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Review

Modern Approaches to Providing Telematics Oral Health Services in Pediatric Dentistry: A Narrative Review

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Abstract: A structural and organizational redesign of the dental care system is necessary today due to current trends in the demographic process and the accompanying changes in the population's healthcare needs. The purpose of this article is to review the literature, analyzing those trends that today represent useful tools for the oral health of pediatric patients, with particular reference to teledentistry and all the supports it uses to reach remote territories or patients who, for various reasons, cannot have access to dental care. An independent literature search was conducted in three electronic databases: PubMed/MEDLINE, Google Scholar, and the COCHRANE library. Thirty-one articles were considered. Reported findings highlight that teledentistry has been used in pediatrics to educate and promote oral health and to provide remote diagnosis and monitoring through mobile health applications, smartphone cameras and apps, intraoral cameras, websites and search engines, and telephonic communications. Specifically, teledentistry has been beneficial in providing dental care in remote locations with difficult access to pediatric dentists, conducting remote diagnostic and screening programs, monitoring patients between appointments, promoting children's oral health through dental education, and providing behavioral counseling prior to office visits. Future research should further investigate the long-term use, additional applications, and cost-effectiveness of teledentistry in children.

Keywords: dental; telemedicine; teledentistry; remote consultation; remote screening; teleconsultation; telediagnosis; pediatric dentistry; pedodontics; orthodontics

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1. Introduction

The continuing evolution of demographic dynamics and the concomitant change in the health needs of the population, with a growing proportion of elderly people and chronic diseases require a redesign of the structure and organization of the network of health services [1,2].

Technological innovation and the COVID-19 pandemic have contributed to highlighting the need to reorganize the healthcare system, especially by supporting the shift in the focus of healthcare from the hospital to the community through innovative models of care that focus on the digitalization of health dynamics [3,4]. Health and social service delivery modalities enabled by telemedicine and teledentistry are important and help ensure equitable access to care in remote areas [5].

Teledentistry is an area of telemedicine dedicated explicitly to dentistry. It has emerged from combining dentistry and digital and telecommunication technology and involves

exchanging clinical information and images over remote distances for dental consultation and treatment planning [6].

The United States Army introduced the teledentistry concept in 1994 as part of the Total Dental Access project [7]. Since then, several authors have conducted studies that have led to the worldwide dissemination of these methods.

The most used methods are classified as synchronous (real-time) and asynchronous (store-and-forward). The synchronous mode provides for real-time interaction between the user, the patient, the dental assistant, or the doctor through technological support that guarantees audiovisual communication. In asynchronous support, health information is collected at a specific time and later shared with the doctor. This practice allows for the exchange of information and materials collected with other specialists [8].

In addition, the advancement of modern technologies has led to the development of mobile health applications (m-Health app) supported by mobile devices, such as mobile phones, personal digital assistants (PDAs), or wireless devices for remote monitoring, with the ability to interact directly with the patient using telecommunication technologies, such as 4G and 5G or the Global Positioning System (GPS) [9]. The recent pandemic of COVID-19 and the resulting need for social distancing has encouraged the use of technology to provide dental care to patients. TD has allowed specialists to perform remote monitoring, minimizing face-to-face contact [10].

Several studies have shown that this method of remote monitoring can also be used in daily clinical practice to reduce the time and cost of regular checkups, to determine the level of oral hygiene and oral cavity health of patients, to provide rapid and accessible screening, and to provide a means for patients to be monitored in the clinic, which has various benefits for many patients, including people who live far from residential areas and have little opportunity to reach hospitals or private practices, patients with special needs, sick syndromic patients, and people living in socioeconomically disadvantaged conditions [11–14].

Therefore, this narrative review primarily aims to review the literature, analyzing the trends that today represent useful tools to provide for the oral health of pediatric patients, with particular reference to teledentistry and all the supports it uses to reach remote territories or patients who, for various reasons, cannot have access to dental care. Second, this paper has set the goal of evaluating and identifying the potential criticalities, future challenges, and perspectives that the introduction of this method may have in the daily activities of the dentist.

2. Materials and Methods

2.1. Search Strategy and Study Selection

A literature search was performed independently by two reviewers (G.S., M.P.) in three electronic databases—PubMed/MEDLINE, Google Scholar, and the COCHRANE library—and gray literature, combining the following keywords with Boolean operators: “teledentistry”, “telemedicine”, “remote consultation”, “remote screening”, “dentistry”, “teleconsultation”, “pediatric dentistry”, “pedodontics”, “telediagnosis”, and “pediatric dentistry”.

Citations obtained through the literature search were recorded, duplicates were eliminated using EndNote, and titles and abstracts were independently reviewed by three reviewers (M.P., G.S., A.B.).

Available full texts that met the inclusion and exclusion criteria listed below were also independently reviewed for potentially eligible studies. Any disagreements between reviewers were resolved by discussion and consensus.

The inclusion criteria were as follows:

- Studies published in a peer-reviewed journal
- Source: studies published in the English language from January 1996 to 1 February 2023
- Study design: controlled (randomized or non-randomized) assessment studies
- Study population: pediatric patients with no gender restrictions

- Study intervention: remote screening, tele-assistance, telemonitoring, tele-education, and telediagnosis by digital support
- Study outcomes: reported outcomes of teledentistry intervention(s).

The exclusion criteria were as follows:

- Source: studies published before 1996 or not published in a peer review journal
- Study intervention: indication for treatment not specified
- Study outcomes: not reported outcomes of teledentistry interventions.

No attempt was made to contact the authors for missing information or unavailability of the full text. In case of discrepancies, the evaluation of the majority was taken into account (two out of three reviewers).

References were exported and managed using Mendeley Reference Manager software.

2.2. Data Collection

Data on the source of the article, teledentistry application(s), study type, population, methods, outcomes, and results were extracted and qualitatively synthesized by two independent reviewers (G.S., M.P.) from each study included in the present narrative review.

3. Results

3.1. Study Selection

A total of 864 records were retrieved from PubMed/MEDLINE (375 articles), Google Scholar (369 articles), and the COCHRANE library (120 articles). Of these, 502 were excluded because duplicates or full texts were unavailable. Of the remaining 362 records, 280 were not relevant, and 82 full texts were screened; 51 entries were also excluded because the evaluation of the full texts did not reveal study outcomes or intervention methods. Finally, 31 articles were included in the qualitative analysis.

The flowchart for study selection is shown in Figure 1.

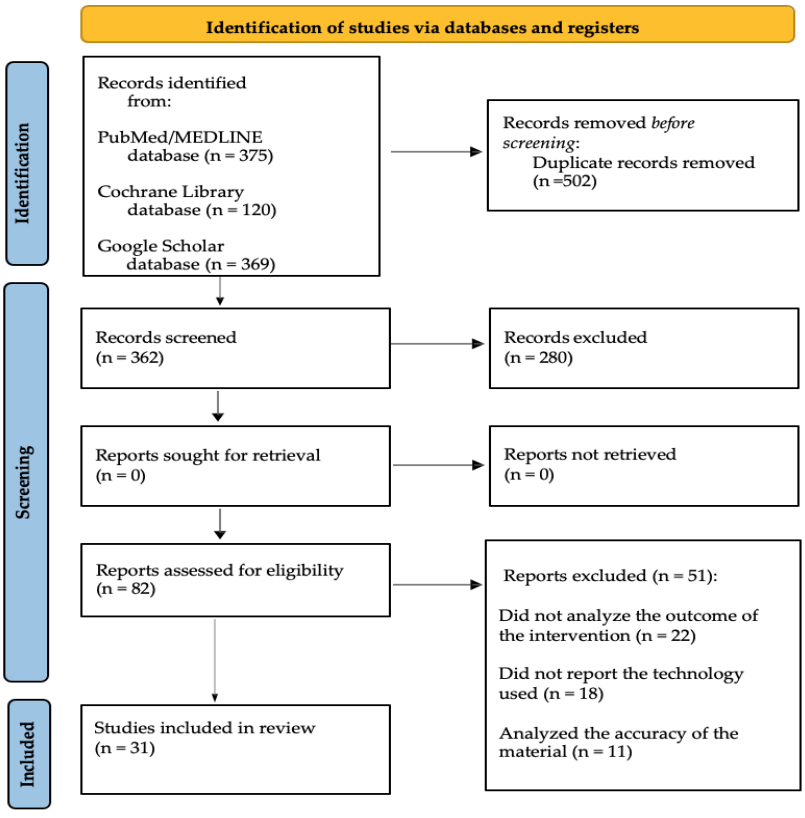


Figure 1. Study selection flowchart.

3.2. Data Collection

Data extracted and collected from the included articles are detailed in Table 1 and organized according to the following parameters: authors, year, country, type of technology used, purpose, methods, and conclusion(s)/outcome(s).

Table 1. Summary of studies included in this review, with data collected and organized according to the following parameters: authors, year, country, type of technology used, purpose, design, conclusion(s)/outcome(s).

Author	Year	Country	Type of Technology Used	Purpose	Design	Outcome
Kopycka-Kedzierawski et al. [15]	2008	USA	Telediagnosis using store-and-forward Dr. Camscope's intraoral camera	The prevalence of caries was evaluated with the aid of teledentistry in preschool children aged between 12 and 60 months.	Images of the primary dentition were obtained through an intraoral camera and evaluated by pediatric dentists.	The results showed that about half of the children involved had dental caries and that teledentistry proved effective for screening for carious lesions in preschool children.
Soler et al. [16]	2009	USA	Molarcropolis app	An interactive game was proposed with the aim of increasing knowledge of oral hygiene methods among adolescents. Through the game, users learn about oral diseases and their etiology, how to deal with them, and what to do to improve their oral health.	People between the ages of 13 and 24 were included in the survey-based study. The effectiveness of the app in raising awareness of oral hygiene-related practices was evaluated.	The results obtained from the survey reported satisfaction from players who found the game fun and educational. They also considered the app useful in learning about oral health
Amàvel et al. [17]	2009	Portugal	Digital camera and web-based system (MedQuest)	The purpose of the study was to evaluate the effectiveness of remote diagnosis for dental problems using technological means, such as noninvasive photographs.	The sample includes children aged 4–6 years. Diagnoses were made through photographs, which were used for screening via a web application.	The results show that digital photographs are a valid means for remote diagnosis of dental problems. The specificity of this method could be improved by increasing the feedback on the dentist's evaluation.
Lienert et al. [18]	2010	Switzerland	Telephonic communication	The study aimed to evaluate the number of telephone calls related to dental trauma made to medical centers.	Retrospective study with a population aged 0–73 years old. One-third of the patients were aged 0 to 6 years.	Telemedicine in dentistry can be a useful tool. Findings show that most of the calls concerned injuries to the primary dentition.
Kopycka-Kedzierawski et al. [19]	2011	USA	Telediagnosis using store-and-forward Dr. Camscope's intraoral camera	Screening for caries	The sample consisted of a cohort of patients aged 12 to 60 months. The children were randomly divided into two groups: Group 1 received a traditional clinical examination with the dentist and Group 2 received a remote teledentistry examination.	The data showed that 31.5 percent of children never had a dental visit and 92 percent of parents did not consider access to dental care for their children to be a problem. These data highlight the importance of making continuous efforts to improve prevention in the population.
Levine et al. [20]	2012	USA	MySmile Buddy	The study aimed to analyze the risk of diet-related caries in children.	Initially, Community health workers (CHWs) were trained for this study. A pilot study was carried out on mothers of children with early childhood caries conditions. The mothers were trained and guided in the use of the app by CHWs who were in turn interviewed about the app's ease of use and navigation.	CHW rated the app as very simple and enjoyable for families to use.

Table 1. *Cont.*

Author	Year	Country	Type of Technology Used	Purpose	Design	Outcome
Torres-Pereira et al. [21]	2012	Brazil	Smartphone camera	The study aimed to analyze and evaluate the effectiveness of teledentistry for the diagnosis of oral diseases through the use of digital clinical images transmitted via email.	After obtaining the ethics committee approval, a non-randomized study was conducted, in which dental office assistants uploaded intraoral images of the first 60 patients who visited the clinic. These images were uploaded to the cloud and analyzed by mid-level practitioners and dentists to assess the presence of caries. An 18-megapixel DSRL was used to take the photos.	Intraoral photographs produced adequate diagnostic information in terms of sensitivity and specificity. This method expedited communication with specialists by reducing diagnostic and treatment delays and speeding up patient flow.
Kopycka-Kedzierawski et al. [22]	2013	USA	Intraoral camera	The purpose of the work was to assess the prevalence of caries in early childhood.	The sample consisted of 291 children who were randomly divided into two groups: Group 1 underwent a traditional dental clinical examination with checkups at 6 and 12 months; Group 2 was evaluated with a teledentistry visit and subjected to follow-up visits at 6 and 12 months.	It was observed that the assessments made through teledentistry exams were comparable to traditional clinical exams for caries screening in children.
Shao et al. [23]	2014	China	DAYA tooth brushing game	The purpose of the study was to evaluate the improvement of tooth brushing effectiveness in children through the use of a computer game to help parents monitor their children's oral health.	To evaluate the effectiveness and usability of the app and game, a pilot study was conducted with children aged 6–10 years as the sample.	From the results that emerged, it was observed that the game was better understood and enjoyed more by children aged >8 years. In addition, parents were able to complete all the monitoring tasks assigned to them. An improvement in the brushing experiences of the children involved was also observed.
Mariño et al. [24]	2014	Australia	An intraoral camera that transmits audio and video and a web camera	The study was conducted with the aim of carrying out a systematic literature review in order to synthesize the available information on teledentistry.	A non-randomized study was performed on pediatric patients who were seen by community dentists. Images collected by the dentists were sent to pediatric dentists for consultation on cleft lip and palate, dental trauma, and orthodontics.	Diagnostic processes and reduced screening times were observed through the use of teledentistry.
Underwood et al. [25]	2015	Netherland	Brush DJ app	The purpose of the study was to evaluate the effectiveness of the application in instructing patients on proper oral hygiene routines, motivating them through listening to music for 2 min during the hygiene phase, setting reminders for rinsing the mouth, maintaining fluoride concentration, changing the toothbrush, and setting appointments with the specialist.	The sample was between 0 and 74 years old, and 37.1% of the participants were between 7 and 12 years old. A survey was conducted to assess their experience and beliefs about oral health apps.	The data showed that participants obtained a greater incentive to brush better and for a longer period of time, providing better compliance and patients' benefits.

Table 1. *Cont.*

Author	Year	Country	Type of Technology Used	Purpose	Design	Outcome
Zotti et al. [26]	2016	Italy	WhatsApp	Video tutorials were used to explain oral hygiene maneuvers. Patients shared their photos in a WhatsApp group.	The sample consisted of adolescent patients undergoing orthodontic treatment. It was divided into two groups: the first (study group) had an average age of 14.1 years and the second (control group) was 13.6 years. The ability to maintain oral hygiene was monitored via selfies and text messages.	The results showed that patients with better oral hygiene compliance developed fewer white spot lesions during orthodontic treatment.
McLaren et al. [27]	2016	USA	Intraoral camera and computer camera	The study aimed to assess parents' oral hygiene methods and eating habits, and dental care of their children during the COVID-19 global pandemic.	The retrospective study was conducted on children with a mean age of 4.77 years (±2.36) which aimed to evaluate the accuracy of therapeutic dental treatment planning by pediatric dentists via teledentistry means (live video).	In conclusion, it can be said that live teledentistry consultation can be an effective means to evaluate and predict the best treatment modality in pediatric patients with significant dental pathology.
Purohit et al. [28]	2017	India	Smartphone camera	The purpose of the study was to evaluate the efficacy and reliability of teledentistry by videographic method, as a tool for screening dental caries in pediatric patients.	The sample consisted of 12-year-old Indian children who underwent a clinical and a videographic examination in order to assess the DMFT index.	Clinical and video-graphic examinations are shown to be comparable in terms of reliability in screening dental caries in school-age patients.
Estai et al. [29]	2017	Australia	The remote mobile teledentistry system for Android phones that collects, transmits, and reviews dental photographs via the 'Remote-i' cloud server.	The purpose of the study was to evaluate, through the use of teledentistry, the effectiveness of remote screening of dental caries.	The sample consisted of people of all ages who carried out dental screening through the use of photographs. These were subsequently shared on the "Remote-i" system and evaluated by trained telehealth assistants.	Teledentistry is a low-cost method for conducting mass dental screenings in remote locations.
de Almeida Geraldino et al. [30]	2017	Brazil	Mobile phone camera	The purpose of the study was to evaluate the levels of agreement among dental examiners in remotely conducted diagnostic steps in traumatic dental injury cases.	The sample consisted of dental trauma patients aged 3 to 39 years. Diagnostic examinations were performed remotely using electronic records and photographs. The concordance between remote and traditional diagnosis was then assessed.	The results obtained showed that remote diagnosis was comparable to traditional diagnosis in terms of accuracy. The use of photos taken with a cell phone could be useful for remote diagnosis of traumatic dental injuries.
Patil et al. [31]	2017	India	Mobile dental application "My Little Dentist"	The study aimed to evaluate the use and effectiveness of digital dental applications in managing anxiety and behavior in pediatric patients.	The study sample consisted of children aged 8 to 12 years. In this pilot study, patients were required to perform dental procedures on virtual avatars in the app to approach and become familiar with the dental clinic.	The results showed that using the application reduced anxiety and improved patients' behavior during subsequent dental visits.

Table 1. *Cont.*

Author	Year	Country	Type of Technology Used	Purpose	Design	Outcome
Meshki et al. [32]	2018	Iran	Mobile dental application "Crazy Dentist"	The purpose of the study was to evaluate the management of pain and anxiety in pediatric patients during their first dental visit after simulating it in a digital game.	The study was structured as a double-blind randomized clinical trial, and the sample consisted of children aged 4–7 years in order to evaluate the effectiveness of the pre-exposure method in reducing anxiety during the first dental visit. The pre-exposure method was adopted through a smartphone dental simulation game.	Dental simulation games as a pretreatment model are a useful tool to reduce anxiety during dental procedures in pediatric patients.
Kohara [33]	2018	Brazil	Two smartphones (iPhone and Nexus 4) and a standard macro camera setup were used for photography.	The objective of the study was to compare the effectiveness of two different smartphones with a conventional camera and the standard clinical examination in detecting carious lesions at different stages of progression in deciduous molars.	Two examiners studied and classified the images according to the International Caries Detection and Assessment System (ICDAS) method. Two other operators performed the direct clinical examination of the teeth and set the parameters in accordance with the reference standard.	The data showed that photographic images provided by cameras were a useful tool to discern healthy enamel surfaces from those with extensive carious lesions; however, they were ineffective in detecting early and moderate carious lesions. Smartphone cameras and conventional macro cameras performed similarly.
Kale et al. [34]	2019	India	Smartphone camera and social networking application	The purpose of the study was to evaluate the ability of mothers to diagnose caries processes using photographs taken with a smartphone.	The sample consisted of mothers with children between the ages of 3 and 5 years. After receiving the necessary information, they were invited to send, via WhatsApp to the dentists, photos captured with their smartphones.	The results obtained showed good outcomes in terms of sensitivity, specificity, and accuracy. It was also observed that children were more cooperative with the examinations performed with the smartphone than with traditional clinical examinations. The reason is attributed to the greater familiarity pediatric patients have with the former.
Elicherla et al. [35]	2019	India	Mobile dental application "Little Lovely Dentist"	The purpose of the work was to evaluate the modulation and management of anxiety in pediatric patients by using the Little Lovely Dentist mobile application and comparing it with the tell-show-do (TSD) technique.	The study sample consisted of children aged 7 to 11 years who were facing their first dental visit. The study design was parallel-armed to compare the effectiveness of traditional tell-show-do (TSD) and a dental simulation app.	The data obtained showed that the use of the app significantly reduced children's anxiety associated with the first visit. it was also found that due to the interactive nature of the app, it was more effective than TSD.
Radhakrishna et al. [36]	2019	USA	Smartphone dentist game	The study aimed to compare tell-show-play-do techniques, via a smartphone game, and the conventional tell-show-do technique in modulating and modifying the behavior of anxious pediatric patients.	The study sample consisted of children aged 4 to 8 years who underwent a randomized interventional clinical trial.	The results showed that dental game apps and the tell-show-play-do method were more effective in reducing anxiety than conventional methods.

Table 1. *Cont.*

Author	Year	Country	Type of Technology Used	Purpose	Design	Outcome
Lotto et al. [37]	2020	Brazil	WhatsApp	Early childhood caries educational text messages.	The study was conducted in a sample of children aged 36 to 60 months with tooth decay. The randomized controlled trial saw the intervention group receive educational text messages via WhatsApp.	Controlling the severity of ECC in low socioeconomic pre-schoolers by improving parental eHealth literacy and changing children's dietary patterns is effective.
Asokan et al. [38]	2020	India	Mobile dental application "Little Lovely Dentist"	The purpose of the study was to evaluate and compare two distraction techniques for managing anxiety in pediatric patients. The first technique consisted of a magic trick and the second was the use of a mobile dental game with tell-show-do (TSD).	The study was structured as a double-blind randomized trial with the aim of comparing the use of a magic trick with the mobile dental app in order to modulate anxiety in pediatric patients. The evaluated sample consisted of children aged 4 to 5 years.	The results showed that both distraction techniques were effective; however, distraction by mobile play was readily accepted by the pediatric patient.
Simsek et al. [39]	2020	Turkia	YouTube	The purpose of the work was to evaluate the quality of informational videos on oral habits found on YouTube.	Videos on oral hygiene were viewed and watched, and the quality of information available to patients and parents was evaluated.	It was found that most of the videos were inadequate and contained insufficient information.
AlShaya et al. [40]	2020	Saudi Arabia	Smartphone camera, Google Drive, and social media application (WhatsApp Messenger)	The purpose of the study was to evaluate the reliability of teledentistry performed via cell phone in diagnostic procedures and treatment planning of dental caries in patients with mixed dentition.	The study was conducted on a group of mixed dentition patients aged 6 to 12 years. Intraoral photographs were evaluated by a pediatric dentist for the diagnostic stage of dental caries.	The reported results show that teledentistry represents a tool with adequate reliability for the initial diagnosis of caries in children. However, this reliability is lower in the absence of radiographs.
Wallace [41]	2020	UK	Data were gathered from clinical notes and recorded on a Microsoft Excel spreadsheet, which was securely stored on a Trust-approved encrypted computer.	The purpose of the study was to evaluate the effectiveness of the use of teledidactics for new pediatric patients at Newcastle Dental Hospital and to establish its potential role in the field of pediatric dentistry by analyzing the advantages and disadvantages associated with this method.	The teledentistry service was administered in 653 appointments for new pediatric patients across a one-month period. A telephone consultation was administered as the first step, which reduced the number of in-person appointments by about one-third.	The conclusions reached are that teledentistry represents a new field that has the potential to improve the diagnostic, therapeutic, and follow-up flow of dental patients.
Sanghvi et al. [42]	2021	UK	Telephone consultation	The purpose of this work was to evaluate the possibility of minimizing the spread of COVID-19 infection by reducing face-to-face interactions. In addition, the ability of pedodontists to properly administer dental teleconsultation was evaluated.	The study was conducted on a sample of patients aged 2 to 16 years during the COVID-19 pandemic. A teleconsultation was performed by the pediatric dentists and parental satisfaction was assessed.	The analysis conducted showed a high degree of satisfaction with telephone consultations. Therefore, it was found that teledentistry was an effective method for assessing patients and following up.

Table 1. *Cont.*

Author	Year	Country	Type of Technology Used	Purpose	Design	Outcome
Damoiselet [43]	2022	France	Covotem software via the Pulsy platform	The purpose of the work was to evaluate the proper functioning and effectiveness of the Covotem software through the Pulsy platform.	The teleconsultation was carried out from an initial triage conducted by trainees or dentists who followed a specific pedodontic protocol. Prior to the appointment, the patient received a text message stating the date, time, and link to the video conference call. An informed consent and medical history questionnaire were also sent via the Apicrypt professional secure messaging system. Subsequently, the patient sent the documents back, attaching intraoral photographs to the same address.	The data collected showed that teledentistry is an excellent tool to plan and organize dental care.
Miriam Varkey [44]	2022	India	Google Forms platform	This study aimed to analyze parents' oral hygiene practices and attitudes, eating habits, and dental care during the SARS-CoV-2 pandemic.	The study sample included 381 Indian parents with children between the ages of 4 and 7 years. A questionnaire was created on Google Forms. It was divided into the following sections: sociodemographic data, child's eating habits, oral hygiene measures, and oral health information.	Gaps in the dental attitudes and practices and eating habits of parents of pediatric patients during the SARS-CoV-2 pandemic were highlighted in this study. This could be due to the lack of awareness of the issues associated with improper oral hygiene, fear of exposure to the virus, and the difficulties parents face.
AlShaya [45]	2022	Saudi Arabia	Mobile phone camera	The purpose of this study was to analyze and evaluate the accuracy of teledentistry in detecting dental caries by comparing it with traditional clinical examination.	The study sample consisted of children aged 5 to 10 years. They were evaluated by a qualified dentist who took intraoral photographs of each child with the help of two teachers. The evaluation performed by teledentistry was compared with the traditional clinical examination.	The results obtained show that teledentistry has acceptable accuracy for caries screening in school-age patients compared with traditional clinical examination.

The analyzed studies were then subdivided according to the type of teledentistry application(s) assessed (Figure 2). Eleven studies assessed the use of telediagnosis in children, while n = 11 studies evaluated tele-education, n = 5 telemonitoring, and n = 5 teleconsultation, respectively.

The study by Shao et al. [23] was placed into two categories respectively: telemonitoring and tele-education, on the basis of their dual objectives.

In addition, the studies were divided according to the digital support used (Figure 3) for teledentistry applications in pedodontic patients: 10 studies used mobile health applications; 8, smartphone cameras; 6, intraoral cameras; 3, WhatsApp; 2, the Google platform; 2, telephone communication; 1, YouTube; and 1, Excel. Mobile health applications were most commonly used for oral health education and promotion in pediatric patients. Smartphone cameras and intraoral cameras were the most commonly used tools for remote diagnosis.

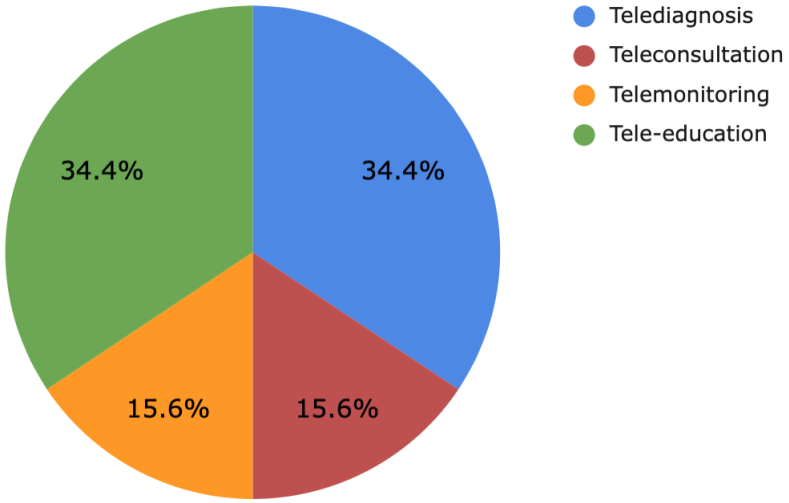


Figure 2. Subdivision of the studies according to teledentistry applications.

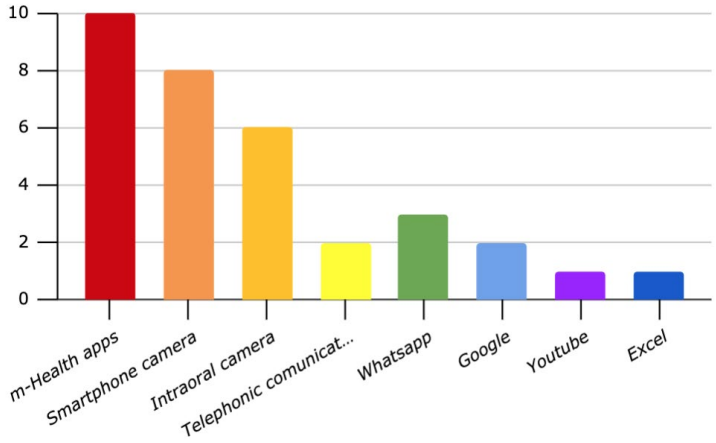


Figure 3. Classification of studies according to the digital methodology applied.

4. Discussion

There is an evident propensity in the literature to support the usefulness and reliability of teledentistry applications, but it must be considered that many of the studies examined provide only preliminary results and only report the reliability and reproducibility of the short-term use of these services. In addition, several studies have included the participation of family members, health professionals, and dentists whose skills, experience, and knowledge are inevitably different and heterogeneous.

The literature review shows that teledentistry, especially in pediatric patient care, has several applications, such as telediagnosis, tele-education, telemonitoring, and teleconsultation [46]. Teledentistry has brought several advantages during the COVID-19 pandemic by limiting contacts and respecting the safety measures imposed by distancing. At the same time, it has prevented the exposure of dental staff and dentists thanks to the use of different tools, such as mobile phones, webcams, intraoral cameras, and dental applications [47].

Several studies have reported dentists' and patients' satisfaction in managing dental and/or orthodontic emergencies with the reduction of in-office appointments. These studies also reported dentists' and patients' satisfaction with the fact that dental monitoring did not affect treatment outcomes [48,49]. Therefore, our objective was to review the literature regarding the use of teledentistry, the most widespread applications, and the most commonly used technologies to address the oral health needs of pediatric patients.

The literature review revealed that teledentistry could be helpful in educating and promoting children's oral health, diagnosing and monitoring pediatric dental patients

in remote areas with limited access to dental care, and serving as a behavioral guide for pediatric patients [22].

The present study found that among the technologies used, m-Health apps were widely used for behavioral education, oral health promotion, and reducing anxiety before an in-person appointment among pediatric patients [31,32]. The smartphone and intraoral cameras were mainly used for diagnosing and monitoring young patients and for studies comparing the results of remote diagnosis with traditional clinical examination.

Oral health education and promotion programs using mobile technologies, the internet, and mobile health applications have attracted public attention and reached a large population. Several authors believe that children are proficient in using digital technologies and use them more intensively than adults [27,31].

Therefore, the use of internet- and mobile-based applications increases patient awareness and knowledge to promote oral hygiene, provides an effective communication tool for parents and the community in remote areas, and could address the shortage of qualified public health dental professionals specializing in the management of pediatric patients [36]. m-Health apps used for patient education should be based on accepted behavior change techniques and provide instructions on how to perform a task, include prompts, and reward the user for achieving the goal [37,38]. According to the analyzed data, the most frequently used features in the m-Health app developed for children's oral health should include educational multimedia and game-based stories. Animation-based educational programs and picture books are mainly used to teach brushing and familiarize with the dental environment and procedures, as children are highly influenced by animations and pictures. In contrast, adult self-care applications are mostly focused on reminders, timers, sensors, online counseling, and SMS.

In the study proposed by Soler et al., adolescents reported that the game was entertaining and educational; it helped them learn new aspects of oral health and had the potential to change their oral health habits [16].

Patil et al. concluded that this method can reduce anxiety about dental treatment and improve patients' behavior during subsequent face-to-face visits [31]. Following these findings, Patel et al. reported that the use of social media for social, emotional, or experiential support in chronic disease, particularly through Facebook and blogs, appeared to improve patient care [2].

Another application of teledentistry studied by several authors is the ability to diagnose and monitor using digital devices, such as smartphones, digital cameras, intraoral cameras, webcams, and computer monitors [21,40]. Remote diagnosis involves the use of images of the patient to diagnose and monitor any oral pathology. Through this approach, it is possible to prioritize patients in need of urgent treatment through remote diagnosis, while ensuring access to pediatric dentistry specialists, who in many cases are difficult to find in the region, thus eliminating the need for the patient to travel to a specialized dental consultation, especially for individuals who have difficulty accessing medical treatment due to geographic or socioeconomic reasons [33,45,50].

From the physician's perspective, the advantage is that he or she can share the captured images with other specialists, which allows the general dentist and/or the specialist dentist to develop an appropriate multidisciplinary treatment plan. This telehealth network approach allows doctors with different expertise to be digitally connected to discuss diagnoses and multidisciplinary treatment plans that lead to the resolution of the most complex clinical cases.

Kohara et al. reported that this method was reliable in diagnosing large carious lesions but less effective in diagnosing initial carious lesions [33]. de Almeida Geraldino et al. also reported that remote diagnosis was comparable to conventional in-person examination [30].

Kopycka-Kedzierawski et al. showed that remote diagnosis was as effective as conventional on-site examination in early caries detection in young children [15]. Kopycka-Kedzierawski et al. performed a study testing the efficacy of teleodontology for caries screening in preschool children at high risk for early childhood caries, and the authors

concluded that teledentistry was shown to be effective in screening for carious lesions [22]. According to these results, Amavel et al. reported that remote diagnosis of oral problems in pediatric patients through photographs was a valuable resource [17]. Kopycka-Kedzierawski et al. in another study, argued that an intraoral camera was a viable and potentially cost-effective alternative to visual oral examination for caries screening in preschool children attending childcare centers [19].

Among the most analyzed aspects is orthodontic telemonitoring. The Italian Society of Orthodontics (SIDO) during the COVID-19 pandemic published the recommended guidelines for the management of orthodontic patients. In these guidelines, a first approach was recommended through virtual assistance by photographic documentation or a video call with digital support, in order to be able to distinguish through a triage the cases in which a face-to-face visit was necessary from those situations that could be managed remotely according with the restrictions of the pandemic [50]. For these reasons, several authors suggested that orthodontic emergencies should be addressed with a gradual approach [48]. It should be emphasized that orthodontic emergencies are unpredictable problems caused by mostly orthodontic appliances causing pain or discomfort, requiring urgent dental care [49]. Compared with other dental problems, orthodontic problems are less severe and often do not require in-office treatment. Many of these problems can be easily solved at home, which reduces stress for patients' families and saves time for both patients and dentists. Despite these benefits and the positive impact of orthodontic monitoring during the pandemic, which has produced encouraging results for both dentists and patients, some procedures require direct access to the mouth and hands-on intervention by the clinician that cannot be performed via telemedicine [49]. These procedures include initial orthodontic examination, data collection, bonding and detaching of orthodontic brackets, bands, and clear aligner attachments, interproximal reduction (stripping), enameloplasty/occlusal adjustment, and cutting, bending, and changing wires [51].

In addition, several authors have reported some limitations related to remote support, including the insufficient quality of the photos, the problems related to the insufficient internet support, and/or the learning curve required for the correct functioning of the device or applications, which affect both the dental staff and the patient and his/her family members [52].

What Does the Future Hold?

Continuative applications of teledentistry in pediatric dental practice have begun to emerge. These include teleconsultation, telediagnosis, tele-education, and telehealth networks, which could be systematically integrated for the maintenance of pediatric oral health. However, some aspects must be addressed to ensure these methods become part of dentists' daily routines. Indeed, aspects related to the privacy and protection of sensitive data of patients and to data protection obligations of a health facility working using telemedicine and teledentistry are diverse and correspond to the sensitivity of the particular data to be processed [53]. For these reasons, staff should request only the data necessary to provide the health service and implement technical and organizational measures to prevent alteration or loss of data and ensure their security throughout the service process. Time limits for data retention or deletion should be established, along with a simple process that identifies ways to address patient needs promptly and clearly. In addition, the cost of compensating healthcare professionals for providing these services should be addressed. Certainly, strategies must be adopted to equip structures with specialized equipment, hardware, and adequate internet coverage to support these procedures to limit the socioeconomic and territorial exclusion dynamics that exist today in many areas; it should be considered that especially in rural or underdeveloped areas, an internet connection is also an obstacle. Communication that is not stable and clear between the patient and the dentist can lead to wasted time, misunderstanding, or misdiagnosis. It may be appropriate to make centers with software, trained staff, and good internet coverage available to patients in rural areas so that they can conveniently connect [54].

The next generation of dentists will have new tools including information networks and simulations, such as learning platforms that deliver virtual content, which will enable the remote transfer of skills. It will be very important to acquire the ability to think and work with these technologies at all levels of education. This will lead to the growth and projection of specialists toward digital health, which will inevitably lead to an adaptation of curricula and training of future dentists [55]. For this reason, it might be desirable to include specific knowledge regarding the possible uses of teledentistry and the skills required for its informed use in the university curriculum of dental students [56].

As a prerequisite for the transition from an experimental method to a structured method in relation to the widespread use of these services, harmonization of telemedicine, as well as teledentistry, guidelines and application models are required.

Despite the initial positive impact, further research is needed to assess effectiveness, cost-benefit, and long-term outcomes.

However, tele-assistance should be seen as an opportunity for dentists and new generations to project the profession into the future. Today, more and more patients are searching online for information about their health, leading to uncertainty, confusion, and scare tactics. Teledentistry services could strengthen the trust relationship between the patient and the dentist. In many cases, the studies examined provide only preliminary results and consider only teledentistry's feasibility and short-term use.

Due to the limited conclusive evidence, heterogeneity of the methods used by the authors, the interventions, and the outcomes evaluated in the studies reviewed, the generalizability of the results is limited. Well-designed studies evaluating teledentistry and its effectiveness, cost-effectiveness, and long-term use are needed.

5. Conclusions

The present narrative review found a growing body of evidence supporting the effectiveness of teledentistry, particularly in pediatric dentistry.

The positive results suggest that this technological advance in dentistry can significantly help reduce the gap between the supply and demand of pediatric dentistry specialists in locations where dental services are limited. In addition, teledentistry can help ensure long-term oral healthcare for the pediatric population and overcome disparities in access to specialty care. However, it is necessary to consider that these services need to have an adequate internet connection, clear policies and regulations, trained staff, and modern technology, the costs of which could be prohibitive, especially if not supported by governments with funds and subsidies.

Future studies are needed to evaluate the reliability and effectiveness of teledentistry applications and the optimal digital methodology that should be used beyond cost-effectiveness and long-term use.

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