demonstrates that teledentistry is a reliable and effective approach for pediatric oral health screening, showing high agreement with conventional clinical examinations across key diagnostic indices. Most studies reported strong to excellent inter-method reliability and high specificity, although sensitivity, particularly for early carious lesions, was more variable, indicating that teledentistry is best suited for screening, triage, and referral rather than definitive diagnosis. Beyond diagnostics, teledentistry-based educational interventions significantly improved oral health knowledge, caregiver behaviors, and, in some cases, clinical outcomes. Teledentistry is a reliable and effective tool for pediatric oral health screening, education, and referral. While best suited for screening and triage rather than definitive diagnosis, it improves access to care, supports early detection of caries, and helps address oral health disparities in underserved pediatric populations.

Keywords: *tele dentistry, caries risk, pediatric, children, rural, underserved*

Introduction

Rural populations have an increased risk of poor oral health, as shown by the increased prevalence of periodontal disease and decayed or missing teeth due to caries in these populations (1-4). Compared to urban pediatric populations, children in rural areas report lower oral health and receive less preventive dental care (5). Furthermore, rural populations have an increased prevalence of partial and full edentulism compared to those in urban areas, with more prevalence in high-poverty rural areas (6). The reduced oral health in rural areas can be attributed to three main factors: geographical factors, healthcare factors, and rural culture factors (7). Access to health care in rural areas is affected by various geographical factors, including distance, isolation, weather, and transportation. Poor oral health in rural populations can also be attributed to the high turnover of primary care providers and a significant lack of specialists (7). Additionally, low health literacy and reticence to seek care in rural culture can further impact access to and utilization of health care services (7, 8). One of the most common oral health issues in rural populations is dental caries.

Dental caries is identified as the most prevalent of non-communicable diseases worldwide by the Global Oral Health Status Report 2022 (9). Over 2 billion people globally have dental caries, which often begin during childhood and can greatly affect life (10). It has continued to be one of the most prevalent health problems in children. Early diagnosis and intervention for dental caries can help prevent or reduce pain, anxiety, and negative health experiences associated with caries (11). Thus, a special effort should be targeted towards facilitating access to oral healthcare facilities and providing oral health education, with more focus on reducing dental caries risk in pediatric populations.

Recently, teledentistry has been utilized to enable access to general and specialty dental care, especially for rural and underserved populations (12-15). Teledentistry is an emerging field in dentistry, which involves the combination of telecommunication with health records and digital imaging. It aims to facilitate the exchange of health information, improve access to dental care, and help in epidemiological surveys. More specifically, it reduced the difficulties associated with providing dental care in remote and rural areas (16). Teledentistry is different from mobile clinics, as it provides oral health care through virtual consultations, image sharing, and remote diagnosis or triage, rather than onsite services (17). It became an essential tool for delivering oral healthcare during the COVID-19 pandemic, as it provided online consultations, assessments of dental problems, and patient assistance (18).

Despite the promising potential of teledentistry, there is a paucity of clinical trials evaluating the trends of its usage in rural areas and its effectiveness in oral health education and in reducing dental caries risk, especially in rural pediatric populations. This systematic review aims to investigate the use of teledentistry for oral health education and caries risk reduction in rural pediatric populations.

Methods

Study design

This systematic review study followed PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, specifically the updated PRISMA 2020 (19).

Definition of outcomes and inclusion criteria

Major outcomes of interest included oral health education–related outcomes (diagnostic accuracy, educational impact, behavior change, service utilization, access to care, and referrals) and caries-related outcomes, including dental caries prevalence, dmft/DMFT scores, caries risk indicators, and oral health burden among pediatric populations. The search strategy of this systematic review was developed based on the Population, Intervention, Comparison, and Outcomes (PICO) framework and the study designs. The target population was the pediatric population under 18 years who reside in rural, underserved, remote, or low-resource areas. Eligible interventions comprised teledentistry-based oral health education and preventive strategies delivered through digital

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or remote platforms, including mobile health (mHealth) applications, SMS or text messaging, smartphone-based programs, video consultations, telephone-based interventions, and other telehealth or eHealth modalities. Comparator groups included conventional in-person dental examination or oral health education, such as face-to-face clinical assessments, school-based dental programs, routine dental visits, or no intervention/usual care.

There were no restrictions on the study designs or geographical areas. Review papers, case reports, editorials, commentaries, conference abstracts without complete text, and studies involving non-human subjects were eliminated. Only studies published in the English language were included.

Search Strategy

A comprehensive literature search was conducted among multiple electronic databases, including PubMed, Web of Science and Scopus, from inception to the present. The database search was conducted on 24th December 2025. Electronic searches were conducted using the following Boolean string keyword search strategy: (child* OR pediatric* OR paediatric* OR adolescent*) AND (rural OR remote OR underserved OR "low resource*" OR "low access") AND (teledentistry OR "tele-dentistry" OR "tele dental" OR telehealth OR telemedicine) AND ("oral health education" OR "dental education" OR "preventive dentistry" OR "health promotion" OR "oral hygiene" OR caries OR "tooth decay" OR "early childhood caries").

Reference lists of included studies and relevant reviews were manually screened to identify additional eligible studies.

Screening and Extraction

All records identified through the database search were imported into reference management software (EndNote X8), and duplicates were removed. Two reviewers independently screened titles and abstracts for eligibility. Full-text articles were then retrieved and assessed independently by the same reviewers against the predefined inclusion and exclusion criteria. Disagreements at any stage of the screening process were resolved through discussion and, when necessary, consultation with a third reviewer. The study selection process was documented using a PRISMA flow diagram.

Data was independently extracted by two reviewers using a standardized data extraction form. Extracted information included study characteristics and participant characteristics (author, year, country, study design, gender, and age of the study population) and key findings related to oral health education and caries risk reduction. Any discrepancies in data extraction were resolved by consensus.

Quality Assessment

In our systematic review, we employed the Newcastle-Ottawa Scale (NOS) as a critical tool for assessing the quality of non-randomized studies included in our analysis (20). NOS evaluates three quality parameters, such as selection, comparability, and outcome, divided across eight specific items. Each item on the scale is scored from one point, except for comparability, which can be adapted to the specific topic of interest to score up to two points. Thus, the maximum for each study is 9, with studies having less than 5 points being identified as representing at high risk of bias. The quasi-experimental studies were assessed using the ROBINS-I tool, which is developed to assess the risk of bias from an individual non-randomized study that examines the effect of an intervention on an outcome. It focuses on seven domains, such as confounding, selection, intervention classification, deviations, missing data, outcome measurement, and reporting (21).

Results

Search Results

We executed the search methodologies outlined previously, resulting in the identification of a total of 107 citations, subsequently reduced to 71 following the removal of duplicates. Upon screening titles and abstracts, only 37 citations met the eligibility criteria for further consideration. Through full-text screening, this number was further refined to 10 articles (22-31) aligning with our inclusion and exclusion criteria. **Figure 1** provides an in-depth depiction of the search strategy and screening process.

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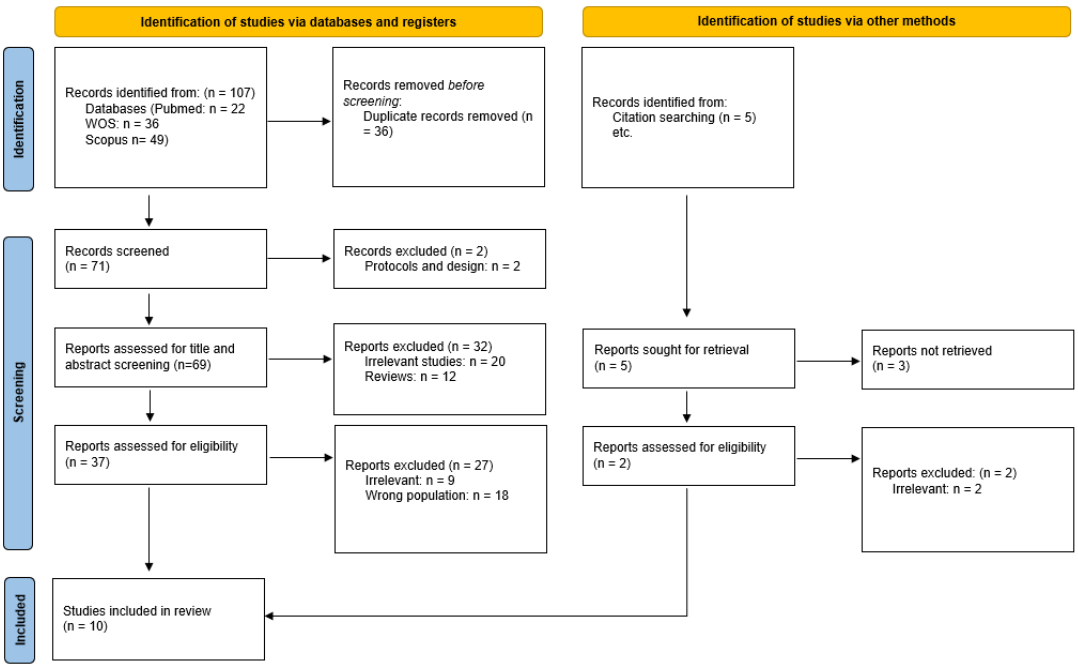

Figure 1: PRISMA Flowchart

Baseline Characteristics of the Included Studies

In this systematic review, a total of ten studies published between 1998 and 2025 were included. The combined sample size of children across these studies was 3714, with a mean age of 3–10 years. Geographically, the studies were conducted in diverse locations, including Australia, Egypt, India, Thailand, Turkey, the USA, and Canada. The study designs were varied, including eight studies that were observational and two that were quasi-experimental designs **(Table 1)**.

Table 1: Baseline Characteristics of Included Studies

Study	Country	Study Design	Study Period	Total Participants	Age of Total Participants(years)	Gender (Male/Female) %
Patterson & Botchway, 1998 (22)	Canada	Observational comparative study	NR	137	NR	NR
Mulligan et al., 2010 (23)	USA	cross-sectional survey	2004	566	10.5 ±3	51.6%/48.4%
Purohit et al., 2017 (24)	India	cross-sectional survey	2015	139	12	44.6%/55.4%
Pithpornchaiyakul et al., 2022 (25)	Thailand	quasi-experimental design	2021 - 2024	71 (Study I: 37 Study II:34)	Study I: 16.4 ±6.1 Study II: 20.1 ±8.0	NR
Ward et al., 2022 (26)	USA	Observational cohort	2019	MCHS :164 CDS: 1467	3.6 ± 0.6 8.1 ±4.1	50%/50% 52.7%/47%
Azimi et al., 2023 (27)	Australia	cross-sectional prospective	2021	44	NR	43.1%/56.8%
Moron et al., 2023 (28)	USA	quasi-experimental design	2021 - 2022	641	NR	44.6%/55.4%
Surdu et al., 2023 (29)	USA	observational	2015 - 2016	144	4.9	48.6%/51.4%
Mola et al., 2024 (30)	Turkey	Comparative, observational study	COVID-19	200	7.86 ± 2.40	47.5%/52.5%
Sakr et al., 2025 (31)	Egypt	observational	2022 - 2023	141	8.96 ± 1.66	56%/44%

NR: not reported

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Diagnostic Accuracy and Agreement Between Teledentistry and Clinical Examination

Overall, the included studies consistently demonstrate that teledentistry is a reliable method for pediatric oral health screening when compared with conventional clinical examination. High levels of agreement were reported across multiple diagnostic indices, including DMFT/dmft and early enamel lesion scores, with several studies showing strong to excellent inter-method reliability. While specificity was generally high, sensitivity varied across studies, particularly in the detection of early carious lesions, suggesting that teledentistry is especially suitable for screening and triage rather than definitive diagnosis. Improvements in image quality and diagnostic protocols in more recent studies appear to have enhanced diagnostic performance **(Table 2)**.

Table 2: Diagnostic Accuracy and Agreement Between Teledentistry and Clinical Examination

Study	Findings
Saker et al., 2025 (31)	Strong agreement between clinical and photo diagnosis for E1 (kw = 0.899) and E2 (kw = 0.834) lesions ($p < 0.001$). Internal consistency ranged from acceptable to excellent ($\alpha > 0.9$).
Mola et al., 2024 (30)	DMFT/dmft and DMFS/dmfs scores were compatible between teledentistry and clinical diagnosis. No statistically significant differences ($p > 0.05$). Comparable detection of dental anomalies.
Azimi et al., 2023 (27)	Tele-dental screening demonstrated high specificity (≥95.5%) but variable sensitivity (44%–88.4%). Parents captured good-quality photographs in 90% of cases.
Purohit et al., 2016 (24)	Mean DMFT values were similar between visual–tactile and video-graphic assessments (P = 0.76). Fair agreement (ICC = 0.56); sensitivity = 0.86, specificity = 0.58; AUC = 0.69.
Patterson & Botchway, 1998 (22)	No significant difference between traditional and telehealth screening using deft/DMFT. Agreement ranged from 89% to 100%.

E1: Initial enamel caries lesion (early enamel demineralization); E2: Advanced enamel caries lesion without dentin involvement; κw (Kw): Weighted Kappa coefficient (measure of inter-rater agreement); α : Cronbach's alpha; DMFT: Decayed, Missing, and Filled Teeth (permanent dentition); dmft – Decayed, Missing, and Filled Teeth (primary dentition; DMFS: Decayed, Missing, and Filled Surfaces (permanent dentition); dmfs: Decayed, Missing, and Filled Surfaces (primary dentition); ICC: Intraclass Correlation Coefficient; AUC: Area Under the Curve

Oral Health Education, Knowledge, and Behavior Change Outcomes

Studies evaluating teledentistry-based educational interventions reported significant improvements in oral health knowledge, perceptions, and caregiver-reported behaviors. Digital platforms, including chatbot-based education and remote professional training, were shown to be feasible, acceptable, and effective. Importantly, some interventions resulted in measurable clinical improvements, such as reduced plaque scores. These findings suggest that teledentistry can successfully complement or replace in-person oral health education, particularly in resource-limited or rural settings **(Table 3).**

Table 3: Oral Health Education, Knowledge, and Behavior Change Outcomes

Study	Findings
Pithpornchaiyakul et al., 2022 (25)	Chatbot interventions significantly improved oral health knowledge, perceptions, and caregiver toothbrushing behaviors ($P < 0.05$). Plaque levels decreased significantly in Study I ($P < 0.001$). High satisfaction (8.6–9.2).

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Moron et al., 2022 (28)	School nurses demonstrated significant improvement in oral health knowledge post-training (93% vs 56%). Children received education, screenings, fluoride varnish, and appropriate referrals.

Service Utilization, Access to Care, and Referral Outcomes

Evidence indicates that teledentistry enhances access to oral health services and improves referral efficiency. High completion rates of telehealth encounters and oral health screenings were reported, especially in school-based programs. Teledentistry-supported care pathways were associated with faster treatment initiation, improved follow-up attendance, and reduced reliance on intensive case management, highlighting its value in improving care coordination among pediatric populations **(Table 4)**.

Table 4: Service Utilization, Access to Care, and Referral Outcomes

Study	Findings
Ward et al., 2022 (26)	Over 99% of telehealth encounters were successfully completed. Nearly all students received oral health screenings, and all children with caries were referred to as follow-up care.
Moron et al., 2022 (28)	Nurses successfully referred to children identified as needing further assessment or urgent dental care to dentists.
Surdu et al., 2020 (29)	97.2% completed specialty treatment and 77.1% accessed follow-up care through teledentistry clinics. Faster treatment was associated with fewer case-management contacts ($p \leq 0.013$).

Caries Prevalence and Oral Health Burden in Pediatric Populations

Across diverse pediatric populations, a high burden of dental caries was consistently reported, particularly among underserved and migrant children. Many studies highlighted substantial levels of untreated decay, reflecting persistent inequities in access to preventive and restorative dental care. Teledentistry-based screening programs effectively identified children with unmet needs and supported referral for further care, reinforcing the role of teledentistry as a public health tool for early detection and disease burden reduction **(Table 5)**.

Table 5: Caries Prevalence and Oral Health Burden in Pediatric Populations

Study	Findings
Mulligan et al., 2023 (23)	High unmet dental needs among migrant children; untreated decay prevalence was 87.4%.
Azimi et al., 2023 (27)	Twenty-five percent of children under 4 years had dental caries (mean dmfs = 0.7).
Ward et al., 2022 (26)	Approximately half of screened students had dental caries (48.6%–50.6%).
Moron et al., 2022 (28)	58% of children had untreated caries, 43% had treated caries, and 3% required urgent care.

Quality assessment

Among the eight included studies were observational nonrandomised studies and were assessed using NOS. Based on this assessment six studies were rated as good quality, and two studies were satisfactory quality **(Table 6)**.

The quasi-experimental studies were assessed using ROBINS-1 tool. According to Pithpornchaiyakul et al., (2022) low risk of bias was reported for classification bias, missing data bias, measurement bias, and reporting bias. While moderate risk of bias was identified for confounding, selection, and

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interventions bias. Therefore, the overall risk of bias was moderate. Similarly, Moron et al., (2023) reporting low risk of bias was across most domains except for confounding and measurement bias, which was moderate risk **(Table 7)**.

Table 6: Quality assessment of observational studies using NOS

Study	Selection	Comparability	Outcome	Total Score	Quality level
Patterson & Botchway, 1998 (22)	4	0	3	7	Good
Mulligan et al., 2010 (23)	4	1	3	8	Good
Purohit et al., 2017 (24)	4	1	3	8	Good
Ward et al., 2022 (26)	3	0	3	6	Satisfactory
Azimi et al., 2023 (27)	4	1	3	8	Good
Surdu et al., 2023 (29)	3	2	3	8	Good
Mola et al., 2024 (30)	3	1	3	7	Good
Sakr et al., 2025 (31)	3	0	3	6	Satisfactory

Table 7: ROBINS risk of bias for non-randomised studies

Author	Confounding bias	Selection bias	Classification bias	Interventions bias	Missing data bias	Measurement bias	Reporting bias	Bias
Pithpornchaiyakul et al., 2022 (25)	Moderate	Moderate	Low	Moderate	Low	Low	Low	Moderate
Moron et al., 2023 (28)	Moderate	Low	Low	Low	Low	Moderate	Low	Low

Discussion

This systematic review aimed to examine the use and effectiveness of teledentistry in improving oral health education and reducing caries risk in rural pediatric populations. 3714 children were included in this study, with a mean age of 3–10 years. Our results show that teledentistry can be a reliable method for pediatric oral health screening when compared with conventional clinical examination. Results also show that teledentistry was associated with significant improvements in oral health knowledge, perceptions, and caregiver-reported behaviors. Additionally, teledentistry improved access to oral health services and referral efficiency.

Our results revealed high diagnostic accuracy for teledentistry and high agreement between it and clinical examination. Included studies showed high specificity but various sensitivity, particularly in the detection of early carious lesions, suggesting that teledentistry can be more efficient in screening and triage rather than definitive diagnosis. This is similar to a previous systematic review by Alabdullah and Daniel (2018) who reported high specificity and relatively low sensitivity (32). The difference in sensitivity values could be due to variation in diagnostic techniques and different sample sizes. The diagnosis process has always included the utilization of smartphones and social media platforms for photo and video sharing. Teledentistry have reported effectiveness in detecting caries, molar incisor hypomineralization, black tooth staining, periodontal health (healthy/unhealthy gingiva), dental trauma, and

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orthodontic anomalies (30). Regarding caries detection, the Caries Risk Assessment Tool (CAT) and the World Health Organization (WHO) caries recording indices (DMFT/dmft, DMFS/dmfs) were constantly used to assess caries risk and caries prevalence (27, 30, 31). It should be noted that the diagnostic accuracy of teledentistry for oral abnormalities in posterior teeth is lower than anterior teeth, as imaging posterior teeth often demands precise angulation, sufficient illumination, and optimal intraoral access, which can be difficult to achieve using smartphone cameras in home-based settings (30).

Findings indicate the effectiveness of teledentistry-based education in improving oral health education and preventive behaviors, consistent with prior evidence by Beltrán et al (2025), who reported significant improvements in treatment adherence, reduced plaque and bleeding indices in orthodontic patients, and enhanced access to screening and referrals in schools owing to teledentistry. They also reported that mobile-based education was associated with improved hygiene habits (33). Our results demonstrated that interactive chatbot-based education improved caregiver knowledge, toothbrushing behavior, and plaque outcomes (25).

Furthermore, similar to our results, Fernández et al. (2021) reported that mHealth and teledentistry interventions were effective in promoting oral health behaviors when they incorporated interactive, repeated engagement (34). Similarly, improvements in provider knowledge were reported by previous systematic reviews by Estai et al. (2018) and Alabdullah and Daniel (2018) (32, 35). In contrast**,** Nascimento da Silva Mulde et al. (2024) noted a lack of clinical evidence on the long-term impact of teledentistry-based education (36). However, it can be attributed to short intervention durations, which cannot detect significant changes in cases of slow progression, like dental caries.

Moreover, contradictory findings can be attributed to variations in target populations and educational formats across different studies. Taking all factors into account, the findings, compared with the existing literature, indicate that teledentistry is effective in improving knowledge and behavior. Nevertheless, further studies are required to assess its impact on long-term clinical outcomes as well as its cost effectiveness.

Additionally, teledentistry has been proven to improve access to care and referral outcomes. This is supported by Mariño et al. (2013) (37) and Estai et al. (2018) (35), who reported high screening and referral completion rates in school-based programs, improved care coordination, and reduced delays among rural populations. In contrast, other studies included in the review by Nascimento da Silva Mulde et al. (2024) considered system-level barriers to be the primary constraints on the effectiveness of teledentistry. Thus, reporting lower follow-up rates with teledentistry, noting that referral success depends on local health system capacity, including workforce availability and insurance coverage. Overall, teledentistry consistently improves access and referral processes when integrated into structured service models, but other health system factors may influence its impact.

The oral health burden and caries prevalence were found to be significant in rural areas among underserved and migrant children. Across different pediatric populations, a high prevalence of dental caries was consistently reported. Several studies demonstrated the substantial levels of untreated carious lesions, which highlight the difficulty in accessing preventive and restorative dental care. For instance, Dawkins et al. (2013) (38) reported that the proportion of children having untreated dental caries was 49.7%, with a mean number of 2.0. They also reported that the proportion and severity of untreated dental caries were higher in older children and children living in rural areas. Another study conducted by Ha et al. (2021) (39) reported that children in rural areas had a higher prevalence of dental caries in primary and permanent teeth, which was attributed to inequalities access to dental care in these underserved areas. A systematic review conducted by Osadolore et. al. (2024) (40) included several studies made in rural areas in African countries, found a high prevalence of dental caries among the children in these areas, which was attributed to the difficulty in accessing dental care.

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These findings underscore the significant prevalence of dental caries among children in underserved areas, which reinforces the role of teledentistry in screening and identifying children who need dental care. Additionally, it highlights the effectiveness of teledentistry in the early detection of caries among children in these underserved areas and in reducing the prevalence of oral diseases.

Strengths and limitations

This systematic review has several strengths, such as employing a multi-database search strategy and following the PRISMA 2020 guidelines, which strengthen the reproducibility and transparency of the study findings. The review included a broad range of studies with different study designs and geographically diverse populations, which strengthens the generalizability of the study findings, specifically among underserved and rural areas. The study also reviewed different outcomes, such as diagnostic tools and accuracy, behavioral changes and educational impact, caries prevalence, and service utilization, which provides a comprehensive assessment of the use of teledentistry among children in rural areas. Additionally, the use of validated quality assessment tools, such as NOS and ROBINS-1, reduced bias. However, this systematic review has several limitations, such as the heterogeneity of the study designs, intervention formats, outcome measures, and follow-up durations, which limited the direct qualitative comparison. The variability in the diagnostic protocols and reporting standards among the included studies may also have affected the consistency of the outcomes. Additionally, the moderate risk of bias identified in some studies reduced the strength of causal inference.

Implications and Recommendations

This systematic review highlights the effective role of teledentistry in oral health screening, early detection of dental caries, improving oral health knowledge, behaviors, education, referral outcomes, and access to dental care, specifically in underserved and rural pediatric populations. Additionally, it demonstrates the high burden of oral diseases among the pediatric population in these underserved areas. Teledentistry can be integrated as screening and triage tool rather than diagnostic tool for pediatric oral health in rural areas. Teledentistry-based oral health education and behavior-change interventions, such as chatbot or mobile-based programs, may be used to complement traditional preventive care. Further studies are needed to evaluate the long-term effectiveness of teledentistry screening and intervention on the prevalence of dental caries among children in rural areas. Moreover, future studies should discuss the integration of teledentistry with healthcare institutions and discuss the use of artificial intelligence technologies in diagnosing and screening as well. Research should also focus on improving diagnostic sensitivity, particularly for early and posterior carious lesions, through better imaging protocols and emerging technologies.

Conclusion

This systematic review provides strong insights into the prevalence of dental caries and oral diseases among children in underserved and rural areas. Additionally, it underscores the beneficial role of teledentistry in screening, diagnosing, and early detection of carious lesions and oral diseases among migrant children and children in rural areas. It also plays a crucial role in their referral, education, and behavioral change. However, the significant prevalence of dental caries and other oral diseases in these areas highlights the need to integrate teledentistry in the healthcare institution to expand its role beyond screening. Further studies are needed to fill the gap in the existing literature that discusses the role of teledentistry in reducing the prevalence of unmet dental needs among children in underserved and rural areas.

Disclosure

Conflict of interest

There is no conflict of interest.

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Ethical consideration

Non applicable.

Data availability

All data is available within the manuscript.

Author contribution

All authors contributed to conceptualizing, data drafting, collection and final writing of the manuscript.

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