



DIGITAL INFORMATION AND COMMUNICATION TECHNOLOGIES IN CHILDREN'S ORAL HEALTH: AN INTEGRATIVE REVIEW

TECNOLOGIAS DIGITAIS DE INFORMAÇÃO E COMUNICAÇÃO NA SAÚDE ORAL DE CRIANÇAS: UMA REVISÃO INTEGRATIVA

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ABSTRACT: The aim of this study was to understand the Digital Information and Communication Technologies used in different contexts to improve children's oral health. This is an integrative review conducted in April 2023, based on the guiding question "What are the Digital Information and Communication Technologies used in different contexts to improve children's oral health?". A search was conducted in the National Library of Medicine, Scopus, Web of Science, and Virtual Health Library databases. Four articles answered the guiding question and comprised the sample. The analysis revealed the use of books with visual files and video clips, mobile applications, and teledentistry as technologies used for children's oral care in the context of educational programs and in direct and remote dental care. It is concluded that technologies for children's oral care are scarce; however, they are present in multidisciplinary contexts with a focus on the assessment, prevention, and promotion of oral health.

KEYWORDS: Communication. Child. Digital Technology. Health. Information Technology. Oral health.

RESUMO: Objetivou-se conhecer as Tecnologias Digitais de Informação e Comunicação utilizadas em diferentes contextos para a melhoria da saúde oral de crianças. Trata-se de revisão integrativa realizada em abril de 2023, a partir da pergunta norteadora "Quais são as Tecnologias Digitais de Informação e Comunicação empregadas em diferentes contextos para a melhoria da saúde oral de crianças?". Realizou-se uma busca nas bases de dados *National Library of Medicine*, *Scopus*, *Web of Science* e Biblioteca Virtual em Saúde. Quatro artigos responderam à questão norteadora e compuseram a amostra. A análise revelou o uso de livros com arquivos visuais e videoclipe, aplicativos móveis e a teleodontologia como tecnologias empregadas para o cuidado oral de crianças no contexto de programas educativos e na assistência odontológica direta e remota. Conclui-se que as tecnologias para o cuidado oral infantil são escassas, contudo, apresentam-se em contextos multiprofissionais com foco na avaliação, prevenção e promoção da saúde bucal.

PALAVRAS-CHAVE: Comunicação. Criança. Saúde bucal. Tecnologia da Informação. Tecnologia Digital.

INTRODUCTION

Digital Information and Communication Technologies (DICT) are technological bases capable of connecting information, environments, and individuals through the use of diversified digital and media resources.¹ Such resources are widely inserted in the daily lives of human beings and in their social interactions, constituting indispensable apparatuses for different segments of society.

In recent decades, DICT have stood out as powerful tools for the development of pedagogical/educational activities², achieving greater notoriety among researchers and professionals in the health field. In this sense, the creation and dissemination of technologies to improve care and increase the quality of life of individuals is evident, covering different thematic areas³, age groups⁴, countries, and health systems.⁵

Consequently, these tools have become part of increasingly complex and heterogeneous educational, preventive, diagnostic and therapeutic practices, including oral health⁶, corroborating the dissemination of knowledge and health promotion.⁷ Despite this inclusion, the community application of DICT in Brazil, as well as in other countries⁸, is still faced with a scenario of socioeconomic vulnerability that leads to limited access to the internet, to the rapid advance of digital media and, subsequently, to information.⁹

Thus, considering that younger and wealthier people tend to use and benefit from digital technologies to support healthy behaviors⁴, the combination of these weaknesses can result in negative outcomes for the systemic and oral health of those individuals not reached by these resources.^{10,11} This scenario of frailty is further aggravated when assessing groups susceptible to oral illnesses and infections that require more specific and cautious attention, such as children.¹²

The latter, called "digital natives", grow up inserted in and surrounded by DICT, becoming more sensitive and intelligible to the potentialities of this universe, which consists of the most important source of information among younger people today.⁷ However, in the context of prevention and promotion of oral health, the development and appropriation of these technologies and their implications still require attention and investigation¹³, including in a multidisciplinary scenario.⁷

In this perspective, it is relevant to gather the national and international literature on DICT adopted to improve children's oral health care, based on the publication of studies that compare their use to common methods in processes, such as dental consultation, evaluation and treatment, whose results are favorable for health promotion.¹⁴ In particular, the knowledge and dissemination of these literatures may guide actions by managers, health professionals, and parents or guardians to use DICT for the benefit of oral cavity health for children, according to each reality.

In view of the above, this study aimed to understand the DICT used in different contexts to improve children's oral health.

METHODOLOGY

This is an integrative review, based on Evidence-Based Practice (EBP), chosen to allow a comprehensive and critical view of the available knowledge on the topic investigated.¹⁵⁻¹⁶ This type of review is specifically appropriate to achieve the objective of the study, as it enables the systematic gathering and analysis of results from primary research with different methods, favoring the incorporation of evidence for decision-making.¹⁵⁻¹⁶ In addition, the integrative review follows a methodological rigor for the selection, analysis, and summary of evidence. Thus, the scientific

control of the study is guaranteed, allowing the identification of gaps in knowledge and subsidizing new research in the area.¹⁵⁻¹⁶ It should be noted that the writing of this study followed the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist.

This review was conducted in six stages, designated as follows: - identification of the theme and drafting the research question; - establishment of criteria for inclusion and exclusion of studies; - categorization of studies; - evaluation of the studies included in the integrative review; - interpretation of the results; and - synthesis of knowledge of the main results evidenced in the analysis of the included articles.¹⁵⁻¹⁶

The guiding question was written based on the PICO strategy, acronym that corresponds to "Population, Interest, and Context". Based on this strategy, considered a relevant resource for the formulation of research questions and the search for evidence in the literature, we assigned Children to the letter "P", Digital Information and Communication Technology to "I", and Oral Health to "Co".

Thus, the following guiding question was obtained: "What are the Digital Information and Communication Technologies used in different contexts to improve children's oral health?". In particular, the addition of "different contexts" to the research question was based on the fact that these technologies could cover a diversity of situations and clinical conducts, such as professional training and dental consultations, evaluation, and treatment.

The search for articles was carried out by two Nursing researchers, one undergraduate student and one master, independently, in April 2023. The research sources were accessed by consulting the Portal of Journals of the Coordination for the Improvement of Higher Education Personnel (CAPES, in Portuguese) of the Ministry of Education (MEC), corresponding to the following databases: National Library of Medicine (PubMed), Scopus, Web of Science, and Virtual Health Library (VHL).

PubMed, Scopus, and Web of Science were chosen due to being globally renowned bases, gathering high-impact publications indexed in international journals in various areas of health. The VHL, in turn, was included to encompass studies published in Latin American and Caribbean countries, enabling a broader view of national and regional scientific production. Thus, the choice of these databases ensures a comprehensive and rigorous bibliographic survey, essential for the construction of the integrative review.

As a search strategy, researchers used the controlled descriptors in English "Communication", "Information Technology", "Digital Technology", "Oral Health" and "Child", indexed in the Medical Subject Headings (MeSH), as well as their counterparts in Portuguese. For the association of the terms in the databases, the Boolean operator "AND" was used.

The results were exported to the *Rayyan* software, after which the titles and abstracts were read, followed by the adoption of the inclusion and exclusion criteria. Were included articles available in full, in Portuguese, English, or Spanish (a criterion established to include studies conducted nationally, including those published in international journals), published in the last 10 years (2013-2023) (an attitude adopted with the aim of covering a larger number of articles in the review, including the most recent) and that answered the guiding question. Were excluded repeated publications, integrative reviews¹⁷ and bibliometric studies (conduct established due to this type of research evaluating and characterizing publications in the academic context, through statistical and mathematical strategies, which is not the focus of this review).¹⁸

The full reading of the selected articles was carried out based on the recommendations of the PRISMA checklist.¹⁹ Thus, two stages were used: 1) Reading of the titles and abstracts; 2) Full reading of the studies that met the inclusion criteria, for the composition of the final sample. The analysis of the articles was conducted blindly by two researchers, one of whom was a Nursing undergraduate student

and the other, a master in Nursing. To resolve any conflicts, a third reviewer, a master's student in Nursing, was invited.

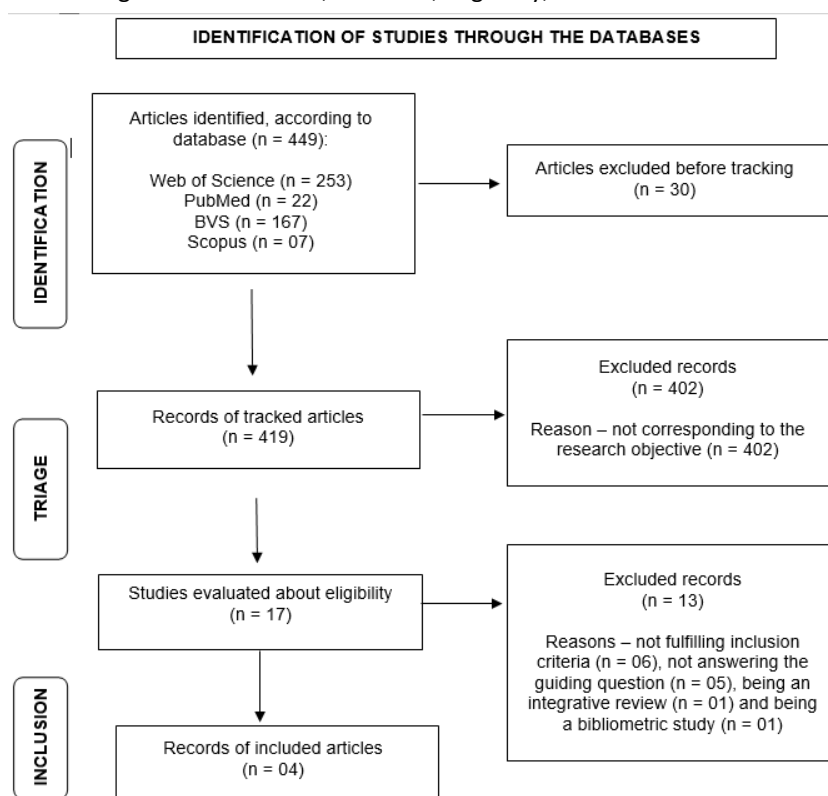
To collect and categorize the data from these publications, an instrument based on the study by Donato and Donato was created.²⁰ It enabled the organization of information as follows: coding of the article; title, author, year and country of publication; journal; area; database; objective; type of study; level of evidence; type of digital technology used; and main results.

The evaluation of the studies was conducted through methodological quality and comparison with the level of scientific evidence.²¹ Thus, this analysis was performed based on the pyramid of evidence model by Walker et al.²², which categorizes the strength of evidence into the following levels: level I – systematic review; level II – randomized controlled trial; level III – quasi-experimental study; and level IV – observational study. The preference for these authors was justified because, in addition to making it possible to classify quasi-experimental studies, they did not limit observational studies to cohort and case-control.

RESULTS

Through the search strategy, 449 studies were found, of which 22 had been published in PubMed, 7 inScopus, 253 in Web of Science, and 167 in VHL. Thirty studies were excluded due to duplicity, leaving a total of 419 publications. Of these, after reading the titles and abstracts, 402 were excluded because they did not correspond to the objective of the review. Of the 17 articles read in full, 6 were excluded because they did not meet the inclusion criteria, 5 because they did not answer the guiding question, 1 because it was an integrative review and equal number because it was a bibliometric study. Thus, the review consisted of 4 articles (Figure 1).

Figure 1 - Flowchart describing the identification, selection, eligibility, and inclusion of studies inserted in this review.



Source: Research data (2023).

Of the total number of articles included (4), all were indexed in the PubMed database. As for the year of publication, a balanced distribution is observed, with one article published in 2020 (A2), one in 2018 (A1), one in 2017 (A3), and one in 2015 (A4). Regarding the area of knowledge, three studies belong to the field of Odontology (A2, A3, and A4), while one was published in the area of Nursing (A1). Their geographic origin demonstrates a predominance of international studies, with two carried out in Australia (A1 and A3), one in Italy (A2), and one in England (A4) (Table 1).

Table 1 - Characterization of the publications included in the review, according to title, authors, year, journal, area, country, and database.

N.	Article title	Author and year	Journal and area	Country	Databases
01	Impact of an education program on the performance of nurses in providing oral care for mechanically ventilated children	Behzadi et al. (2018) ²³	Australian Critical Care/ Nursing	Australia	PubMed
02	"Mom Let's Go to the Dentist!" preliminary feasibility of a tailored dental intervention for children with autism spectrum disorder in the Italian public health service	Narzisi et al. (2020) ²⁴	Brain Sciences/ Odontology	Italy	PubMed
03	Comparison of a Smartphone-Based Photographic Method with face-to-face caries assessment: a mobile teledentistry model	Estai et al. (2017) ²⁵	Telemedicine Journal and e-Health/ Odontology	Australia	PubMed
04	The use of a mobile app to motivate evidence-based oral hygiene behavior	Underwood et al. (2015) ²⁶	British Dental Journal/ Odontology	England	PubMed

Source: Research data (2023).

The studies included in this review address different objectives, encompassing the evaluation of an education program for nurses (A1), the implementation of a project aimed at the dental care of children with autism spectrum disorder (ASD) (A2), the effectiveness of teledentistry in the remote detection of caries (A3), and users' perception of the use of an oral health app (A4) (Table 2).

Regarding the methodological design and the level of evidence, three studies (A1, A2, and A4) were classified as quasi-experimental, presenting level of evidence III.

Concerning the digital technologies used, there was a predominance of the use of mobile apps, included in two studies (A3 and A4). In addition, the articles also report the use of other technological tools, such as workshops, simulations, follow-up programs, video clips, and teledentistry servers.

Table 2 - Characterization of the publications included in this review, according to objective, type of study, level of evidence and type of digital technology used

N.	Objective	Type of study	Level of evidence	Type of digital technology used
01	To determine the effectiveness of the nurse education program on the performance of nurses in providing oral care to children on mechanical ventilation	Quasi-experimental study	III	Workshop, simulation, follow-up programs and devices – book, containing visual files, and video clip
02	To describe the initial results of a project aimed at public dental care for children with ASD ^a , aided by ICT ^b	Quasi-experimental study	III	Web app
03	To investigate the effectiveness of mobile teledentistry in the remote detection of caries	Cross-sectional observational study	IV	Smartphone, Android app and telemedicine server
04	To assess users' perception of the use of an oral health app	Quasi-experimental study	III	Mobile app

^aASD – Autism spectrum disorder; ^bICT – Information and Communication Technology.
Source: Research data (2023).

Regarding the main results observed in the articles, study A1 revealed that nursing professionals trained through the educational program with DICT showed significant improvements in oral care performance for children on mechanical ventilation. Research A2 showed results indicating that the use of the web app reduced the stress of children with ASD, facilitating their cooperation in the procedures and contributing to learning oral hygiene habits (Table 3).

Study A3 showed that the use of teledentistry in the remote detection of caries through images captured by smartphones and analyzed remotely has a minimum sensitivity of 60% and specificity of up to 96%, percentages slightly below the clinical examination. As for research A4, it observed that participants who used an oral health app reported improvements in oral hygiene, such as cleaner teeth and less gingival bleeding.

Table 3 - Characterization of the publications included in this review, according to main results

N.	Main results
01	The nurses' mean performance scores before the education program, in the intervention group (professionals who had access to the usual service and to the formal and structured education program) and control group (professionals who had access to the usual service, including resources and in-work education), were 42.8 (± 18.5) and 48.7 (± 15.7), respectively, with no statistical difference. After four weeks of the program's adoption, a significant increase in these scores was observed in the intervention group (68.6 ± 31.4), when compared to the corresponding control (48.6 ± 15.41) and pre-intervention scores (42.8 ± 18.5) ($p < 0.001$). For the control group, there was no significant difference after four weeks (48.6 ± 15.41).
02	Parents positively evaluated the use of the app because it provides, among other phenomena, reduction in stress and greater cooperation of the child during dental procedures. Additionally, according to them, the app helped the child learn about the autonomous use of means of oral hygiene, in addition to recommending it to other parents of children with ASD ^a .
03	Of the 3,200 teeth evaluated, based on the photographic records of the oral cavity of the 100 participants, which included children, 266 (8.0%) and 596 (19.0%) were not subject to classification by the evaluating dentists 1 and 2, respectively. Regarding the sensitivity and specificity of the photographic method for caries detection, compared to conventional clinical examination, they ranged from 60% to 63% and from 96.0% to 99.0%, respectively.
04	Of the 189 participants, 69 (37.1%) were children aged 7 to 12 years, 120 (75.0%) used the app for less than a week, and 11 (6.0%) used it for at least one year. Of those surveyed, 56 (44.8%), 113 (70.0%) and 57 (39.3%) used the app twice a day, reported cleaner teeth since its adoption and had less gingival bleeding with its use, respectively. In addition, the participants mentioned that the app motivated them to brush their teeth, even longer and in the correct order, making the process fun.

^aASD – Autism spectrum disorder.
Source: Research data (2023).

These findings reinforce the need to integrate technological innovations in multiprofessional care contexts, in order to promote the oral health of the child population and foster the continuing education of health professionals, with the aim of expanding access and quality of dental care.

DISCUSSION

The use of Digital Information and Communication Technologies constitutes a reality beyond the processes of information production and transmission, contributing to the acquisition of knowledge and skills by students, educators, health professionals, and patients.

In this sense, the review presented here, by gathering publications by different authors on DICT used in different contexts to improve children's oral health, which included professional practice, diagnosis, therapy and prevention, indicated the use of these technologies may raise the need for parents or guardians to adhere to these means for promotion, prevention, and maintenance of their children's oral and systemic health. For health professionals, this adoption can improve their technical and scientific knowledge and foster the provision of more qualified services with greater access by the community.

In terms of results, when evaluating the number of studies included in this research, according to database, the fact that all of them are included in PubMed is justified by the fact that it is the largest database available since 1996, consisting of more than 26 million citations from Medline, life sciences journals, and online books. In addition, it displays links to access full texts in PubMed Central citations²⁷, which can favor access to them.

Regarding the year, the articles included in this review, by involving those published in 2015, 2017 and 2018 up to the article published in 2020, highlight the importance that digital technology has assumed on the world stage, a phenomenon that was notable in 2016.²⁸ In particular, this process was intensified and accelerated by the Coronavirus Disease 2019 (covid-19) pandemic, a time when social isolation and quarantine were experienced.²⁹

Concerning the journal selected by the authors of the publications included here, the diversity of journals observed may be due to the relevance of the theme addressed in this research. This hypothesis is reinforced by the fact that all these journals are international and have different purposes. As for the largest number of studies having been published in the field of dentistry, this result may be clearly conceivable when analyzing the subject portrayed in this study. Regarding country, the higher number of studies conducted in Australia may be a reflection of the history of this nation, marked, in the last decade, by the constant increase in caries among children.³⁰

Regarding the objectives portrayed by the studies that were part of the sample, discussing the effect of a health education program on nurses, especially if permanent, values the role that this type of intervention plays in changing professional practices and work organization.³¹ In addition, when associated with Information and Communication Technologies, it can favor and facilitate innovative learning by enabling greater access to information and rationalization of time management.³² Consequently, it is possible to have a more qualified job, capable of positively impacting the access, quality, and humanization of the service provided.³²

Specifically, in article 1 of this review²³, the education program for nurses focused on the oral care of children on mechanical ventilation, using different digital technologies, promoted a greater performance of these workers in relation to this care. This finding stands out because nurses are one of the professionals who care for the oral cavity of intubated children and those on mechanical ventilation,

even preventing ventilator-associated pneumonia (VAP). This is considered a common condition in pediatric intensive care units.²³

Diverging from this context, a study by Kusahara et al.³³ found that, although most nursing professionals performed oral hygiene on critically ill newborns, only half were qualified to do so. According to the authors, although the professionals aimed to expand their knowledge about oral hygiene actions, they did not prioritize participation in classes and lectures related to the subject.

Thus, when comparing the data from article 1 and Kusahara et al.³³, it can be assumed that the incorporation of digital technologies in the health education process can stimulate professional training, especially if we consider that these technologies are increasingly inserted in daily life. This assumption is corroborated by the existence of a guideline that helps managers understand the learning of mobile technologies and their benefits in the education of all.³² Another document reinforces the inclusion of digital technologies among health professionals in order to educate them in technical, administrative, and managerial terms.³²

With respect to the objective of describing the results obtained by a project aimed at public dental care for children with ASD²⁴ (article 2 of this research), the institution, in particular, of a project aimed at this care and this public highlights the need to apply faster strategies for the provision of services to these patients, particularly when acknowledging the long time elapsed, in general, for the implementation of public policies. Furthermore, this purpose, when linked to the use of a web app, reduced stress and favored the child's cooperation during dental procedures. In addition, it facilitated the child's learning in relation to the autonomous use of means of oral hygiene.

In this sense, these data highlight the participation of digital technologies in facilitating communication between dental professionals and patients with ASD, whose difficulty in speech production and comprehension is a striking characteristic. The qualification of these health workers in the establishment of behaviors appropriate to this reality and the improvement of knowledge can be attributed to these technologies.²⁴ Thus, the integration of these technologies into the actions of dentists, with the involvement of children and their parents or guardians, can attenuate the complexity and clinical manifestations associated with ASD, as well as reduce the stimulus triggered by the environment itself and the care provided, cooperating with the oral health of patients.³⁴

In addition, according to article 4²⁶, which aimed to assess the users' perception of the use of an oral health app, it induced cleaner teeth and less gingival bleeding, as well as motivated the practice of oral hygiene among different users, including children. In particular, these data highlight the effectiveness of this type of technology, whose use has increased substantially in recent years³⁵, which may have resulted from the interest and importance of oral health by its users, as well as the fact that it's free and its application for any type of brush.²⁶ These data can also be associated with the fact that mobile apps are able to develop many activities, including specific ones, in addition to providing opportunities for co-responsibility on the part of the users in relation to health³⁶ and access to information.²⁶

Thus, the adoption of digital technologies, notably the app, be it by the health worker, the patient or their guardian, or other users, represents a relevant behavior for the implementation of actions for the promotion, prevention, and maintenance of oral health. These can be linked to education programs and projects, whose objectives of educating and encouraging the individual to commit to their own and others' health³⁷ can be better achieved with the adoption of digital technologies.

In this context, the literature mentions that the use of mobile apps has benefited patients, relatives, professionals, and managers. In particular, this improvement has been observed in the context

of health promotion, prevention, care, and monitoring.³⁸ Furthermore, according to Silva et al.³⁹, the use of an app enhances the improvement of health, including by amplifying preventive actions.

Regarding the use of mobile teledentistry, discussed in article 3²⁵, the purpose of investigating the effectiveness of this technology in the remote detection of caries, including in children, can ensure its use as a way to expand access to dental services, providing remote care, counseling, and technological therapy, without the need for direct personal contact.⁴⁰ This hypothesis was actually achieved in view of the sensitivity and specificity obtained by the authors in their research.

Comparing the objective of the studies included in this research, publication 3²⁵ stood out for addressing a way of identifying caries, enabling its use as a diagnostic strategy and, therefore, differentiating itself from the other articles. In particular, the relevance of this article is based on the fact that caries is a chronic infectious disease of high prevalence in the world scenario, capable of inducing systemic diseases, affecting quality of life, and causing great economic losses.⁴⁰

In this context, it is also worth highlighting the high prevalence of early childhood caries, observed mainly in developing countries, indicating the influence of socioeconomic factors on health and the lack of awareness about family care with the oral cavity of children on a global level⁴¹, which may even be linked to the lack of means or conditions that provide access to health information. In order to change this scenario, therefore, considering the recommendation to provide educational programs and interventions in dental care that involve the family and multiprofessional teams⁴¹, DICT are presented as potential tools for promoting oral health.

In this sense, it is worth noting that teledentistry, highlighted in article 3²⁵, is considered a branch of telehealth that has evolved in recent years, which fosters the exchange of information and experiences, as well as access to health care in unfavorable situations in geographical, cultural, political, social, and temporal terms.⁴² In addition, through teledentistry, oral health education programs can be carried out by public and private institutions⁴², benefiting professionals and the general population, which can contribute to a decrease in the incidence and prevalence of oral illnesses and an improvement in the quality of life for children and their families.

Regarding the methodological design of the studies discussed in this review, the fact that almost all of the articles corresponded to quasi-experimental studies highlights their importance as an alternative means of conducting public health intervention research, in which control, manipulation, and randomization may be unfeasible.⁴³⁻⁴⁴ However, this finding was unexpected if we consider that DICT have been increasingly taking space in the health sphere, in the context of policies, education, and dissemination of information through the most diverse means⁴⁵, enabling the execution of more complex research, such as systematic reviews, meta-analyses, and clinical studies.

Concerning the predominance of level of evidence III, this finding suggests that the studies of this review exhibited a lower level of evidence when compared to systematic reviews and randomized and controlled research, limiting its clinical applicability.⁴⁶ However, the literature states that the highest level of evidence is not necessarily the most appropriate for the research question.⁴⁷ In addition, the methodological design proposed by the studies, based on observation and lack of total experimental control, are aligned with their objectives, thus producing internal validity to the data obtained, even if they cannot be generalized.⁴⁸

In terms of practical application, the aggregate of knowledge about DICT retrieved by this review may corroborate the implementation of professional training strategies and the development of public health policies that enable the diligent use of digital technologies in different scenarios of child care. In addition, it may subsidize the development of new technologies to promote oral health in a multidisciplinary context, considering aspects from primary to intensive care.

Regarding the limitations of the study, this research presented, as a major restriction, the small number of publications that addressed the content investigated here.

CONCLUSION

From the data obtained, it can be concluded that, despite the limited diversity of digital technologies adopted in different contexts to improve children's oral health, they encompassed mobile apps, books with visual files, video clips, and mobile teledentistry. In addition, these technologies were used to favor the oral health of children in situations such as professional practice, prevention, diagnosis, and therapy of oral diseases; the latter two should be better explored in future research.

In view of this, we suggest the conduction of methodological studies for the creation and evaluation of DICT aimed at multiprofessional care and the promotion of children's oral health in the Brazilian health context, in addition to meta-analyses to investigate the effect of the application of these new technologies in different care scenarios.

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