International Journal of Scientific Advances
ISSN: 2708-7972
Volume: 7 | Issue: 5 | Sep – Oct 2026 Available Online: www.ijscia.com
DOI: 10.51542/ijscia.v7i5.3

The Effectiveness of Chatbot-Based Interventions in Promoting Oral Health Behavior Change Among Children and Caregivers: A Systematic Literature Review

Awfa Nafisah[1], Gilang Rasuna Sabdho Wening[2*]

[1]Undergraduate Student, Faculty of Dental Medicine,
Universitas Airlangga, Surabaya, Indonesia

[2]Departement of Dental Public Health, Faculty of Dental Medicine,
Universitas Airlangga, Surabaya, Indonesia.

E-mail: awfa.nafisah-2023@fkg.unair.ac.id; gilang-r-s-w@fkg.unair.ac.id

*Corresponding author details: Gilang Rasuna Sabdho Wening;
gilang-r-s-w@fkg.unair.ac.id

ABSTRACT

Oral diseases, particularly dental caries, remain a leading yet largely preventable public health burden among children, driven substantially by modifiable behavioral factors such as caregiver-led and self-performed toothbrushing practices. This study aims to systematically review the effectiveness of chatbot-based interventions in promoting oral health behavior changes among children and their caregivers. The method used is a Systematic Literature Review (SLR) approach guided by PRISMA 2020, with searches carried out in PubMed, ScienceDirect, and Scopus. A search across the three databases identified 291 records, of which 3 studies met the predefined eligibility criteria following title/abstract screening and full-text assessment. The included studies employed two distinct theoretical frameworks: the Protection Motivation Theory (PMT), applied to caregiver-mediated chatbot interventions for infants and toddlers, and the Behavior Change Wheel (BCW)/COM-B model, applied to a gamified chatbot delivered directly to school-aged children. Across all three studies, chatbot interventions were associated with significant improvements in toothbrushing frequency, PMT-based perceptions (with the exception of perceived vulnerability), and consistently high usability and satisfaction ratings. Overall, chatbot-based interventions are a promising and well-accepted tool for oral health behavior change, while highlighting the need for more rigorous, longer-term, and cross-culturally validated research to confirm their comparative effectiveness.

Keywords: chatbot; oral health behavior; protection motivation theory; behavior change wheel; children; caregivers

INTRODUCTION

Oral diseases remain one of the most prevalent yet largely preventable global public health challenges, affecting billions of people across all age groups [1]. Among children, dental caries continues to be the most common chronic disease worldwide, with untreated caries in primary teeth affecting hundreds of millions of children globally [2]. Beyond the immediate clinical burden, poor oral health in children has been shown to negatively affect school attendance, academic performance, and overall quality of life [3]. The persistence of this problem despite decades of public health efforts underscores that oral diseases are not merely biological in origin but are strongly shaped by everyday behavioral patterns, particularly toothbrushing practices performed or supervised by caregivers during early childhood [4].

Behavioral factors are widely recognized as the most modifiable determinants of children's oral health outcomes [5]. Establishing consistent oral hygiene habits during early childhood and school age is considered critical, as these years represent a formative period for shaping long term health behaviors, beliefs, and attitudes, and school-based promotion programs have shown measurable effectiveness across this age range [6]. However, real-world implementation of such programs still faces structural obstacles, including limited dental health personnel and inconsistent coordination between health centers, schools, and parents [7]. Achieving sustained behavior change is further complicated by the fact that conventional educational approaches, such as leaflets, verbal instruction, or one-time counseling, have shown limited long-term effectiveness in promoting the desired behavior [8].

In-person training, while effective, requires substantial time, trained personnel, and repeated caregiver visits to dental facilities, resources that are often unavailable in rural or under-resourced settings.

The broader landscape of digital health technology in dentistry has expanded considerably in recent years. A bibliometric analysis of the global literature found that digital health applications in oral and dental care have grown substantially, spanning diagnostic support, patient education, and remote monitoring [9]. Within this landscape, artificial intelligence and machine learning applications have attracted particular research interest, including their use in analyzing large-scale dental caries datasets [10]. More specifically for children, a scoping review of Internet of Things-based oral health promotion found that connected devices and sensor-based feedback systems can support toothbrushing behavior, though the evidence base remains limited to a small number of studies with heterogeneous designs [11]. These parallel developments in IoT, machine learning, and mobile applications indicate a broader technological shift toward remote, scalable oral health interventions, of which chatbot-based approaches form one specific strand.

Evidence consistently shows that interventions grounded in established behavior change theories are more effective than those lacking a theoretical foundation [12]. Theoretical frameworks provide a systematic structure for diagnosing the barriers to a target behavior and for designing intervention components that directly address those barriers, rather than relying on generic health information delivery [13]. Despite this, a considerable proportion of existing oral health mobile applications have been developed without theoretical grounding or professional dental input, resulting in variable content quality and unproven efficacy [14,15,16]. Non-digital gamified tools face a related challenge: a reminder sticker book intervention for elementary school children, for example, improved dental health knowledge and reduced plaque index scores, illustrating that game-based engagement can be effective even without digital infrastructure, though such tools still require systematic evaluation against theory-based digital alternatives [17]. This gap between the growing number of oral health tools, digital or otherwise, and the scarcity of theory-based, professionally validated interventions represents an important area for further investigation.

Within this context, chatbots, conversational computer programs capable of simulating human like text or voice interaction, have emerged as a promising digital health intervention tool [18]. Chatbots offer several advantages over static educational applications, including 24/7 availability, personalized and interactive engagement, and the ability to be integrated into widely used messaging platforms without requiring users to install unfamiliar software. This advantage was particularly salient during the COVID-19 pandemic, when a study of parental satisfaction with teledentistry in Indonesia found that remote dental communication methods were generally well received despite the loss of in-person contact [19]. Several frameworks have been proposed to guide the design of behavior-change-oriented chatbots. Zhang et al. [18] introduced the artificial intelligence (AI) chatbot behavior change model, which outlines four essential components: defining chatbot characteristics and understanding user context, building relational capacity, constructing persuasive conversational capacity through behavior change theory, and evaluating outcomes. Among behavior change theories applied to chatbot design, the Protection Motivation Theory (PMT) [20, 21] and the Behavior Change Wheel (BCW), centered on the capability-opportunity-motivation (COM-B) model [12], have both been used to structure persuasive content aimed at fostering caregivers' and children's engagement in oral self-care.

Although chatbots have been widely studied across other areas of healthcare, their application specifically within pediatric dentistry and oral health promotion remains limited. A small number of studies have begun to explore chatbot-based interventions for this purpose. Pithpornchaiyakul et al. [22] demonstrated that a PMT-based chatbot, the "21-Day FunDee," combined with in-person training, and its modified 30-day version delivered entirely online during the COVID-19 pandemic, both significantly improved caregivers' toothbrushing practices and oral health perceptions. Building on this work, Pupong et al. [23] further evaluated the effectiveness, usability, and acceptability of the "30-Day FunDee" chatbot in a larger sample of caregivers, reporting significant improvements in toothbrushing frequency and PMT-based perceptions, alongside high satisfaction and engagement scores. Separately, Chang et al. [24]. applied the Behavior Change Wheel and COM-B model to design a gamified chatbot targeting school-aged children directly, achieving high usability and likeability scores among child users and their parents. While these studies collectively suggest that chatbot-based interventions hold considerable promise for promoting oral health behavior change, they differ in target populations, theoretical frameworks, delivery platforms, and outcome measures, making it difficult to draw an integrated conclusion about their overall effectiveness.

To date, no systematic synthesis has been conducted to consolidate the existing evidence on chatbot-based interventions for oral health behavior change across these varying populations and theoretical approaches. This represents an important research gap, particularly given the increasing interest in scalable digital interventions to address persistent inequities in access to oral health education. Therefore, this review aims to systematically identify, evaluate, and synthesize the available evidence on the effectiveness of chatbot-based interventions in promoting oral health behavior change among children and their caregivers, with particular attention to the theoretical frameworks employed, the outcomes measured, and the key factors contributing to intervention success.

MATERIAL AND METHODS

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guideline [25], which provides a standardized framework for ensuring transparency and methodological rigor throughout the identification, screening, eligibility assessment, and inclusion of studies.

Eligibility criteria

Eligibility criteria were defined a priori using the Population, Intervention, Comparison, Outcome, and Study design (PICOS) framework, reflecting the specific scope of this review on chatbot-based interventions for oral health behavior change.

Population (P): Children (including infants, toddlers, and school-aged children) and/or their caregivers/parents responsible for the child's oral hygiene care.

Intervention (I): Chatbot-based digital interventions (rule-based or artificial intelligence-enhanced conversational agents) designed to deliver oral health education or promote oral self-care behavior.

Comparison (C): Conventional oral health education or no intervention/control group; comparison was not mandatory given the largely pre-post and quasi-experimental nature of available evidence.

Outcome (O): Behavioral outcomes, theory-based psychological constructs, and/or chatbot usability, likeability, and acceptability.

Study design (S): Original research articles employing randomized controlled trial, quasi-experimental (pre-post), comparative, or mixed methods designs. Narrative reviews, systematic reviews, protocols without results, conference abstracts, and opinion pieces were excluded.

Additional inclusion criteria comprised publications in English, full-text availability, and open-access status with a valid Digital Object Identifier (DOI).

Information sources and search strategy

A systematic search was conducted across three electronic databases: PubMed, ScienceDirect, and Scopus, selected to provide comprehensive coverage of both biomedical/dental literature and the broader health informatics/digital health literature. The search strategy combined keywords related to three core concepts, chatbot technology, oral health, and behavior change, connected using Boolean operators, structured as follows: (“chatbot*” OR “conversational agent*” OR “artificial intelligence”) AND (“oral health” OR “dental care” OR “toothbrushing” OR “oral hygiene”) AND (“behavior change” OR “behaviour change” OR “health education” OR “children” OR “caregiver*”)

Database-specific syntax adjustments (e.g., TITLE-ABS-KEY for Scopus, field tags for PubMed, and simplified operator strings for Science Direct due to its search engine limitations) were applied accordingly. The search yielded a total of 291 records: PubMed (n = 9), Science Direct (n = 25), and Scopus (n = 257).

Study selection process

The study selection process followed the four stages outlined in the PRISMA 2020 flow diagram: identification, screening, eligibility assessment, and inclusion (Figure 1). Of the 291 records identified, 145 were removed prior to screening, comprising duplicate records (n = 12) and records removed for other reasons (n = 133). The latter comprised records lacking an abstract or substantive content, such as tables of contents and reference compilations (n = 15), and records identified as full books or book chapters without open-access full text or a valid DOI, which was inconsistent with the predefined inclusion criteria (n = 118). The remaining records were screened by title and abstract (n = 146), and all were subsequently sought for full text retrieval (n = 146), with no reports unretrievable (n = 0).

All 146 retrieved reports were assessed for eligibility against the PICOS criteria. Of these, 143 reports were excluded, with reasons categorized as: application of the AI/chatbot technology to diagnostic or radiographic tasks without direct patient interaction, application outside the dental/oral health context, and studies targeting dental students or practicing dentists for academic or clinical training purposes rather than patient self-care. Following full-text assessment, three studies met all eligibility criteria and were included in the final synthesis [22–24]. Title and abstract screening and full-text eligibility assessment were conducted jointly by both authors, who reviewed all records collaboratively and reached inclusion and exclusion decisions by consensus.

Data extraction and synthesis

Data from the included studies were independently extracted into a standardized extraction table comprising the following fields: author(s) and year of publication, key findings, outcomes measured, study significance, and target population. Given the heterogeneity in study designs, populations, and outcome measures across the included studies, a narrative synthesis approach was adopted rather than a meta-analysis. Extracted findings were organized thematically according to the theoretical framework employed (Protection Motivation Theory versus Behavior Change Wheel/COM-B model) and the type of outcome reported (behavioral, psychological, or usability/acceptability-related)

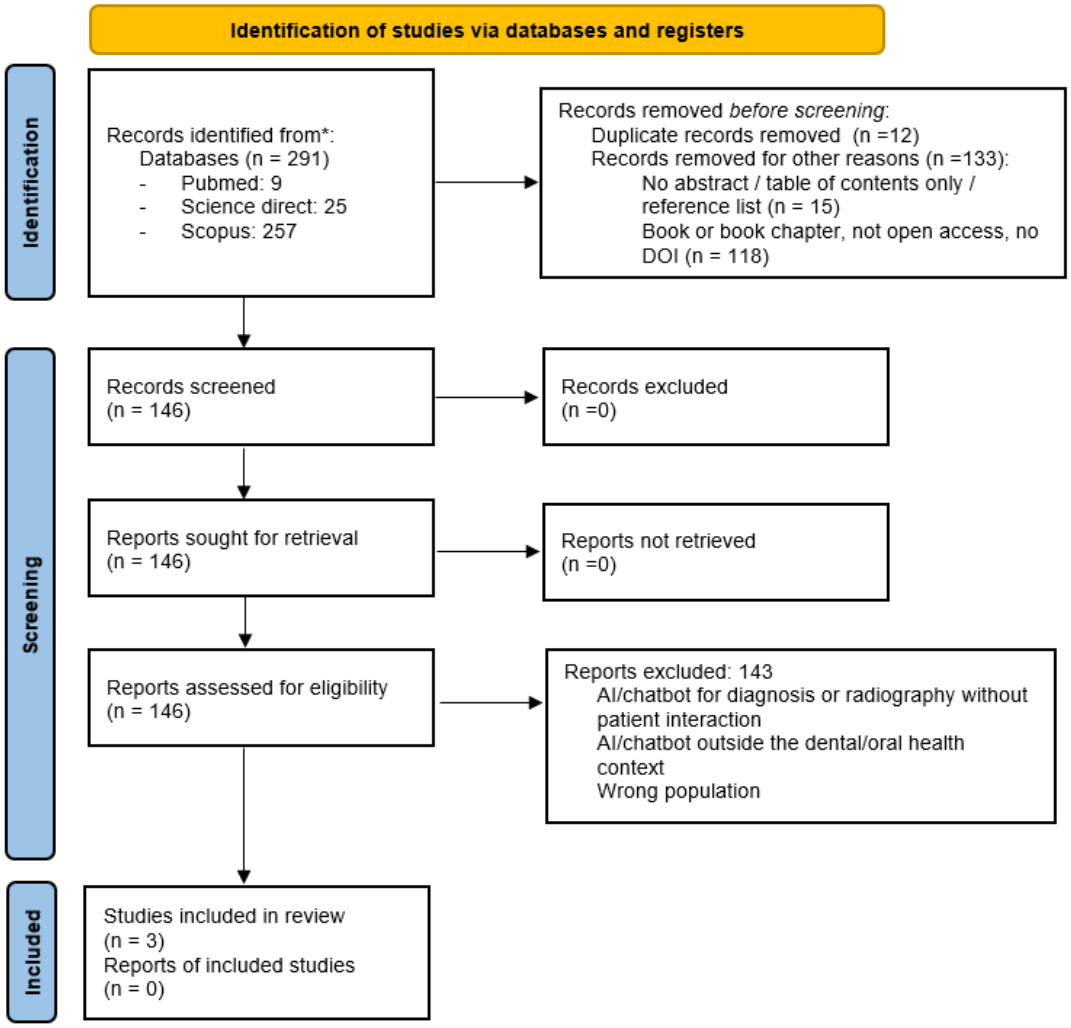

FIGURE 1: PRISMA 2020 flow diagram of the study selection process.

RESULTS

Overview of Included Studies

Three studies met the eligibility criteria and were included in the final synthesis [22–24]. All three were published between 2022 and 2025 and originated from East and Southeast Asia: two from Thailand [22, 23] and one from Taiwan [24]. Two studies delivered the chatbot intervention to caregivers of infants and toddlers aged 6–36 months, who acted as intermediaries for the child's oral hygiene practices [22, 23], while the third delivered the chatbot directly to school-aged children (5–12 years) with parental accompaniment [24]. Characteristics of the included studies are summarized in Table 1.

TABLE 1: Summary of studies included in the systematic review.

Reference	Country	Population	Theoretical Framework	Platform	Design	Key findings
Pithpornchaiyakul et al., 2022 [22]	Thailand	Caregivers of children aged 6–36 months	AI chatbot behavior change model + PMT	Facebook Messenger (Chatfuel)	Comparative pre-post (secondary data analysis)	Both 21-day (with in person training) and 30-day (chatbot-only) programs significantly improved knowledge, PMT perceptions, and toothbrushing; 21-day arm also achieved significant plaque reduction
Pupong et al., 2025 [23]	Thailand	Caregivers of children aged 6–36 months	AI chatbot behavior change model + PMT	Facebook Messenger (Chatfuel)	Pre-post mixed methods (N=58)	Toothbrushing frequency increased from 72.4% to 93.1%; PMT perceptions improved significantly except perceived vulnerability; high usability and satisfaction (4.7/5)

Reference	Country	Population	Theoretical Framework	Platform	Design	Key findings
Chang et al., 2024 [24]	Taiwan	School-aged children (5–12 years) and accompanying parents	Behavior Change Wheel / COM-B model with gamification	LINE bot	Pilot usability study (N=30)	High usability (CUQ 79.91/100) and likeability (4.32/5); "guiding toothbrushing" and "quizzes and challenges" features most preferred

Theoretical Frameworks Applied

Two of the three included studies belong to the same intervention lineage, the "FunDee" chatbot, and were both structured using Zhang et al.'s artificial intelligence chatbot behavior change model [18] combined with the Protection Motivation Theory (PMT) [20, 21]. PMT constructs, perceived severity, perceived vulnerability, response efficacy, and self-efficacy, were operationalized as the chatbot's persuasive content in both studies [22, 23]. Chang et al. [24], by contrast, applied the Behavior Change Wheel (BCW) and its central COM-B model [12], using intervention functions, training, education, enablement, persuasion, and incentivization, delivered directly to children and enriched with nine gamification features.

Behavioral, Psychological, and Usability Outcomes

Both PMT-based studies reported statistically significant increases in caregiver-led toothbrushing frequency, rising from 72.4% to 93.1% in Pupong et al. [23] and from 65–76% to 88–97% across the two comparative arms in Pithpornchaiyakul et al. [22]. The study arm combining the chatbot with in-person training additionally achieved a 62.5% reduction in visible plaque index [22]. Chang et al. [24] did not report a comparable behavioral frequency outcome, as its evaluation focused on a single pilot session.

For PMT-based psychological outcomes, perceived severity, response efficacy, and self efficacy improved significantly post-intervention in both studies, while perceived vulnerability showed inconsistent or non-significant change in several study arms [22, 23]. Across all three studies, chatbots were rated highly on usability and acceptability: a Chatbot Usability Questionnaire score of 79.91/100 and likeability of 4.32/5 in Chang et al. [24]; overall satisfaction and usability both rated 4.7/5 in Pupong et al. [23]; and satisfaction scores of 9.2/10 and 8.6/10 across the two arms in Pithpornchaiyakul et al. [22].

DISCUSSION

The results reveal a clear divide in theoretical approach that tracks closely with target population. PMT-based interventions [22, 23] were consistently applied to caregiver-mediated behavior change for infants and toddlers, aiming to shift caregivers' cognitive appraisal of threat and coping capacity, whereas the BCW/COM-B-based intervention [24] aimed to directly build the child's own capability and opportunity to perform the behavior, using motivation-enhancing game mechanics rather than fear-based appeals. This mirrors a broader pattern in dental AI research, where machine learning and digital health applications have proliferated rapidly in diagnostic and data-analytic contexts [10], while rigorous head-to-head evaluation of specific behavior-change frameworks remains comparatively rare. Because theoretical framework and target population are confounded across the current evidence base, no study has directly compared the relative effectiveness of PMT- versus BCW/COM-B-guided chatbots within a single trial, making it unclear whether observed outcome differences are attributable to the theory applied, the population targeted, or both. This represents a meaningful gap for future head-to-head or factorial-design research seeking to isolate the contribution of theoretical framework choice to intervention effectiveness. The consistent pattern in which perceived vulnerability responded less strongly to chatbot persuasion than perceived severity, response efficacy, or self-efficacy [22, 23] suggests that caregivers' subjective sense of their child's susceptibility to oral disease may be more resistant to text-based persuasion than their beliefs about disease severity or their own coping capability. This is plausible given that vulnerability perception often benefits from tangible, visible risk cues rather than narrative or infographic content alone, an interpretation consistent with the broader behavior change literature emphasizing the role of concrete feedback in risk perception [13]. The convergence of high usability and satisfaction ratings across all three studies, despite differing theoretical frameworks, populations, and delivery platforms [22–24], indicates that user acceptance of chatbot-delivered oral health education may be a relatively robust finding. However, this should be interpreted cautiously, as all three studies recruited participants through convenience sampling, which may inflate satisfaction estimates through self-selection and novelty effects rather than reflecting sustained, real-world adoption. Several methodological limitations constrain the strength of these conclusions. None of the three studies employed a randomized controlled design with a genuine no-intervention control arm: Pithpornchaiyakul et al. [22] compared two chatbot variants against each other rather than against a non-chatbot control, while Pupong et al. [23] and Chang et al. [24] used single-arm pre-post or pilot designs, raising the risk of maturity bias. Sample sizes were modest (28 to 71 caregiver–child dyads), and follow-up periods were short, extending to only two months post baseline at most [23], insufficient to confirm whether newly formed toothbrushing habits, which typically require between 18 and 254 days to consolidate, are sustained over the longer term. Objective clinical indicators of oral hygiene were assessed in only one of the three studies [22],

with the remaining two relying exclusively on self-reported behavior, introducing potential social desirability bias. Finally, all three chatbots were developed and validated within a single linguistic and cultural context (Thai or Mandarin Chinese) [22–24], constraining the generalizability of these findings to other populations and healthcare systems.

Beyond the limitations of the included studies described above, this review is also subject to several limitations of its own. The search was restricted to three databases (PubMed, ScienceDirect, and Scopus) and did not include additional sources such as Web of Science, the Cochrane Library, or regional databases, which may have captured additional eligible studies. The search was further limited to English-language publications, which may have excluded relevant literature published in other languages, a particular concern given that two of the three included studies originated from Thailand. In addition, the requirement for open-access full text and a valid DOI, applied to ensure feasibility of full data extraction, excluded 118 potentially relevant records published as books or book chapters, which may have introduced selection bias. A further 15 records were excluded due to incomplete bibliographic metadata (e.g., missing abstracts), some of which may have represented eligible studies that could not be adequately evaluated. Finally, screening and eligibility assessment were conducted collaboratively rather than independently by the two authors, which may have increased the risk of undetected selection errors relative to a fully independent dual-review process.

CONCLUSION

Based on the systematic review of three included studies examining chatbot-based interventions for oral health behavior change among children and caregivers, several conclusions can be drawn. Chatbot-based interventions consistently improve oral health behavior: across all three studies, chatbot delivery was associated with statistically significant improvements in caregiver-led toothbrushing frequency and related self-care practices, regardless of the underlying theoretical framework. Theoretical framework choice appears linked to target population, but its independent contribution to effectiveness remains untested, since no study has isolated the theory's effect from the population's effect. Among the Protection Motivation Theory components studied, perceived vulnerability was the least responsive construct to chatbot-based persuasion. User acceptance of oral health chatbots is high and consistent across contexts, despite differences in population, platform, and theoretical grounding; however, the evidence base remains limited in methodological rigor and generalizability, given the absence of randomized controlled designs with true control arms, modest sample sizes, short follow-up periods, and geographic and linguistic concentration.

These findings suggest that chatbot-based interventions represent a promising, scalable, and well-accepted approach for promoting oral health behavior change in children and their caregivers. However, the current evidence remains preliminary. Future research should prioritize randomized controlled trials with active control arms, longer-term follow-up incorporating objective clinical indicators, head-to-head comparisons of theoretical frameworks within the same population, and validation across more linguistically and culturally diverse settings.

REFERENCES

[1] Peres MA, D Macpherson LM, Weyant RJ, et al. Oral health 1 Oral diseases: a global public health challenge, https://vizhub.healthdata.org/ (2019).

[2] Kassebaum NJ, Bernabé E, Dahiya M, et al. Global burden of untreated caries: A systematic review and metaregression. J Dent Res 2015; 94: 650–658.

[3] Jackson SL, Vann WF, Kotch JB, et al. Impact of poor oral health on children's school attendance and performance. Am J Public Health 2011; 101: 1900–1906.

[4] Van Den Branden S, Van Den Broucke S, Leroy R, et al. Effect evaluation of an oral health promotion intervention in preschool children. Eur J Public Health 2014; 24: 893–898.

[5] Duijster D, de Jong-Lenters M, Verrips E, et al. Establishing oral health promoting behaviours in children - parents' views on barriers, facilitators and professional support: A qualitative study. BMC Oral Health; 15. Epub ahead of print 10 December 2015. DOI: 10.1186/s12903-015-0145-0.

[6] Bramantoro T, Santoso CMA, Hariyani N, et al. Effectiveness of the school-based oral health promotion programmes from preschool to high school: A systematic review. PLoS ONE; 16. Epub ahead of print 1 August 2021. DOI: 10.1371/journal.pone.0256007.

[7] Agung IGAA, Triadnya Palgunadi INP. Strategy for improving the quality of School Dental Health Efforts at Tabanan Public Health Center. Dent J 2022; 55: 215–220.

[8] Hagger MS, Weed M. DEBATE: Do interventions based on behavioral theory work in the real world? International Journal of Behavioral Nutrition and Physical Activity; 16. Epub ahead of print 25 April 2019. DOI: 10.1186/s12966-019-0795-4.

[9] Buddhikot CS, Garcha V, Shetty V, et al. Bibliometric Analysis of Context, Trends, and Contents of Digital Health Technology Used in Dental Health. BioMed Research International; 2023. Epub ahead of print 2023. DOI: 10.1155/2023/5539470.

[10] Hasan F, Setia Budi H, Yuliana LT, et al. Trends of machine learning for dental caries research in Southeast Asia: insights from a bibliometric analysis. F1000Res 2024; 13: 908.

[11] Khafid M, Bramantoro T, Hariyani N, et al. The Use of Internet of Things (IoT) Technology to Promote Children's Oral Health: A Scoping Review. European Journal of Dentistry 2024; 18: 703–711.

[12] Michie S, van Stralen MM, West R. The behaviour change wheel: A new method for characterising and designing behaviour change interventions. Implementation Science; 6. Epub ahead of print 23 April 2011. DOI: 10.1186/1748-5908-6-42.

[13] Sharif MO, Newton T, Cunningham SJ. A systematic review to assess interventions delivered by mobile phones in improving adherence to oral hygiene advice for children and adolescents. Br Dent J 2019; 227: 375–382.

[14] Chen R, Santo K, Wong G, et al. Mobile apps for dental caries prevention: Systematic search and quality evaluation. JMIR Mhealth Uhealth; 9. Epub ahead of print 1 January 2021. DOI: 10.2196/19958.

[15] Parker K, Bharmal RV, Sharif MO. The availability and characteristics of patient-focused oral hygiene apps. Br Dent J 2019; 226: 600–604.

[16] Miles O, West R, Nadarzynski T. Health chatbots acceptability moderated by perceived stigma and severity: A cross-sectional survey. Digit Health; 7. Epub ahead of print 1 November 2021. DOI: 10.1177/20552076211063012.

[17] Effendi MC, Hartami E, Balbeid M, et al. Effectiveness of reminder sticker books at increasing dental health knowledge and oral hygiene. Dent J 2021; 54: 5–10.

[18] Zhang J, Oh YJ, Lange P, et al. Artificial intelligence chatbot behavior change model for designing artificial intelligence chatbots to promote physical activity and a healthy diet: Viewpoint. Journal of Medical Internet Research; 22. Epub ahead of print 30 September 2020. DOI: 10.2196/22845.

[19] Sujatmoko PPG, Laksmiastuti SR. Parents' satisfaction with the teledentistry method during the COVID-19 pandemic: A study in Java and Bali. Dent J 2024; 57: 15–21.

[20] Rogers RW. A Protection Motivation Theory of Fear Appeals and Attitude Change1. J Psychol 1975; 91: 93–114.

[21] Maddux JE, Rogers RW. Protection Motivation and Self-Efficacy: A Revised Theory of Fear Appeals and Attitude Change. 1983.

[22] Pithpornchaiyakul S, Naorungroj S, Pupong K, et al. Using a Chatbot as an Alternative Approach for In-Person Toothbrushing Training During the COVID-19 Pandemic: Comparative Study. J Med Internet Res; 24. Epub ahead of print 1 October 2022. DOI: 10.2196/39218.

[23] Pupong K, Hunsrisakhun J, Pithpornchaiyakul S, et al. Development of Chatbot-Based Oral Health Care for Young Children and Evaluation of its Effectiveness, Usability, and Acceptability: Mixed Methods Study. JMIR Pediatr Parent; 8. Epub ahead of print 2025. DOI: 10.2196/62738.

[24] Chang WJ, Chang PC, Chang YH. The gamification and development of a chatbot to promote oral self-care by adopting behavior change wheel for Taiwanese children. Digit Health; 10. Epub ahead of print 1 January 2024. DOI: 10.1177/20552076241256750.

[25] Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ; 372. Epub ahead of print 29 March 2021. DOI: 10.1136/bmj.n71.