Original article

# The development of oral health promotion model using comprehensive dental care application for army in the Thai Third Army Area

Arnun Jukisalapong[1,2] and Prapapen Suwan[1]

[1]Western University; [2]Fort Khuncheaungthammikkarat Hospital

***Abstract:***

***Background:*** *Oral health represents a global concern that has garnered significant attention from nations worldwide. The integration of information technology within healthcare constitutes a vital aspect in fostering well-being.* ***Objectives:*** *To develop an oral health promotion model using a comprehensive dental care application. The specific objectives are: 1) to diagnose the situation and needs for oral health promotion, 2) to develop the model using dental care application, and 3) to do a pilot test and evaluate the model.* ***Material and methods:*** *The research consists of three phases: Phase 1: Situation analysis, Phase 2: Model development based on data collected, and Phase 3 Model Testing and Evaluation. Phase 1, data were collected from two sample groups: Group 1 (270 participants) and Group 2 (15 participants), quantitative data collection was done using a set of questionnaires measuring oral health beliefs, oral health care behaviors, digital skills, and oral health status. And the guideline for in-depth interview was used to collect qualitative data from Group 2. Phase 2, a comprehensive dental care application was developed. Phase 3, the model was tested and evaluated with the sampled group of 60 individuals, experimental and comparison groups of 30 individuals each.* ***Results:*** *After the experiment, according to the statistical analysis employing Chi-square Test, Cross-tabulation, Fisher's Exact test, t-test and Welch t-test, it was found that the experimental group had a significantly higher level of oral health beliefs, oral health care behaviors, and keeping appointment rate than the comparison group ($p < 0.05$) and held the highest level of satisfaction of application using (Mean = 4.61).* ***Conclusions:*** *With this oral health promotion model, patients can learn oral health care by themselves, resulting in improved oral health beliefs, oral health care behaviors, and oral health status.*

***Keywords:*** ● *Oral health promotion model* ● *Comprehensive dental care application* ● *Dental health* ● *Dentistry*

***RTA Med J 2024;77(2):149-65.***

*Received 11 May 2024 Corrected 17 June 2024 Accepted 25 June 2024*

*Correspondence should be addressed to Maj. Arnun Jukisalapong, DDS, MSc, MPH, MBA, DBA, PhD Candidate, Nation University, Tel +66840455545 E-mail: chopinconcerto@gmail.com*

**นิพนธ์ต้นฉบับ**

# การพัฒนารูปแบบการส่งเสริมสุขภาพช่องปาก โดยการใช้แอปพลิเคชันทันตกรรมครบวงจร ในทหารประจำการ กองทัพภาคที่ 3

อานันท์ จักรอิศราพงศ์[1,2] และ ประภาเพ็ญ สุวรรณ[1]
[1]มหาวิทยาลัยเวสเทิร์น [2]โรงพยาบาลค่ายขุนเจืองธรรมิกราช

***บทคัดย่อ***

***บทนำ*** *การวิจัยเรื่องการพัฒนารูปแบบการส่งเสริมสุขภาพช่องปาก โดยการใช้แอปพลิเคชันทันตกรรมครบวงจร ในทหารประจำการ กองทัพภาคที่ 3* ***วัตถุประสงค์*** *1) วินิจฉัยสถานการณ์และความต้องการในการส่งเสริมสุขภาพช่องปาก ในทหารกองประจำการกองทัพภาคที่ 3 2) ร่างและพัฒนารูปแบบการส่งเสริมสุขภาพช่องปากโดยใช้แอปพลิเคชันทันตกรรมครบวงจร 3) ทดลองใช้และประเมินผลรูปแบบการส่งเสริมสุขภาพช่องปาก โดยใช้แอปพลิเคชัน* ***วัสดุและวิธีการ*** *การวิจัยครั้งนี้เป็นการวิจัยและการพัฒนา (Research and Development) ประกอบด้วย 3 ระยะคือ ระยะที่ 1 วินิจฉัยสถานการณ์ ระยะที่ 2 พัฒนารูปแบบฯ และระยะที่ 3 ทดลองใช้และประเมินรูปแบบฯ กลุ่มตัวอย่างระยะที่ 1 แบ่งเป็น 2 กลุ่ม ได้แก่กลุ่มที่ 1 เป็นการศึกษาข้อมูลเชิงปริมาณ ซึ่งกลุ่มตัวอย่างคือ ทหารกองประจำการ กองทัพภาคที่ 3 จำนวน 270 คน ที่มารับบริการทันตกรรมในโรงพยาบาลทหารบก กองทัพภาคที่ 3 เครื่องมือที่ใช้ในการรวบรวมข้อมูลคือแบบสอบถามความเชื่อเกี่ยวกับโรคช่องปาก แบบสอบถามพฤติกรรมการดูแลสุขภาพช่องปาก แบบสอบถามทักษะการใช้เครื่องมือดิจิทัล และแบบบันทึกสุขภาพช่องปาก และกลุ่มที่ 2 เป็นการศึกษาข้อมูลเชิงคุณภาพกับผู้รับบริการทันตกรรมในโรงพยาบาลรวมทั้งหมด 15 คน เครื่องมือที่ใช้ในการรวบรวมข้อมูลคือแนวคำถามการสัมภาษณ์เชิงลึก (In-depth interview) ในระยะที่ 2 เป็นการพัฒนารูปแบบการส่งเสริมสุขภาพช่องปาก โดยการใช้แอปพลิเคชันทันตกรรมครบวงจร โดยกลุ่มผู้ช่วยพัฒนาและผู้วิจัยได้ร่วมกันพัฒนาแอปพลิเคชันที่ครอบคลุมเนื้อหาการดูแลสุขภาพช่องปากและการปฏิบัติหลังได้รับบริการทันตกรรม และระยะที่ 3 ระยะทดลองใช้และประเมินรูปแบบฯ กับกลุ่มตัวอย่าง 60 คน กลุ่มทดลองและกลุ่มเปรียบเทียบกลุ่มละ 30 คน เป็นเวลา 2-4 สัปดาห์* ***ผลการศึกษา*** *หลังการทดลองพบว่า กลุ่มทดลองมีความเชื่อเกี่ยวกับโรคช่องปาก พฤติกรรมการดูแลสุขภาพช่องปาก สภาวะสุขภาพช่องปาก และอัตราการกลับมาตามนัดดีกว่ากลุ่มเปรียบเทียบอย่างมีนัยสำคัญ ($p < 0.05$)* ***สรุป*** *รูปการส่งเสริมสุขภาพช่องปาก โดยใช้แอปพลิเคชันทันตกรรมครบวงจรที่พัฒนาขึ้นนี้ ผู้ป่วยสามารถเรียนรู้การดูแลสุขภาพช่องปากได้ด้วยตนเอง ส่งผลให้จะพัฒนาความเชื่อด้านโรคช่องปาก ส่งเสริมพฤติกรรมการดูแลสุขภาพช่องปากที่ และทำให้สภาวะสุขภาพช่องปากของผู้ป่วยที่ดีขึ้น*

***คำสำคัญ:*** ● *รูปแบบการส่งเสริมสุขภาพช่องปาก* ● *แอปพลิเคชันทันตกรรมครบวงจร* ● *ทันตกรรม*
***เวชสารแพทย์ทหารบก 2567;77(2):149-65.***

*ได้รับต้นฉบับ 11 พฤษภาคม 2567 แก้ไขบทความ 17 มิถุนายน 2567 รับลงตีพิมพ์ 25 มิถุนายน 2567*
*ต้องการสำเนาต้นฉบับติดต่อ พ.ต. ทพ.อานันท์ จักรอิศราพงศ์ มหาวิทยาลัยเวสเทิร์น Email: chopinconcerto@gmail.com*

## Introduction

The issue of oral health represents a global concern that has garnered significant attention from nations worldwide due to its profound implications for overall population well-being. Recognizing the interconnection between oral health and general health, the World Health Organization (WHO) has underscored the pivotal role of oral health in influencing the quality of life across all age cohorts. Prevalent oral health concerns on a global scale primarily encompass dental caries and periodontal disease, persistent maladies that health organizations endeavor to mitigate through sustained initiatives encompassing health promotion, disease prevention, treatment, and rehabilitation endeavors. The overarching objective of these concerted efforts is to foster an environment conducive to maintaining optimal oral health, thereby fostering favorable impacts on individuals' overall health and well-being[1,2].

The prevailing oral health issues in Thailand, notably dental caries and periodontal disease, are predominantly attributed to a deficiency in oral health knowledge among the populace and the adoption of incorrect oral hygiene practices. A comprehensive understanding of the etiology of these diseases underscores the potential for their prevention through consistent adherence to appropriate oral care practices. One proposed intervention to mitigate these issues involves the implementation of educational initiatives focusing on fostering correct and routine oral hygiene habits, constituting an integral component of effective oral health promotion endeavors. Despite active involvement of the Department of Health in promoting oral health, the attainment of favorable outcomes and widespread coverage throughout the population remains elusive. Hence, the imperative exists for the exploration of diverse and efficacious methods tailored to the dynamic social and technological milieu. Augmenting educational endeavors aimed at instilling proper and consistent oral hygiene practices stands as a viable strategy. Concurrently, the development of targeted oral health promotion strategies that align with prevailing societal norms and technological advancements is imperative. Despite of the Department of Health's concerted efforts in oral health promotion, the achievement of desired outcomes and equitable outreach to all demographic segments remains a challenge. Consequently, the adoption of multifaceted approaches, attuned to societal dynamics and technological shifts, emerges as indispensable for the effective promotion of oral health[2-6].

In the context of dental treatment, it is customary for dentists to initiate patient consultations with a thorough oral examination aimed at identifying underlying issues contributing to the patient's discomfort. Subsequent to this evaluation, findings are meticulously recorded in the patient's medical dossier maintained at the healthcare institution visited, thereby ensuring a seamless continuum of care within a singular healthcare environment. Nevertheless, in instances where patients necessitate ongoing therapeutic interventions, there exists the propensity for inadvertent oversight of scheduled appointments, potentially culminating in the exacerbation of prevailing conditions and heightened vulnerability to oral pathologies, such as the progression of extant lesions[7,8]. Furthermore, post-treatment considerations encompass the imperative for patients to receive comprehensive guidance on requisite post-procedural care practices. This includes imparting instructions on various procedures such as tooth extraction, plaque eradication, dental fillings, denture placement, or wisdom surgical removal[9]. Additionally, patients may

actively seek elucidation from dental practitioners or dental hygienists concerning optimal oral care protocols aimed at averting the onset of diverse oral health ailments, including gingivitis and related conditions, frequently stemming from deficient or erratic oral hygiene regimens[10-12]. In the event that patients fail to receive accurate, intelligible, and credible information from reputable dental professionals, there exists the potential for recourse to unreliable sources for guidance, thus predisposing individuals to erroneous practices and misconceptions pertaining to oral health preservation[13-15]. Consequently, the development and deployment of mobile electronic learning platforms aimed at imparting accurate information on appropriate oral hygiene practices emerge as a promising avenue for facilitating patient education. Such initiatives hold the potential to augment knowledge acquisition and foster adherence to proper oral care regimens, ultimately culminating in a tangible reduction in preventable oral health afflictions[2].

In light of the absence of an effective means for patients to maintain their dental treatment records personally, individuals frequently lack awareness regarding the imperative for ongoing treatment and may inadvertently overlook scheduled appointments. Moreover, routine dental visits often entail the provision of treatment solely addressing prevailing conditions, with limited information dissemination pertaining to broader oral health concerns or specific treatment modalities. This constraint is exacerbated by the high patient caseloads encountered in many healthcare facilities, resulting in temporal constraints on the provision of comprehensive information or satisfactory responses to patient queries. Consequently, patients may receive inadequate guidance regarding oral health maintenance. In response, researchers endeavor to develop a mobile application facilitating the personalized storage of dental treatment data, enabling patients to digitally record treatment information via their mobile devices. This platform affords patients continuous access to their treatment records, thereby facilitating ongoing monitoring of their oral health status. Moreover, given the prevalence of dental caries and periodontal disease, scholars aspire to promote effective oral health strategies accessible to patients for self-education and continuous care. The envisioned application will furnish tailored guidance on oral care practices tailored to each patient's unique condition, thereby enhancing their comprehension, and fostering the adoption of appropriate self-care measures. This initiative holds promise for enhancing patients' management of their oral health care, thereby contributing to their overall well-being and the sustainable maintenance of oral health in the long term.

## Material and Methods

This research proposal had been approved by the Ethical Committee on Research in Human Subjects of Western University, as the document No. HE-WTU2567-0012. Patients who agreed to participate in the study read and signed the consent form designed for this purpose.

### Research objectives

This study aims to develop an oral health promotion model using a comprehensive dental care application. The specific objectives are: 1) to diagnose the situation and needs for oral health promotion, 2) to develop the model using dental care application, and 3) to do a pilot test and evaluate the model.

## Research methodology

**1. Study design:** This model development project was carried out based on the Research and Development (R&D) process, composing 3 phases: Phase 1: Situation analysis; Phase 2: Model development; Phase 3: Model testing and Evaluation. In Phase 3, a quasi-experimental design known as the Pretest-Posttest Two Group Design was employed. The experimental group participated in the Oral Health Promotion Program using Dental Care Application developed, while the comparison group did not (Figure 1).

**Phase 1: Problem Diagnosis and Relevant Factors Assessment**

The study aimed to understand the issues surrounding dental care-seeking behavior through the following:

- Dental Disease Statistics: Analyzing statistical data on the prevalence and incidence of dental diseases to comprehend the magnitude of the problem.
- Beliefs Regarding Oral Diseases: Investigating beliefs concerning the susceptibility and severity of oral diseases among the target population.
- Oral Health Care Behaviors: Assessing the oral health care behaviors of dental service recipients to identify patterns and gaps in their practices.
- Oral Health Status: Evaluating the current oral health status of the population to identify prevalent conditions and areas requiring attention.
- Dental professionals and Patient Perspectives: Conducting in-depth interviews with dental professionals and patients to understand their perspectives on the need for information that facilitates prompt treatment and oral health maintenance. This qualitative data aims to provide insights into the subjective experiences and preferences of both dental professionals and patients regarding oral health care.

By conducting in-depth interviews and analyzing relevant qualitative and quantitative data, the study seeks to gain a comprehensive understanding of the challenges and factors influencing dental care-seeking behavior, thereby informing the development of effective interventions.

**Phase 2: Development of an Oral Health Promotion Model**

The development team comprises researchers (dentists), dental hygienists, programmers, and representatives of patients. Together, they aim to develop an application that integrates oral health data of patients and provides essential oral health care knowledge to reduce the risk of oral diseases. The development framework emphasizes the following principles:

- Client-Centered Approach: Focusing on the needs and preferences of individual patients to tailor the intervention accordingly.
- Communication Theories: Utilizing theories and models of communication to effectively convey oral health information to patients.
- Application Development Principles: Employing best practices in application development to ensure usability and functionality.
- Health Belief Model: Incorporating the Health Belief Model to understand and address factors influencing oral health behaviors.

Prototype developed will be tested with a small group and continuously refined and improved until a complete prototype is achieved.

**Phase 3: Model Testing and Evaluation**

The prototype model developed from Phase 3 was tested of 60 dental clients, 30 each in the experimental and the comparison groups for 4 weeks. The experimental group received the oral health promotion application which the comparison group did not. The comparison issues emphasize the following principles:

- Oral health beliefs
- Oral health care behaviors
- Oral health status
- Appointment Keeping
- Satisfaction with model usage

**Figure 1** Conceptual framework

**2. Population and Sample:** In Phase 1: Situation analysis, the population under scrutiny comprises individuals who received dental services, specifically members of the Third Army Region, totaling 35,614 individuals.[16] This data was obtained from service recipient records for the fiscal year 2022. The sample size was determined using Daniel's (2010) formula, which calculates sample size based on the population size to estimate population proportions. It was assumed that the proportion of the population possessing the characteristic of interest is 0.5, with a confidence level of 95%. In Phase 3: Model Testing and Evaluation, after the keeping appointment for drafted model has been pretested with the small group of dental patients and revised, it has been tested with 60 dental patients. The selection of the sample group using simple random sampling was 30 individuals each in the experimental and the comparison groups, for 4 weeks.

**3. Sample selection:** In Phase 1: Situation analysis, the calculated sample size is 245 individuals. The researcher intended to increase the sample size by 10% for data collection. Therefore, the revised sample size was 270 individuals.

**4. Inclusion criteria:** 1) Thai patients of the dental care services at the Army Hospital, aged 20-60 years; 2) Individuals proficient in reading and comprehending Thai language; and 3) willing to participate in the research and consent to providing information about the study. The comparison group of 30 individuals were selected in accordance with the similar inclusion criteria.

**5. Research Instruments**

A set of questionnaires was sent to experts to verify the content validity. The reliability of the questionnaire was done by applying Cronbach's $\alpha$-Coefficient. The reliability value was found to be higher than 0.7 in all parts of the questionnaires.

**Data collection**

Each patient signed an informed consent form and agreed to participate in the present study. The research process consists of three phases: Phase 1: Situation analysis; Phase 2: Model development, and Phase 3 Model Testing and Evaluation. In Phase 1, two sample groups were studied and collected for quantitative and qualitative data: Group 1 comprised 270 dental service recipients, while Group 2 comprised 15 dental service recipients. Phase 1 was concerned with quantitative data collection using questionnaires measuring oral health beliefs, oral health care behavior, digital tool usage skills, and oral health status[17-22]. And the guideline for in-depth interview was used to collect qualitative data. In Phase 2, the comprehensive dental care application was developed[23-26], covering contents on oral health care and appropriate practices after receiving dental health treatment. In Phase 3, the model was tested and evaluated with the sampled group of 60 individuals, experimental and comparison groups of 30 individuals each.

**Data analysis**

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS/PC for windows). The individual factor measurements were compared using T-test. The level of significance for all tests was set at $\alpha = 0.05$.

## Results

### Phase 1: Situation analysis

#### 1. Literature review

The analysis of oral health issues reveals a multifaceted landscape characterized by diverse factors and underlying causes pertaining to the promotion of oral well-being. Among the prevalent oral diseases, dental caries and periodontitis stand out as primary concerns warranting attention. The significance of addressing oral health concerns extends beyond the confines of the oral cavity, encompassing broader implications for overall physical health and psychological well-being. Additionally, oral health issues exert a tangible impact on social dynamics, confidence levels, and the general quality of life experienced by individuals. Thus, the provision of appropriate oral health care and targeted treatment interventions assumes paramount importance in mitigating adverse outcomes and fostering optimal daily functioning.

Efforts to promote oral health are evident on both international and national fronts, with a pronounced emphasis on disease prevention and the cultivation of positive oral health behaviors among diverse demographic groups. However, within the context of Thailand, substantial challenges persist regarding the equitable access to dental care services, particularly among rural populations and socio-economically disadvantaged segments of society. Consequently, a substantial proportion of the populace remains underserved, leading to a pervasive lack of awareness regarding oral health needs and the imperative of ongoing oral health maintenance practices. Considering these realities, the imperative for the establishment of accessible and high-quality dental services emerges as a pressing priority, necessitating a concerted focus on effective management strategies, the deployment of skilled dental personnel, and the provision of adequate dental care resources. This collective endeavor aims to ensure the equitable delivery of dental services, transcending geographical and socioeconomic barriers to access.

Remarkably absent from the extant literature are studies elucidating the integration of oral health promotion applications with the collection of dental treatment data among patient cohorts. Similarly, there is a conspicuous dearth of oral health promotion models tailored to the specific oral health needs and conditions of individual patients. Given the nuanced complexities and far-reaching implications associated with oral health challenges, it is evident that these issues remain salient and exert a profound influence on the holistic health status of affected individuals. Addressing these challenges mandates a comprehensive approach, encompassing proactive health promotion initiatives, robust disease prevention strategies, post-treatment care protocols, and regular dental surveillance, all of which collectively contribute to enhancing oral health outcomes and minimizing the incidence of dental diseases.

#### 2. The collection of observational data

##### 1) Personal Data

The demographic profile of the study sample revealed a predominant male representation at 71.9%, with females comprising the remaining 28.1%. The age distribution predominantly ranged between 20 and 30 years (43.3%), followed closely by ages 31 to 40 years (37.4%). A significant portion of the participants identified as single (54.1%). In terms of educational attainment, 50.7% held a bachelor's

degree, while 25.2% completed high school or vocational education, 20.7% attained an associate or diploma degree, and only 3.3% obtained a master's degree. Regarding occupation, a notable proportion reported being unemployed (50.7%), with 20.4% engaged in trade or private businesses, 15.6% employed as general laborers, and 7.4% involved in agriculture. The majority of participants reported a monthly income between 10,000 and 20,000 baht (59.6%). Television served as the primary source of oral health information for most individuals (46.7%), followed by notice boards or public relations signs (15.9%), healthcare personnel (15.2%), radio (2.6%), newspapers (2.6%), and loudspeaker announcements (3%).

**2) Beliefs Regarding Oral Health Diseases**

Analysis of participants' perceptions regarding oral diseases indicated that a substantial portion perceived risk at a moderate level (21.1%), while the majority perceived severity at a moderate to good level (49.3%). In terms of perceived benefits of disease prevention, the majority exhibited a positive perception (88.1%), whereas perceptions of problems or obstacles in disease prevention were mostly moderate (74.1%). Overall, a small percentage demonstrated a positive belief regarding oral health diseases (2.96%), while the majority exhibited a moderate belief (76.67%) and a smaller proportion displayed a poor belief (20.37%). These findings underscored prevalent misconceptions among dental patients regarding oral diseases, encompassing perceptions of risk, severity, prevention benefits, and obstacles in disease prevention.

**3) Oral Health Care Behaviors**

Examining oral health care behaviors among participants revealed prevalent practices such as using fluoride toothpaste (75.5%), tongue scraping (58.1%), and brushing teeth for over 2 minutes (56.7%). Conversely, less commonly practiced behaviors included smoking (80.0%), consuming sticky sweets (56.3%), and regular dental visits every 6 months (40.4%). Overall, participants exhibited inadequate knowledge regarding oral health care behaviors, with 57.04% categorized at a poor level and 42.96% at a moderate level.

**4) Digital Tool Usage Skills**

A considerable proportion of participants expressed confidence in utilizing online resources for oral health care (63.7%), with a majority exhibiting confidence in verifying the credibility of online information (57.8%). Overall, digital tool utilization skills were predominantly at a moderate level (66.30%), with a substantial portion categorized at a poor level (57.04%) and a minority at a good level (7.77%).

**5) Stakeholder Feedback on Comprehensive Dental Health Application Development**

Participants articulated a need for enhanced self-care skills, particularly in brushing techniques and flossing, alongside a desire for improved awareness of tooth decay, gum disease, and the importance of consistent treatment. They advocated for accessible and accurate oral health care information. Dental professionals emphasized the prevalence of tooth decay and gum disease as primary oral health concerns, often detected late when symptoms were severe, necessitating complex treatment modalities such as tooth extraction, root canal therapy, and periodontal interventions.

**Phase 2: Model development**

**1. Planning and Analysis of Data from Phase 1**

The researchers assembled a diverse group of stakeholders involved in oral health promotion, comprising one dentist (acting as the researcher), one dental hygienist, two dental assistants, one programmer, and five dental service recipient representatives. Data obtained during the initial diagnostic phase, including insights into beliefs surrounding oral diseases, proficiency in utilizing digital tools, maintenance of oral health records, and findings from in-depth interviews regarding oral health care practices, underwent rigorous analysis. Subsequently, these insights were leveraged to conceptualize and develop an application aimed at augmenting awareness regarding oral health care and fostering correct oral health practices.

**2. Comprehensive Dental Health Application Design**

The design process of the dental health application involved collaborative efforts among stakeholders engaged in oral health promotion. The primary objective was to enhance the awareness among dental service recipients, enabling them to independently and consistently uphold oral health practices. Employing the Appreciation-Influence-Control (A-I-C) framework, stakeholders collectively formulated plans and designed a user-friendly application with comprehensive content on oral health promotion. Throughout the design phase, extensive feedback was solicited to ensure the applicability of the application to the context of dental service recipients. It was imperative that the application guaranteed privacy and data security to prevent any unauthorized access to personal information. The application was designed to collect medical and dental data, conduct individualized dental health assessments, and provide self-care information in various formats, including videos and text files accessible via mobile devices. The planning and design process underwent iterative cycles of refinement to develop the most suitable application prototype.

**3. Efficient Application Refinement for Testing**

Before conducting formal testing, the designed application prototype underwent pilot testing with five non-sample dental service recipients to evaluate their comprehension of the content and the suitability of the application. Adjustments were made based on the feedback received, particularly in cases where the pilot group demonstrated a lack of comprehension. The refined prototype was subsequently presented to advisors for further evaluation and feedback. Following this, it underwent testing with a group of representative dental service recipients to assess their understanding and usability of the prototype. This iterative refinement process aimed to ensure a comprehensive understanding and effective usability of the application prototype (Figure 2-5).


**Figure 2** Comprehensive Dental Care Application: Log in section

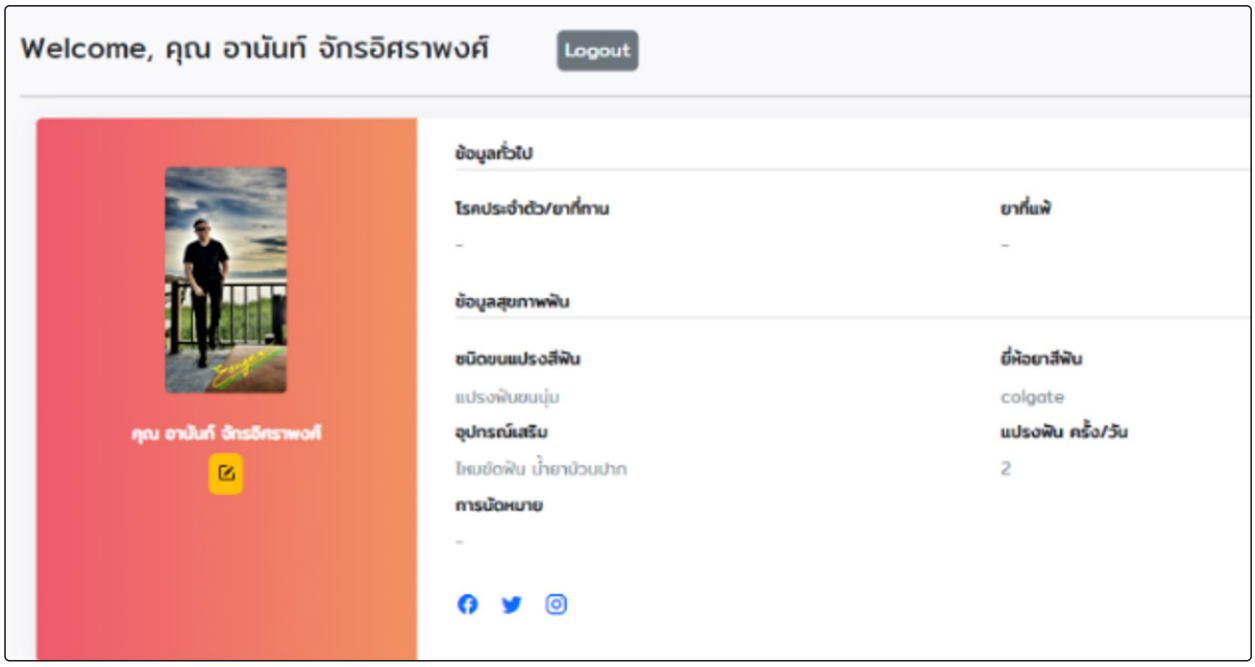


**Figure 3** Comprehensive Dental Care Application: General Information section

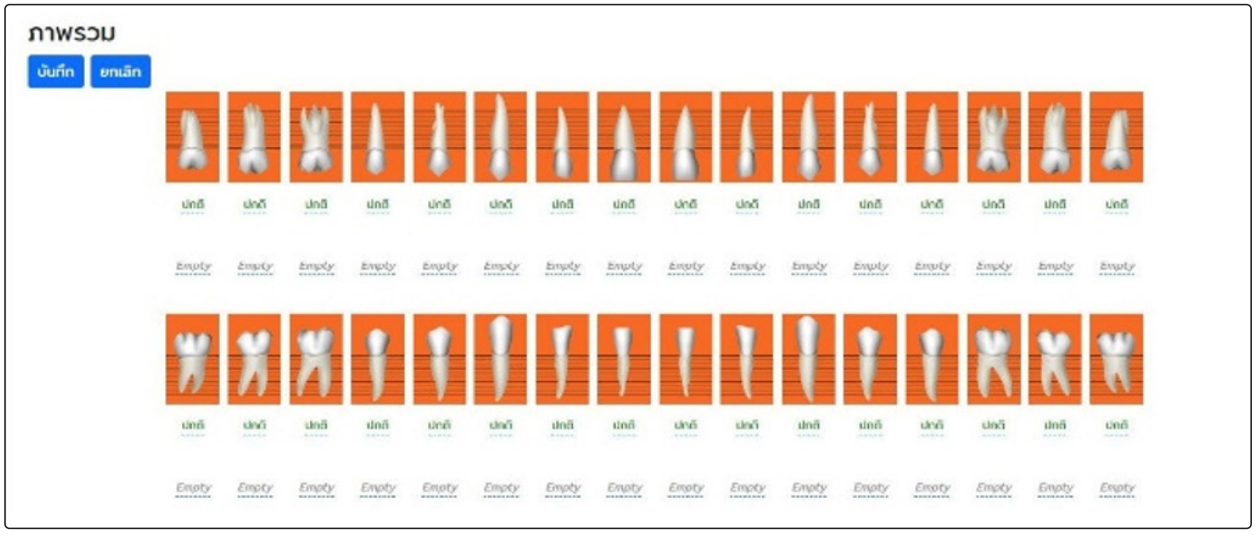


**Figure 4** Comprehensive Dental Care Application: Intraoral section

**Phage 3: Model Testing and Evaluation**

The prototype model developed from Phase 3 was tested with 60 dental clients, 30 each in the experimental and the comparison groups for 4 weeks. The experimental group received the oral health promotion application while the comparison group did not.

**1. Personal Data**

The developed model was tested with an experimental group of 30 participants from Khunchueangthammikkarat Hospital, and a comparison group of 30 from the same hospital. Statistical analysis revealed no significant difference in gender between the experimental and comparison groups ($\chi^2$ = 0.067). However, there was a statistically significant difference in marital status ($\chi^2$ = 10.143), with the experimental group predominantly being in relationships compared to the mostly single comparison group.

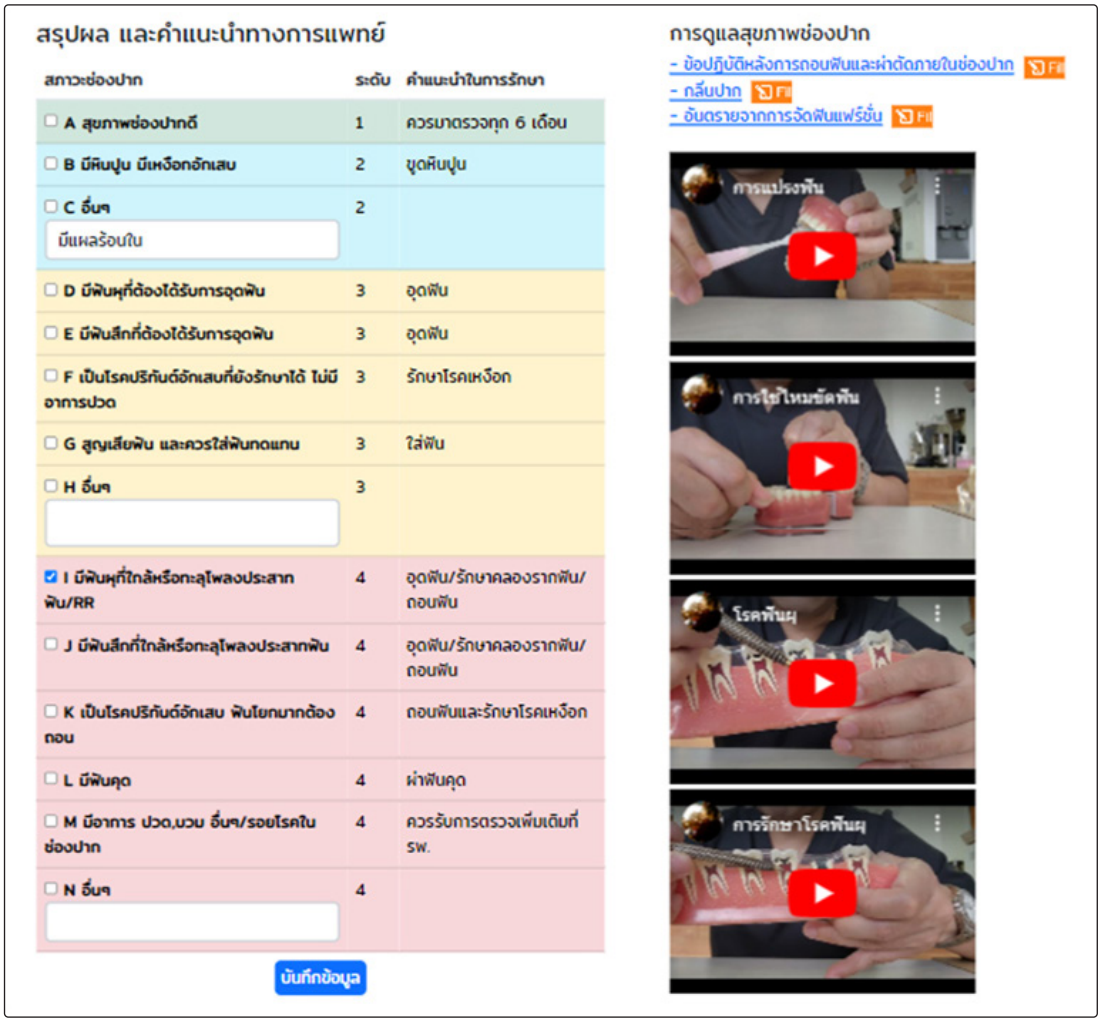


**Figure 5** Comprehensive Dental Care Application: Summary and Oral health Promotion section

Regarding education level, there was no statistical difference between the experimental and comparison groups ($\chi^2$ = 3.007), with both groups predominantly having a bachelor's degree. Similarly, there was no significant difference in occupation ($\chi^2$ = 1.983), with both groups primarily engaged in sales/business as a secondary occupation. In terms of income, there was no statistical difference between the experimental and comparison groups ($\chi^2$ = 5.111), with the majority having a monthly income of 10,000-20,000 baht.

**2. Beliefs Regarding Oral Health Diseases** (Table1)

**1) Perception of Oral Disease Risk:**

After the intervention, the experimental group showed a significantly higher perception of oral disease risk compared to both pre-intervention (t = -3.84, $p < 0.05$) and the comparison group (t = 3.37, $p < 0.05$).

**2) Perception of Oral Disease Severity:**

Post-intervention, the experimental group demonstrated a significantly higher perception of oral disease severity compared to both pre-intervention (t = -2.54, $p < 0.05$) and the comparison group (t = 3.90, $p < 0.05$).

**Table 1** Difference analysis of beliefs regarding oral health between the experimental and the comparison groups, before and after the experiments (n = 30 each)

| Beliefs Regarding Oral Health Diseases | $\bar{X}$ | S.D. | t | *p*-value |
|---|---|---|---|---|
| **With in group** | | | | |
| **Experimental group** | | | | |
| Before experiment | 3.51 | 0.47 | -4.33 | < 0.05 |
| After experiment | 3.93 | 0.25 | | |
| **Comparison group** | | | | |
| Before experiment | 3.55 | 0.56 | 0.68 | > 0.05 |
| After experiment | 3.46 | 0.40 | | |
| **Between groups** | | | | |
| **Before experiment** | | | | |
| Experimental group | 3.51 | 0.47 | -0.3 | > 0.05 |
| Comparison group | 3.55 | 0.56 | | |
| **After experiment** | | | | |
| Experimental group | 3.93 | 0.25 | 4.94 | < 0.05 |
| Comparison group | 3.46 | 0.40 | | |

**3) Perception of Preventive Benefits:**

Post-intervention, the experimental group showed a significantly higher perception of preventive benefits compared to pre-intervention (t = -1.60, $p < 0.05$) but not compared to the comparison group (t = 1.54, $p < 0.05$).

**4) Perception of Problems/Barriers in Prevention:**

Post-intervention, the experimental group had a significantly higher perception of problems/barriers in prevention compared to pre-intervention (t = -3.31) and the comparison group (t = 4.41, $p < 0.05$).

Overall, post-intervention, the experimental group showed significant improvements in perceptions related to oral health beliefs compared to both pre-intervention and the comparison group.

**3. Oral Health Care Behaviors** (Table 2)

Post-intervention, the experimental group exhibited significantly higher oral health care behaviors compared to both pre-intervention (t = -3.53, $p < 0.05$) and the comparison group (t = 4.835, $p < 0.05$).

**4. Oral Health Status** (Table 3)

Before the intervention, there was no significant difference in oral health status between the experimental and comparison groups (t = -1.31, $p < 0.05$). However, post-intervention, the oral health status of the experimental group was significantly better than both pre-intervention (t = 2.38, $p < 0.05$) and the comparison group (t = 1.317, $p < 0.05$).

**5. Appointment Keeping**

In the second appointment, 100% of the experimental group and 76.67% of the comparison group attended, indicating higher compliance in the experimental group.

**Table 2** Difference analysis of oral health care behaviors between the experimental and the comparison groups, before and after the experiment (n = 30 each)

| Oral health care behaviors | X | S.D. | t | *p*-value |
|---|---|---|---|---|
| **With in group** | | | | |
| **Experimental group** | | | | |
| Before experiment | 3.62 | 0.50 | -2.53 | < 0.05 |
| After experiment | 3.91 | 0.38 | | |
| **Comparison group** | | | | |
| Before experiment | 3.50 | 0.58 | -0.556 | > 0.05 |
| After experiment | 3.56 | 0.10 | | |
| **Between groups** | | | | |
| **Before experiment** | | | | |
| Experimental group | 3.62 | 0.50 | 0.868 | > 0.05 |
| Comparison group | 3.50 | 0.58 | | |
| **After experiment** | | | | |
| Experimental group | 3.91 | 0.38 | 4.835 | < 0.05 |
| Comparison group | 3.56 | 0.10 | | |

**Table 3** Difference analysis of oral health status of the experimental and the comparison groups, before and after the experiment (n = 30 each)

| Oral Health Status | | S.D. | t | *p*-value |
|---|---|---|---|---|
| **With in group** | | | | |
| **Experimental group** | | | | |
| Before experiment | 2.80 | 0.847 | 2.38 | < 0.05 |
| After experiment | 2.17 | 1.177 | | |
| **Comparison group** | | | | |
| Before experiment | 3.10 | 0.923 | 4.226 | < 0.05 |
| After experiment | 1.70 | 1.368 | | |
| **Between groups** | | | | |
| **Before experiment** | | | | |
| Experimental group | 2.80 | 0.847 | -1.31 | > 0.05 |
| Comparison group | 3.10 | 0.923 | | |
| **After experiment** | | | | |
| Experimental group | 2.17 | 1.177 | 1.317 | < 0.05 |
| Comparison group | 1.70 | 1.368 | | |

**6. Satisfaction with Comprehensive Dental Health Promotion Model**

Post-intervention assessment revealed high levels of satisfaction among dental service recipients with the developed comprehensive dental health promotion model utilizing the dental application, with an average satisfaction score of 4.61.

## Discussion

Evaluation of the Effectiveness of a Development of Oral Health Promotion Model Using Comprehensive Dental Care Application, Measured by Changes in the Following Variables:

**1. Beliefs Regarding Oral Health Diseases:**

Analysis of statistical data revealed that beliefs regarding the occurrence of oral health diseases, comprising perception of risk, severity, benefits of prevention, and perceived barriers, were higher among the experimental group compared to before the experiment and significantly higher than the comparison group. This aligns with the hypothesis posited, suggesting that "after using the model, the experimental group will have higher beliefs regarding oral health diseases compared to before the experiment and higher than the comparison group", which is in accordance with the Health Belief Model, which aims to explain and understand factors influencing health behaviors, particularly in decision-making related to health practices. This indicates that beliefs regarding the occurrence of oral health diseases may be a variable used to predict outcomes of oral health care behaviors. These findings align with the study which investigated the effectiveness of using an application with parents of pre-school children and found that the parents' knowledge of their children's oral health care had increased.[27]

**2. Oral Health Care Behaviors:**

Statistical analysis revealed that oral health care behaviors in the experimental group had significantly higher average scores compared to before the experiment and higher than the comparison group. This supports the hypothesis that "after using the model, the experimental group will have better oral health care behaviors compared to before the experiment and better than the comparison group." This is consistent with the Health Belief Model, which emphasizes the reliance on various factors to encourage individuals to engage in health-related behaviors. It suggests that confidence in risk perception, expected benefits, and interpretation of available knowledge and information can influence decision-making regarding health-related behaviors, demonstrating that oral health care behaviors may be a variable used to predict oral health status outcomes. The increase in oral health care behaviors resulting from the use of this application is consistent with the research which found that after using the application with children aged 4-12 years, the sample group exhibited improved brushing behaviors in both frequency and quality.[28]

**3. Oral Health Status:**

Statistical analysis revealed that oral health status levels in the experimental group were significantly higher on average compared to before the experiment and higher than the comparison group. This aligns with the hypothesis that "after using the model, the experimental group will have

better oral health status than before the experiment and better than the comparison group." Since the experimental group had received comprehensive dental services, including the use of a comprehensive dental care application, allowing for self-care at home and remote monitoring via mobile phones, this facilitated increased awareness, belief, and behaviors conducive to better oral health care compared to the comparison group, which received general post-treatment advice only.

**4. Appointment Keeping:**

Experimental group participants demonstrated a higher number of follow-up appointments compared to the comparison group, consistent with the hypothesis that "after using the model, the experimental group will have a higher number of follow-up appointments than the comparison group." This is attributed to the comprehensive dental care application's capability to identify dental issues, provide personalized oral health care guidance, and allow for appointment scheduling and monitoring, enhancing participants' awareness of their oral health and the necessity for ongoing treatment and follow-up.

**5. Satisfaction with Model Usage:**

Experimental group participants reported high satisfaction levels with model usage, consistent with the hypothesis that "after using the model, the experimental group will have high satisfaction with the application." The tailored nature of the application, personalized to individual users and offering convenient access to reliable information and online dental consultations, met users' needs and expectations effectively. Thus, the high satisfaction levels suggest that the developed model effectively fulfilled users' requirements for convenient, accessible, and informative oral health care management.

The study findings indicate that the experimental group exhibited improved behaviors across various domains, statistically significant compared to the comparison group, likely attributed to the utilization of the oral health promotion model employing the comprehensive dental care application. The client-centered approach emphasized in the model's development, focusing on individualized care and user-friendly features, facilitated effective engagement, learning, and behavior modification among participants. This process of model development adhered to research and development principles, ensuring thorough refinement before implementation in the third phase of the study.

## Recommendations

To enhance the comprehensiveness of the developed dental care application as the first Oral Health Promotion Application in Thailand, it is imperative to undertake extensive research and development. This endeavor should encompass the following key aspects:

1. Research studies should be conducted to explore and develop models for promoting oral health within the dental departments of the Ministry of Public Health, universities, and both governmental and non-governmental organizations. This approach will facilitate the acquisition of pertinent data essential for tailoring the application to cater to diverse organizational needs.

2. Extensive studies should be conducted within larger population groups to validate and implement the developed models. These studies should also aim to localize the application to different regions, ensuring its appropriateness for varying lifestyles, socio-cultural contexts, and environmental conditions prevalent within each demographic group.

3. Research endeavors should delve into the development of health promotion models through a comprehensive consideration of patients with co-morbidities. This approach will yield insights into the interrelation between oral diseases and systemic conditions, given the myriad oral diseases currently associated with various systemic ailments.

## Summary

The study evaluated the effectiveness of Development of Oral Health Promotion Model using Comprehensive Dental Care Application by measuring changes in beliefs, behaviors, oral health status, appointments keeping, and satisfaction. Data analysis revealed that the experimental group exhibited higher beliefs, better oral health care behaviors, improved oral health status, more follow-up appointments, and greater satisfaction compared to the comparison group. These findings suggest that the model effectively promoted positive oral health outcomes through personalized care, convenient access to information, and online consultations. The study underscores the importance of client-centered approaches and thorough refinement of interventions before implementation.

## References

1. *Joufi AI, Claiborne DM, Shuman D. Oral Health Education and Promotion Activities by Early Head Start Programs in the United States: A systematic review. J Dent Hyg. 2021;95(5):14-21.*
2. *World Health Organization. Oral health [Internet]. [Cited 2023 Apr. 1]. Available from : https://www.who.int/health-topics/oral-health#tab=tab_1/*
3. *Ministry of Public Health. (2560). A-I-C Participatory Planning Technique [Internet]. [Cited 2023 Jan 18]. Available from:http://advisor.anamai.moph.go.th/tamra/AIC/aic02.html/.*
4. *Niemiec BA. Periodontal therapy. Top Companion Anim Med. 2008;23(2):81-90.*
5. *Hammel JM, Fischel J. Dental Emergencies. Emerg Med Clin North Am. 2019;37(1):81-93.*
6. *Donoff RB, Simon L. To achieve oral health in America, dental education needs to evolve. J Am Dent Assoc. 2022;153(8):731-3.*
7. *Patel J, Siddiqui Z, Krishnan A, Thyvalikakath TP. Leveraging Electronic Dental Record Data to Classify Patients Based on Their Smoking Intensity. Methods Inf Med. 2018 ;57(5-06):253-60. Erratum in: Methods Inf Med. 2018;57(5-06):e2.*
8. *Sayed ME. Knowledge, attitude and behaviour of dental health care providers towards health electronic record systems in Saudi Arabia. Health Info Libr J. 2021 ;38(3):194-202.*
9. *Stoopler ET. Oral health education for the masses. Spec Care Dentist. 2018;38(2):63-4.*
10. *Prochaska JO, Redding CA, Harlow LL, Rossi JS, Velicer WF. The transtheoretical model of change and HIV prevention: a review. Health Educ Q. 1994;21(4):471-86*
11. *Rosenstock IM, Strecher VJ, Becker MH. Social learning theory and the Health Belief Model. Health Educ Q. 1988;15(2):175-83.*
12. *Potisomporn P, Sukarawan W, Sriarj W. Oral Health Education Improved Oral Health Knowledge, Attitudes, and Plaque Scores in Thai Third-grade Students: A Randomised Clinical Trial. Oral Health Prev Dent. 2019;17(6):523-31.*
13. *Selzler AM, Habash R, Robson L, Lenton E, Goldstein R, Brooks D. Self-efficacy and health-related quality of life in chronic obstructive pulmonary disease: A meta-analysis. Patient Educ Couns. 2020;103(4):682-92.*

14. *Spangler HD, Simancas-Pallares MA, Ginnis J, Ferreira Zandoná AG, Roach J, Divaris K. A Web-Based Rendering Application for Communicating Dental Conditions. Healthcare (Basel). 2021;9(8):960.*
15. *Subedi K, Shrestha A, Bhagat T, Baral D. Effectiveness of oral health education intervention among 12-15-year-old school children in Dharan, Nepal: a randomized controlled trial. BMC Oral Health. 2021;21(1):525.*
16. *Army Dental Corps, Department of Army Medical Services. Dental Service Statistics for Fiscal Year 2565. Bangkok: Department of Medical Services; 2023.*
17. *Jones CJ, Smith H, Llewellyn C. Evaluating the effectiveness of health belief model interventions in improving adherence: a systematic review. Health Psychol Rev. 2014;8(3):253-69.*
18. *Salles A. Self-Efficacy as a Measure of Confidence. JAMA surgery. 2017;152(5):506–7.*
19. *Klassen RM, Klassen JRL. Self-efficacy beliefs of medical students: a critical review. Perspect Med Educ. 2018;7(2):76-82.*
20. *Farley H. Promoting self-efficacy in patients with chronic disease beyond traditional education: A literature review. Nurs Open. 2019;7(1):30-41.*
21. *Mohammadkhah F, Ramezankhani A, Atashpoosh A, Ahmady Moghadam F, Bakhtiar M, Khani Jeihooni A. Effect of training based on health belief model and behavioral intention on improving dental and oral self-care behavior in 9-12-year-old Iranian female students. BMC Oral Health. 2022;22(1):515.*
22. *Sumita I, Toyama N, Ekuni D, Maruyama T, Yokoi A, Fukuhara D, et al. The Impact of Oral Health Behaviors, Health Belief Model, and Absolute Risk Aversion on the Willingness of Japanese University Students to Undergo Regular Dental Check-Ups: A Cross-Sectional Study. Int J Environ Res Public Health. 2022;19(21):13920.*
23. *Abramovicz-Finkelsztain R, Barsottini CG, Marin HF. Electronic Dental Records System Adoption. Stud Health Technol Inform. 2015;216:17-20.*
24. *Amos KJ, Bearman M, Palermo C. Evidence Regarding Teaching and Assessment of Record-Keeping Skills in Training of Dental Students. J Dent Educ. 2015;79(10):1222-9.*
25. *Thierer TE, Delander KA. Improving Documentation, Compliance, and Approvals in an Electronic Dental Record at a U.S. Dental School. J Dent Educ. 2017;81(4):442-9.*
26. *Claman DB, Molina JL, Peng J, Fischbach H, Casamassimo PS. Accuracy of Parental Self-Report of Medical History in a Dental Setting: Integrated Electronic Health Record and Nonintegrated Dental Record. Pediatr Dent. 2021;43(3):230-6.*
27. *Rismayani L. Development and feasibility study of mobile application "Yummy" in preschool oral health promotion. The Incisor (Indonesian Journal of Care's in Oral Health). 2022;6(2):363-73.*
28. *Rasmus K, Toratti A, Karki S, Pesonen P, Laitala ML, Anttonen V. Acceptability of a mobile application in children's oral health promotion-a pilot study. Int J Environ Res Public Health. 2021;18(6):3256.*