

**Capstone project**

**Evaluation and Usability of Mobile Dental Apps Using MARS - Mobile App Rating Scale**

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## ABSTRACT

Study Objective: mHealth applications are increasingly being utilized to promote oral health and dental self-management. The purpose of this study was to assess the current state of consumer dental health apps for users over the age of 12 by evaluating their quality, usability, aesthetic appeal, and functional completeness against the Mobile App Rating Scale (MARS) and IMS Institute functionality criteria.

Methods: Systematic searching was done across the Google Play Store and Apple App Store utilizing oral health-related keywords. Apps were filtered based on relevance for oral health self-management, support for the English language, availability to users 12 years and above, a minimum user rating of 2.5 stars, and a recent update in the last five years. Pediatric-only use, entertainment-only, and apps unrelated to dental education were considered exclusion criteria. After filtering, 21 different apps (10 Apple, 11 Google) were found eligible for inclusion. Each app was independently reviewed by three reviewers through MARS and the IMS functionality framework, measuring the presence of 11 features such as informing, instructing, recording, displaying, guidance, reminders, and communication.

Results: For the 21 apps reviewed, the median MARS overall score was 3.3/5, and 57% (12/21) scored at or above the acceptability threshold ( $\geq 3.0$ ). Functionality had the best rating (mean  $\approx 4.0$ ), while information quality ranked lowest ( $\approx 3.0$ ). A median of 6 functionalities was presented by apps. While nearly all apps had information content and display of data features, just 19% supported communication with providers, and 28% gave personalized feedback or behavioral coaching.

Conclusions: While most dental apps are fairly functional and well-designed, many are deficient in offering detailed educational content and functionalities that can support behavior change or patient-provider communication. To optimize public oral health outcomes, future apps should seek to include validated content, personalized choices, and clinically relevant functionalities.

Keywords: mHealth, mobile health, oral health, dental hygiene, dental education, flossing, brushing, MARS.

## INTRODUCTION

Mobile health (mHealth) applications have gained significant attention as tools for promoting self-management in various health domains, including oral health. Oral diseases, such as dental caries and gum disease, are largely preventable through consistent daily practices, and mHealth apps present a promising opportunity to support these behaviors. With over 1,000 dental-related apps available across major app stores, there is evident public interest in using mobile technologies to improve dental hygiene habits. However, despite the high volume of available apps, there is considerable variability in their quality, effectiveness, and content. While many

apps offer basic educational materials or entertainment-based features, fewer provide scientifically-backed, clinically relevant content or employ strategies to support long-term behavior change.

Previous research has highlighted similar concerns in other health domains. For example, *Choi et al. (2018)* evaluated sleep self-management apps and found that although these apps offered potential benefits, they often lacked critical features such as personalized feedback, integration with healthcare providers, and empirical validation. This observation raises a pertinent issue for the dental app landscape, suggesting that many available apps may not meet the necessary standards to drive meaningful health improvements. Furthermore, many apps suffer from inadequate content coverage, with important areas like gum health, diet, and tobacco use often overlooked.

In the field of oral health, previous evaluations have shown that many dental apps also fall short in terms of content comprehensiveness. *Sharif et al. (2019)* reviewed oral hygiene apps using the Mobile App Rating Scale (MARS) and found gaps in important topics such as gum health and diet, and noted that many apps lacked advanced features like personalized feedback to enhance user engagement. Given these findings, there is a clear need for a more thorough assessment of mobile dental apps to better understand their functionality and usability and to identify opportunities for enhancing their effectiveness in supporting oral health behaviors.

**Study Objective** - This study aims to address these gaps by systematically evaluating 21 mobile dental apps available on the Apple App Store and Google Play Store. Using the Mobile App Rating Scale (MARS) and IMS Institute for Healthcare Informatics functionality criteria, we evaluate the overall quality, usability, and functional completeness of these apps. The study focuses on four key domains: **engagement**, **functionality**, **aesthetic design**, and **information quality**. By comparing the results with findings from other mHealth domains, this research seeks to provide a comprehensive overview of the state of dental health apps and to offer recommendations for improving their quality and impact.

Ultimately, by identifying the strengths and weaknesses of these apps, this study aims to inform both users and developers, encouraging the creation of more effective, evidence-based tools for promoting oral health.

## **METHODS**

This study used a cross-sectional, systematic review design to evaluate the functional completeness and quality of consumer-targeted mobile apps for self-management of oral health. The primary objective was to identify and compare mHealth apps available to consumers aged 12 years and above that support oral hygiene education, behavior monitoring, and patient self-monitoring. To accomplish this, we used two established frameworks: the Mobile App

Rating Scale (MARS) and the IMS Institute for Healthcare Informatics functionality scoring framework.

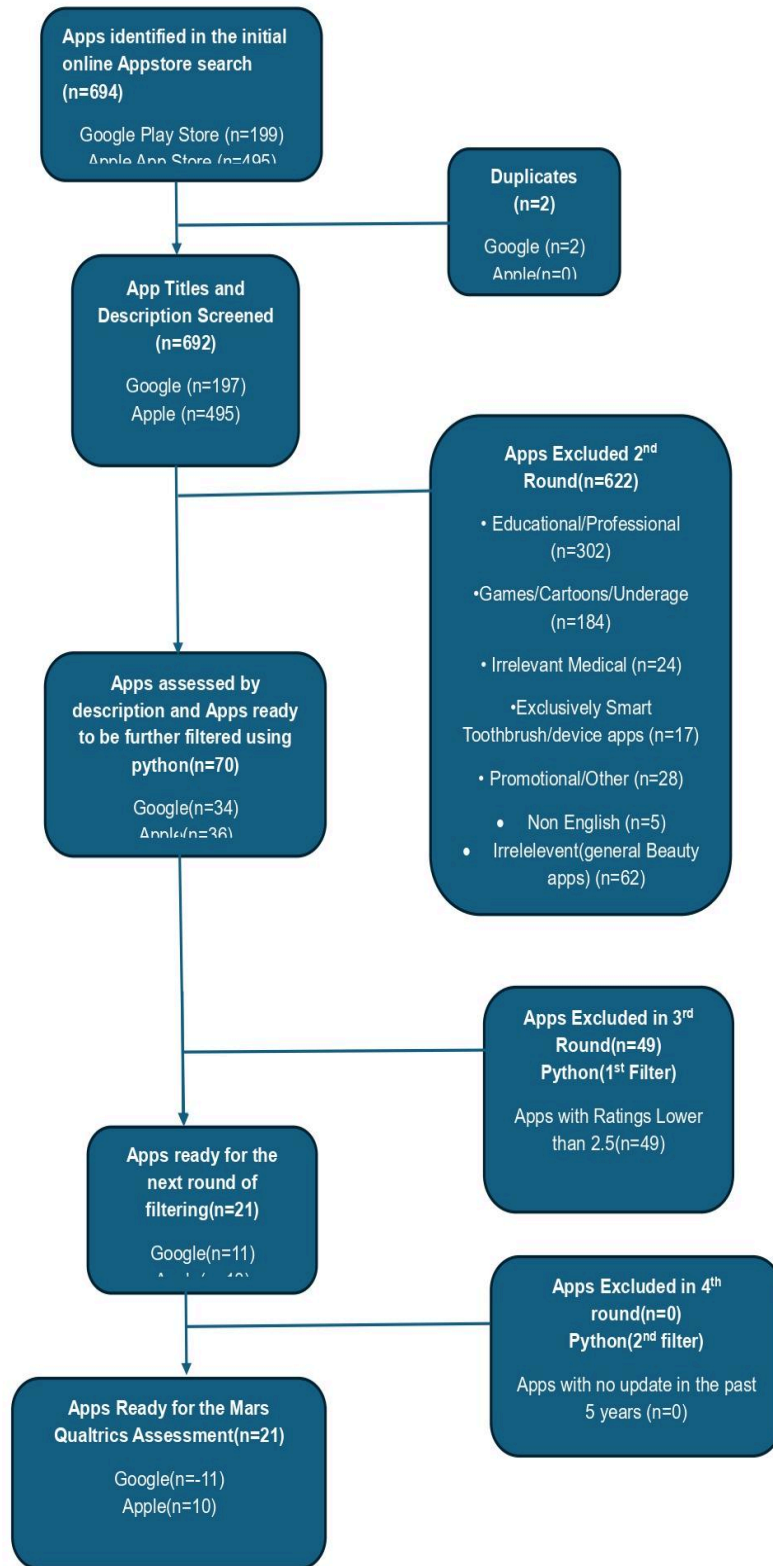
A comprehensive app search was conducted in March 2025 on two big platforms: the Apple App Store (iOS) and Google Play Store (Android). The search terms used were "*Oral Health*," "*Dental Care*," "*Tooth Brushing*," "*Flossing*," and "*Dentist*," and were confined to apps available within the "*Health & Fitness*" and "*Medical*" categories. The initial search resulted in 694 apps—495 in the Apple App Store and 199 in the Google Play Store. After two duplicates were excluded, 692 apps were screened individually. Titles and descriptions were manually assessed to consider relevance to self-care oral health. Apps were included if they were designed for users who were 12 years or older, had English language support, and were functionally available during review. Apps also had to meet bare minimum user specifications, including a minimum user rating of 2.5 stars and a most recent update within the past five years.

Exclusion criteria were established to remove apps not aligned with the study's purpose. These included apps designed solely for dental professionals (e.g., diagnostic tools or continuing education), appointment-only scheduling platforms, duplicate apps (only the more complete version was retained), and entertainment-focused apps with no educational or health relevance. The initial manual review excluded 564 apps for reasons such as being professional-focused (n=338), entertainment/gaming or targeted at children (n=164), irrelevant to oral health (n=19), exclusive to smart devices (n=13), promotional (n=28), non-English (n=2), or categorized as general wellness or beauty apps (n=2).

Following this exclusion process, 70 apps underwent additional filtering through a Python-based automated script that applied criteria for star ratings and update timelines. A further 49 apps were excluded due to a user rating below 2.5, and no apps were excluded for being out-of-date. Ultimately, 21 unique apps—10 from the Apple App Store and 11 from Google Play- met all inclusion criteria and were selected for full evaluation(**Figure 1**)

Each of the 21 apps was downloaded and evaluated independently by three trained reviewers. Reviewers were instructed to engage with each app for 30 to 60 minutes, exploring all features according to a standardized protocol. The apps were then evaluated using the Mobile App Rating Scale (MARS), a validated tool designed to assess app quality across four domains: Engagement (entertainment, interest, customization), Functionality (performance, ease of use, navigation), Aesthetics (layout and visual appeal), and Information quality (accuracy, relevance, credibility). Each item was scored on a 5-point Likert scale (1 = inadequate to 5 = excellent), and an overall mean score was computed from the four domain averages. A subjective quality score, reflecting the reviewer's overall impression and likelihood to recommend the app, was also recorded. Inter-rater discrepancies of more than 1 point on any item were resolved through discussion and consensus, and final scores for each app were calculated as the average across all raters.**Table1**

**Figure 1: PRISMA flowchart.**



**Table 1: MARS items and subscales criteria.**

<b>App Quality Scoring Criteria</b>	<b>Subscales</b>
1. Engagement	1.1 Entertainment 1.2 Interest 1.3 Customization 1.4 Interactivity 1.5 Target group
2. Functionality	2.1 Performance 2.2 Ease of use 2.3 Navigation 2.4 Gestural design
3. Aesthetics	3.1 Layout 3.2 Graphics 3.3 Visual appeal: how good does the app look?
4. Information	4.1 Accuracy of app description 4.2 Goals 4.3 Quality of information 4.4 Quantity of information 4.5 Visual information 4.6 Credibility 4.7 Evidence base
5. Subjective quality	5.1 Would you recommend this app? 5.2 How many times do you think you would use this app? 5.3 Would you pay for this app? 5.4 What is your overall star rating of the app?

MARS = Mobile Application Rating Scale.

**IMS Functionality Score:** At the same time, the reviewers assessed each app's functionality profile against criteria developed from the IMS Institute for Healthcare Informatics report on app functionalities. We assessed a total of 11 possible functionalities, consistent with prior mHealth app reviews. These were seven broad function categories: Inform (providing information resources in text, video, or pictorial form), Instruct (educating the user on tasks or skills, e.g., tutorials on brushing technique), Record (ability to gather user data – manually or via device sensors), Display (presenting recorded data or outputs in charts or visualizations), Guide (providing personalized guidance or recommendations based on data, potentially including diagnostic advice or recommendations to visit professional care), Remind/Alert (providing reminders or alerts, e.g., brushing reminders or medication reminders), and Communicate (facilitating communication or data sharing with healthcare providers or social networks). Additionally, extending Choi et al s work, the "Record" function was also divided into four sub-functions: the app's capacity to Collect Data (input and store personal health data), Share Data (export or transmit data out of the app), Evaluate Data (analyze or interpret user-input data, e.g., summarizing performance or progress), and Intervene (trigger an alert or recommendation based on the data, e.g., altering a reminder schedule if the user misses a session). For each app, it was noted whether or not each of these functionalities was available (yes/no), based on the app's

described features and our own firsthand experience. Each app was then assigned an IMS functionality score equal to the number of functionalities available (maximum score 11).

**Table 2: IMS Functionality Scoring Criteria**

Functionality Scoring Criteria	Description
1. Inform	Provides information in a variety of formats (text, photo, video)
2. Instruct	Provides instructions to the user (eg, app user guides, instructions to interpret sleep charts)
3. Record	Capture user-entered data (eg, manual sleep log, sensor-based automatic sleep log)
3.1 Collect data	Able to enter and store health data on individual phone
3.2 Share data	Able to transmit health data (eg, export, upload, email sleep data)
3.3 Evaluate data	Able to evaluate the entered health data by patient and provider, provider and administrator, or patient and caregiver
3.4 Intervene	Able to send alerts based on the data collected or propose behavioral intervention or changes (eg, smart wakeup alarm based on user sleep data, anti-snoring alerts when snoring is detected)
4. Display	Graphically display user-entered data/output user-entered data (eg, sleep trends chart)
5. Guide	Provide guidance based on user-entered information, and may further offer a diagnosis, or recommend a consultation with a physician/a course of treatment (eg, recommendations for improving sleep based on user sleep data)
6. Remind or alert	Provide reminders to the user (eg, bedtime notification)
7. Communicate	Provide communication between health care providers, patients, consumers, caregivers and/or provide links to social networks (eg, email or upload sleep data to Facebook)

Total score (0 to 11): one point is assigned to each functionality that is present.

**Data Analysis:** We tabulated the MARS scores (overall and subscale breakdown) and the functionality presence for all apps. Descriptive statistics (median, mean, range) were used to summarize the distribution of app quality scores and functionality scores across the sample of apps. We identified the top-performing apps in terms of overall MARS score and examined whether higher quality apps tended to have more functionalities. A summary table of the highest-rated apps was prepared. We also calculated the frequency (and percentage) of apps possessing each specific functionality category. All analyses were qualitative or descriptive; no hypothesis-driven statistical comparisons were performed, as the goal was to map the landscape

of app quality and features.

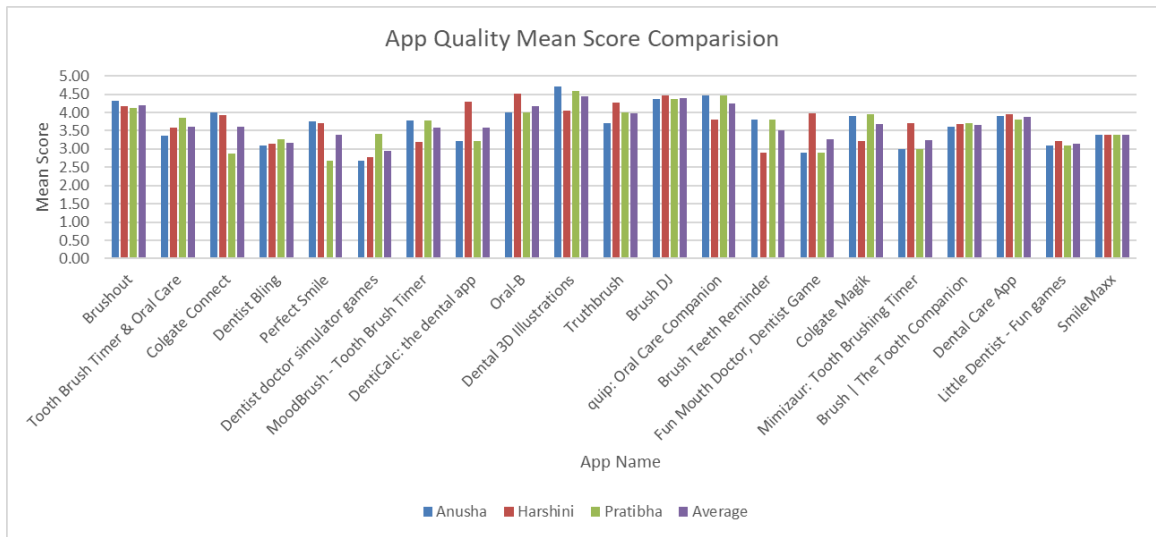


Figure 3: App Quality Mean Score Comparison

The above chart compares the overall mean quality scores of the same set of dental apps rated by all three evaluators. The scores are more consistent across raters for well-designed apps such as *Dental 3D illustrations* (4.448), *Brush DJ* (4.405), *quip: Oral Care Companion* (4.247), *Brushout* (4.196, and *Oral-B* (4.175). This analysis provides a comprehensive view of general app usability, aesthetics, information quality, and engagement from a collective perspective.

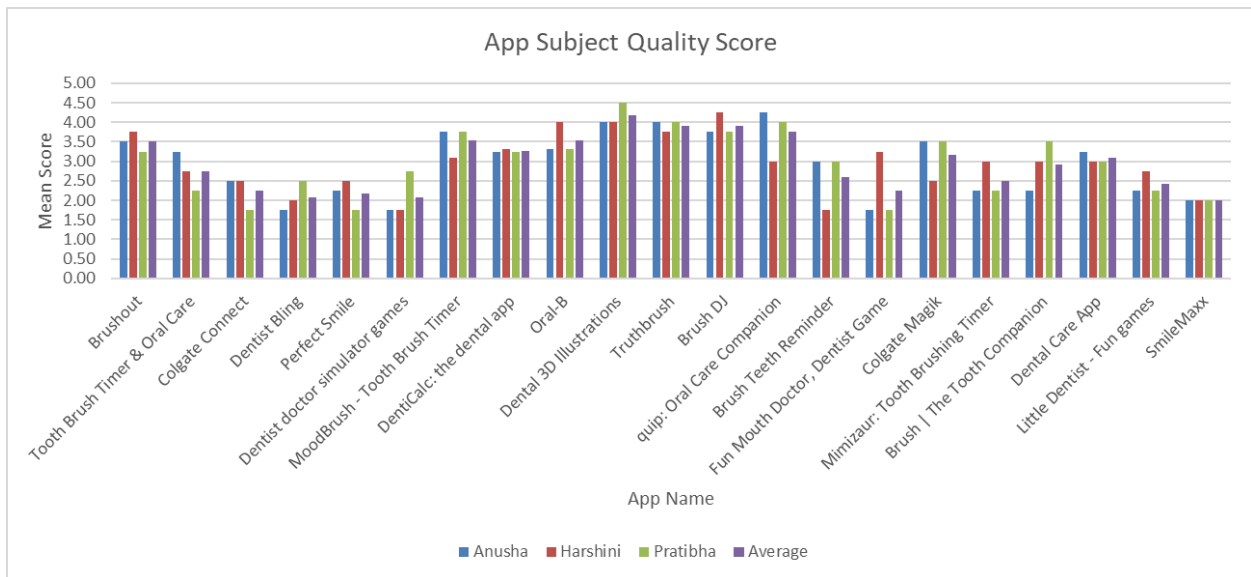


Figure 3: App Subject Quality Score

The above chart presents the subject-specific quality scores of various dental health apps as rated by Anusha, Deva, and Pratibha. It reveals variations in individual perceptions across different



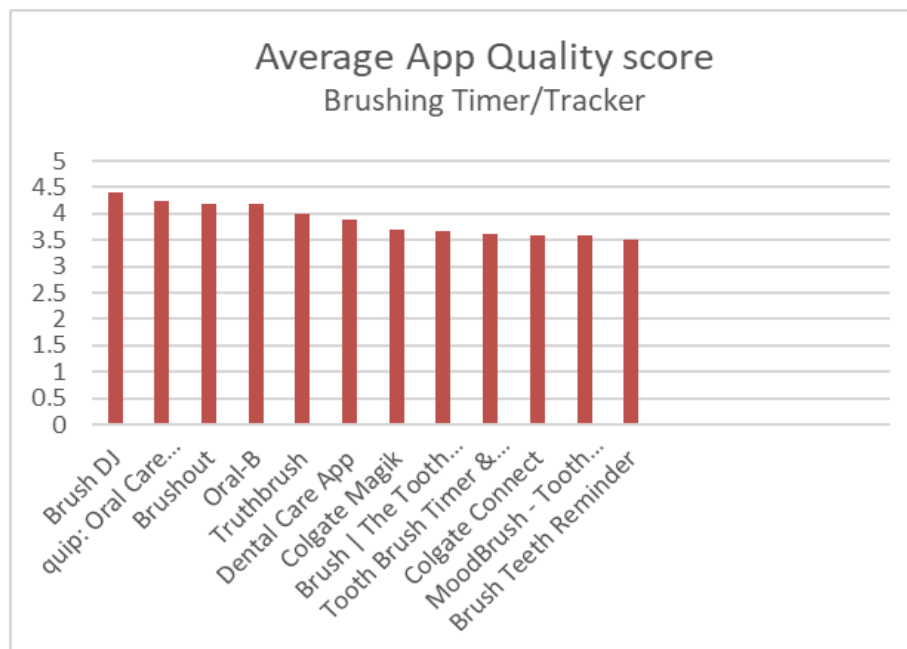
apps, with standout performers like *Dental 3D Illustrations*, *Brush DJ*, *Truth brush*, and *Quip* receiving relatively higher subject scores. The visualization helps identify which apps deliver more effective educational or functional value based on subject relevance.

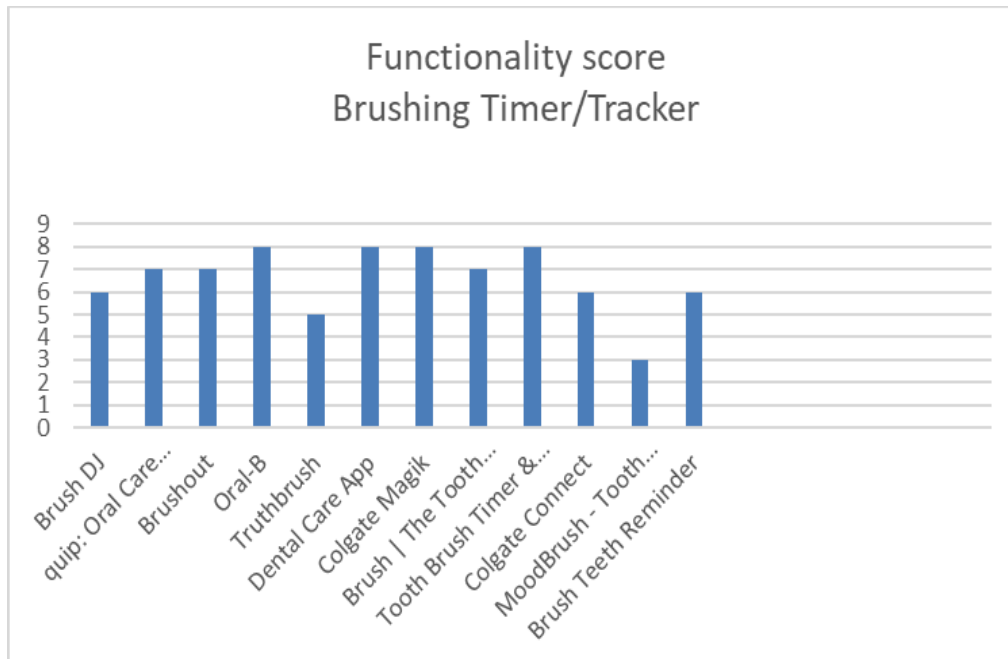
## RESULTS

**Included Apps:** The search yielded 178 unique apps following the initial filtering process (such as exclusion of obvious duplicates and removal of irrelevant apps). After applying the inclusion criteria and screening full descriptions, 21 unique apps remained to be assessed. The majority of included apps were apps for facilitating daily toothbrushing (n = 11, 52%), such as brushing timer apps and brushing habit tracker apps. A second category of apps utilized an interactive/play approach to oral health (n = 6, 29%), typically designed for children (e.g., games like virtual dentist or reward-based brushing challenge). The final category of apps was patient tracking or educational apps (n = 4, 19%), including apps for dental appointment/condition tracking, 3D tooth anatomy education, or helping patients track symptoms to share with their dentist.

### Brushing Timer / Tracker Apps

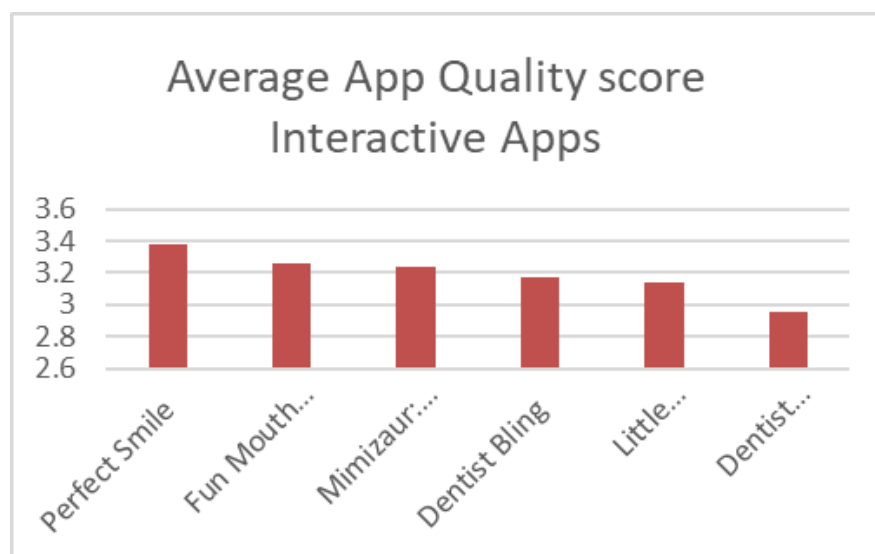
Among the brushing timer/tracker apps, **Dental 3D Illustrations** emerged as the highest-rated tool with a **MARS score of 4.45** and an **IMS functionality score of 7/11**. Its rich visual aids likely support a better understanding of brushing techniques. **Brush DJ**, with a **MARS score of 4.41** and an **IMS score of 6/11**, remains a top contender for its music-synced brushing timer that encourages habit formation. **Brushout**, scoring **4.20 on MARS** and **7/11 on IMS**, offers a clean design and intuitive features, making it a well-rounded brushing tracker.

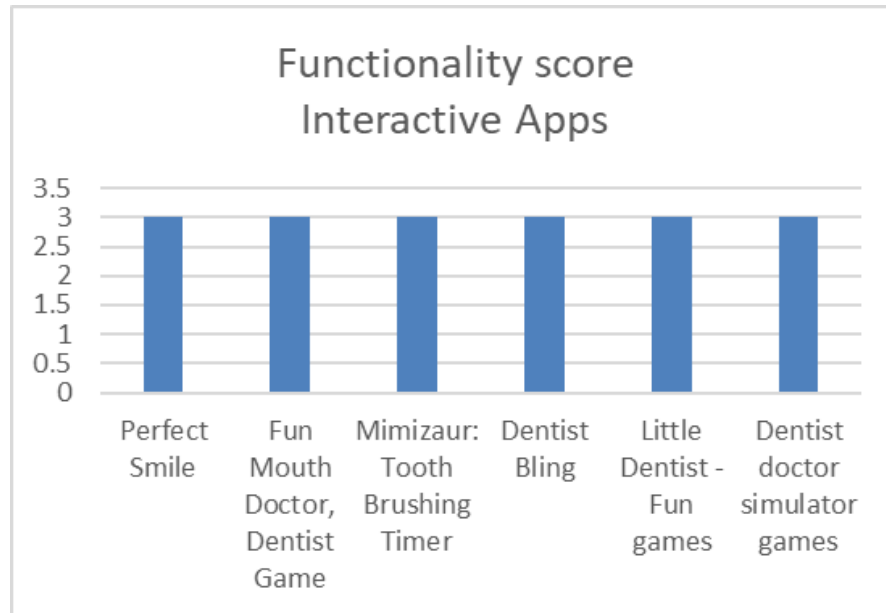




### Interactive and Gamified Apps

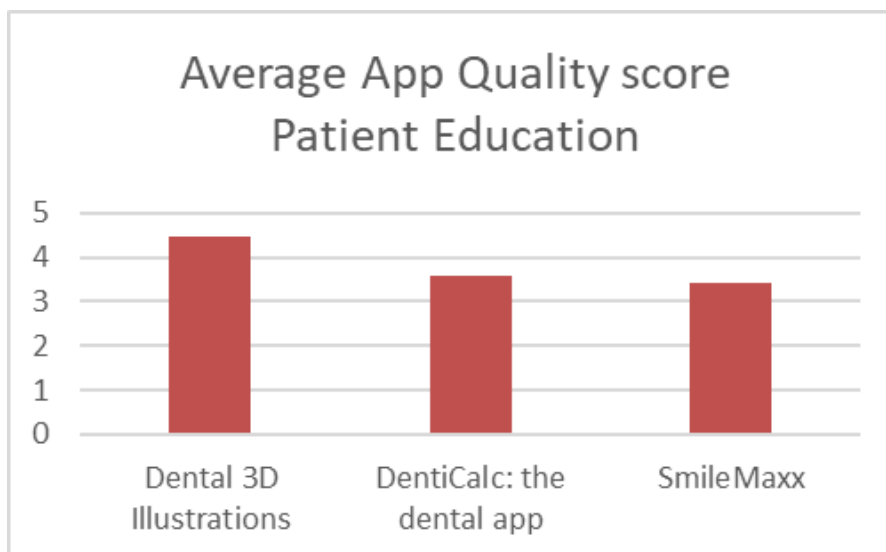
In the Interactive Category, **Quip: Oral Care Companion** led with a **MARS score of 4.25** and an **IMS score of 7/11**, offering personalized tracking and reminders in a user-friendly interface. **Colgate Magik**, known for its AR features aimed at children, earned a **MARS score of 3.69** and a high **IMS score of 8/11**, making it ideal for engaging young users in oral hygiene through gamified elements. **Brush | The Tooth Companion** followed closely with a **MARS score of 3.66** and an **IMS score of 7/11**, incorporating interactive visuals and playful themes.

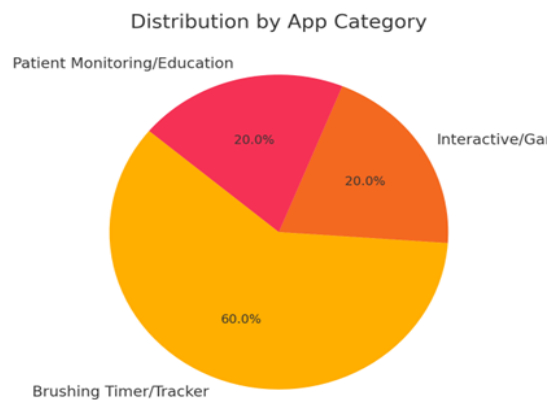
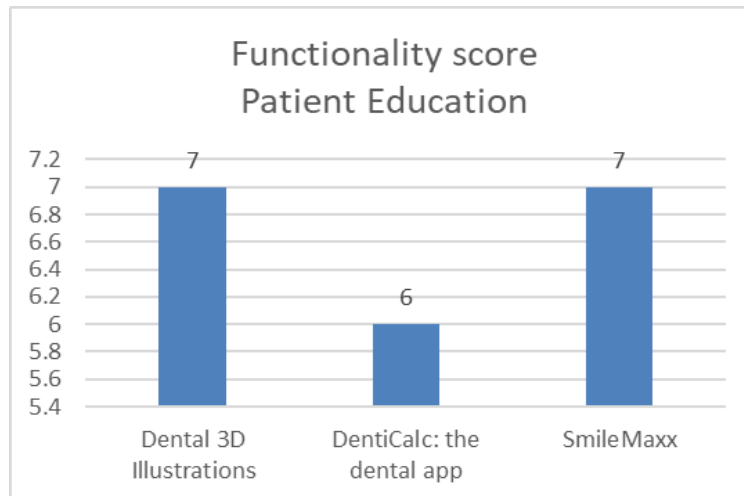




### Patient Education Apps

For Patient Education, the **Dental Care App** demonstrated the most comprehensive offering, with a **MARS score of 3.88** and a high **IMS score of 8/11**. It likely supports patient compliance through data tracking and educational resources. **SmileMaxx**, with a **MARS score of 3.40** and an **IMS score of 7/11**, provides moderate monitoring features suited for general dental care.





**Top-Ranked Apps:** The five highest-rated apps and their key attributes are summarized in **Table 1**. These top apps represent a mix of functionalities. All of them serve as brushing aids in one form or another, but they distinguish themselves by combining multiple useful features and delivering a polished user experience.

- For instance, ***Brush DJ*** (*overall MARS 4.4*) makes brushing fun by syncing to music and includes a setting for routine reminders; although it focuses on a single function (timing brushing), it executes it exceedingly well, which is reflected in its high engagement and aesthetics ratings.
- ***Dental 3D illustrations*** (*MARS 4.48*) stood out for their innovation and their rich visual aids likely support a better understanding of brushing techniques.
- Finally, the ***Quip Oral Care Companion*** (*MARS 4.2*) provided a solid all-around experience with brushing timers, tracking of habits, and refill reminders for brush heads.

- The ***Oral-B app (MARS 4.1)*** integrates with a smart toothbrush to record brushing frequency and technique; it provides real-time feedback, educational content, and progress tracking, resulting in both a high functionality score (8/11) and strong information content.
- ***Brushout (MARS 4.1)*** offers an appealing combination of a visual timer, brushing tutorials, and customization options (such as different theme characters for kids), which helped it score highly on engagement.

These top apps all had above-average **IMS functionality scores** (ranging 7–8 out of 11), indicating they tend to incorporate a breadth of features (e.g., combining information, instruction, tracking, and reminder capabilities). Notably, however, even the best dental apps did not implement the full spectrum of possible functions (none scored above 8/11 on our functionality index), often missing advanced features like direct dentist communication or fully adaptive intervention algorithms.

**Table 3: Highest-rated dental health apps (top 5 by overall MARS score).**

Rank	App Name	Primary App Purpose	Overall Mars Score (±SD)	IMS Functionality Score <sup>1</sup>
1	<b>Dental 3D illustrations</b>	Patient monitoring with visuals	4.45	7/11
2	<b>Brush DJ</b>	Brushing timer with music engagement (gamified)	4.4	6/11
3	<b>quip: Oral Care</b>	Oral hygiene tracker with reminders (adult-focused)	4.25	8/11
4	<b>Oral-B</b>	Guided tooth brushing timer and oral care tips	4.1	7/11
5	<b>Brushout</b>	Interactive brushing game with a visual timer	4.1	8/11

<sup>1</sup> *IMS functionality score reflects how many of 11 possible app functionalities are present (Inform, Instruct, Record data, Display data, Guide, Remind, Communicate, plus sub functions for data collection, sharing, evaluation, intervention).*

**Functionality Analysis:** Using the IMS Institute criteria, we found considerable variability in the features offered by dental apps. The apps had an average of 5.6 out of 11 possible functionalities on our scale. The **median number of functionalities was 6**, indicating that most apps provide a moderate range of functions. Figure 1 illustrates the distribution of functionality categories among the apps. Some basic functionalities were nearly universal: all 21 apps (100%) could **display** information or user data in some form, for example, showing a timer countdown, a chart of brushing history, or game graphics (Display). Similarly, 20 apps (95%) included an **informational** component, such as textual tips, FAQ sections, or educational videos on oral care (Inform). A majority of apps (62%) actively **instructed** users, meaning they offered guidance or step-by-step instructions (for instance, apps that guide proper brushing technique or gamify brushing steps provided instruction; Instruct). Also, about two-thirds of the apps (67%) had a **record** function, i.e., they captured some user data (Record); this was usually brushing activity data (like logging when a brushing session occurred or how long it lasted). In many cases, this data entry was automatic (through a connected toothbrush sensor) or semi-automatic (pressing a button to log a completed task). However, only 57% of apps explicitly allowed the user to **collect** and save data in a log (Collect Data), indicating that some timer apps do not store past activity once the session is over.

More advanced data handling was relatively uncommon. Only 6 apps (28%) could **evaluate data** by analyzing user inputs – for example, summarizing oral hygiene patterns over time or providing feedback based on performance. Correspondingly, just 6 apps (28%) had an **intervention** function wherein the app would issue a tailored alert or recommendation triggered by the collected data. One such example of an intervention is an app adjusting the frequency of reminder notifications if a user repeatedly misses brush times (this was observed in a couple of habit-tracking apps). Another example is a smart toothbrush app that flags areas of the mouth that were missed and advises the user to re-brush those spots, thereby intervening in the user's routine. These kinds of proactive, data-driven interventions were the exception rather than the norm in our sample.

Communication features were similarly scarce. Only 4 apps (19%) offered any form of **communication/share** functionality. Those that did typically enabled sharing one's brushing progress with others, for instance, posting a trophy to social media or emailing a summary of your hygiene report to a dentist or parent. No app provided real-time direct communication with dental professionals, and none had a built-in community forum or support group function. This is an area where dental apps lag behind some other health apps that facilitate patient-provider connectivity. The lack of communication features in most dental apps suggests they are designed primarily for self-management in isolation, without integrating into broader healthcare networks or social support systems.

On a positive note, **reminder/alert** capability was present in 9 apps (43%). These apps allowed users to set up reminders – most commonly, push notifications to prompt twice-daily brushing,

rinse reminders, or alerts for dental appointments or replacing a toothbrush. Reminders are a straightforward yet important feature for behavior change, and nearly half of the apps recognized this by including some alert system. Additionally, about 8 apps (38%) provided personalized **guidance** (Guide). Guidance here refers to interpreting user data or status and giving user-specific advice. For example, an app might suggest, “You’ve brushed for 7 days straight, great job – consider flossing next for even better results,” or in a child’s game, adapt the difficulty based on the child’s progress. While not many apps achieved true personalization, those that did often impressed in our evaluation, as guidance can significantly enhance an app’s relevance to the user.

A detailed breakdown of the prevalence of each functionality in the 21 apps is shown below in **Table 2**. This distribution highlights that while basic functions (informing, recording, reminding) are common, relatively few apps implement sharing, data evaluation, or communication features. None of the evaluated dental apps performed *all* of the functions in this list. The maximum functionality score observed was 8/11, achieved by four apps (including Oral-B, Colgate Magik, Toothy, and one other), but even these did not incorporate certain capabilities (for instance, most lacked a direct communication channel or a sophisticated intervention algorithm). In contrast, prior research on apps for other health domains (such as sleep tracking) found some apps reaching a maximum of 11 functionalities, underlining a gap in feature richness for the current generation of dental apps.

**Table 2. Prevalence of functionalities among included dental apps (N = 21)**

<b>Functionality (IMS category)</b>	<b>Number of Apps (%) with this Feature</b>	<b>Examples / Notes</b>
<b>Inform (provide info content)</b>	20 (95%)	e.g., oral health tips, educational info
<b>Instruct (user guidance)</b>	13 (62%)	e.g., step-by-step brushing instructions
<b>Record (capture user data)</b>	14 (67%)	Any form of data logging present
<b>Collect data</b>	12 (57%)	The user can input, or the app automatically logs data

<b>Share data</b>	4 (19%)	The user can export or share data externally
<b>Evaluate data</b>	6 (28%)	App analyzes/interprets user data
<b>Intervene</b>	6 (28%)	App triggers alerts/advice based on data
<b>Display (visualize data)</b>	21 (100%)	Graphical display of progress or info
<b>Guide (personalized guidance)</b>	8 (38%)	Advice or decision support for the user
<b>Remind/Alert (notifications)</b>	9 (43%)	Scheduling reminders or alerts
<b>Communicate (social/professional sharing)</b>	4 (19%)	Connect with peers or providers

*(Note: “Record” is counted if an app has any data collection ability, while the sub-categories 3.1–3.4 detail specific aspects of data handling. “Communicate” includes any social sharing or provider communication feature.)*

In summary, our functionality analysis suggests that most dental self-management apps emphasize **information delivery, basic logging, and reminding**, but very few incorporate deeper interactivity like data-driven feedback or connectivity. This indicates a potential opportunity for future apps to expand their feature sets. For instance, adding even simple data evaluation (like weekly summaries of brushing frequency) and sharing functions could enhance the utility of these apps for users and possibly for their dentists or caregivers.



Which brushing time tracker or dental app should I choose?

#### Brushing Time Trackers

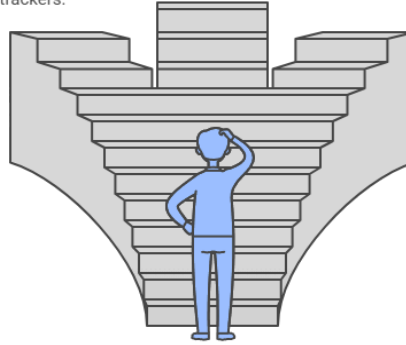
Ideal for those who want to improve their brushing habits with timers and trackers.

#### Interactive Dental Games

Suitable for users who prefer a fun and engaging way to learn about dental care.

#### Patient Monitoring Apps

Best for users who need comprehensive dental health monitoring.



## Discussion

This study reviewed 21 mobile dental apps and concluded that there is vast diversity concerning function and quality. Our study's median MARS score was 3.3/5 and indicates that most apps function fairly well in easy functions like timers and reminders, but are lacking in advanced functions such as customization, feedback, and connectivity with health practitioners. This finding is in line with past studies in the mHealth community. For instance, *Diaz-Skeete et al. (2021)*, in their evaluation of apps for older adults with heart failure, found that even though many apps offered simple tracking capabilities, they fell short when it came to providing personalized feedback and linking individuals with healthcare professionals. Similarly, *Choi et al. (2018)* discovered that while sleep apps were promising, they lacked the essential features of integration with healthcare professionals and feedback that is personalized feedback. Our study also noticed the same gaps in dental apps, where personalization and communication with dentists were glaringly absent.

*Sharif and Alkadhimi (2019)* also noted that many oral health apps lacked comprehensive educational content, particularly on critical topics like gum health, diet, and smoking, which are key to preventing oral diseases. Our study corroborates these findings, revealing that while most dental apps provided basic information about oral hygiene, many failed to address these crucial topics comprehensively. This highlights the need for app developers to collaborate with dental professionals to integrate scientifically-backed content that goes beyond surface-level advice.

In terms of functionality, while basic features such as brushing timers, habit trackers, and reminders were common, our study found a clear lack of personalized guidance. Only 28% of the apps provided personalized feedback based on user data, consistent with *Sharif and Alkadhimi*

(2019), who found a similar gap in personalization. Personalized features, such as adaptive feedback and data-driven suggestions, are critical for enhancing user engagement and promoting long-term behavior change, as emphasized by *Choi et al. (2018)*. Incorporating these features could make dental apps more effective in fostering lasting oral health practices.

As a matter of the most significant quality of information, our study found that the majority of the apps offered general oral health information but failed to cover important topics like gum health, diet, and tobacco use. This omission significantly corresponds with *Brooks et al. (2018)*, who pointed out that the success of health applications does not only depend on their functionality but also on how much and how valid the information offered is. Future dental apps need to target using evidence-based content and align with dental professionals to ensure that the content is accurate and current.

User interaction was another area where dental apps fell short. While most of the apps contained reminders and timers, very few apps contained social features or supported communication with the healthcare system. Lack of social support and linkage with the healthcare system limits the ability of the apps to sustain long-term behavior change. *Choi et al. (2018)* and *Chen et al. (2021)* suggested the importance of social sharing and accountability features in increasing user engagement and long-term adherence to health behavior. Features that allow the sharing of progress or seeking consultations from healthcare experts can increase motivation and ultimately improve health outcomes.

The usability of dental apps also varied significantly. While many apps were easy to navigate, several suffered from cluttered interfaces or poor design choices that hindered the user experience. This is consistent with *Sharif and Alkadhimi (2019)*, who also noted usability issues in oral hygiene apps, such as complicated interfaces that made them less accessible. Improving design through user-centered principles and conducting usability testing could enhance user satisfaction and retention.

Furthermore, *Väyrynen et al. (2021)*, in their review of mobile apps for oral health, pointed out that while dental apps provide useful features like brushing timers, they often lack comprehensive tools for managing and preventing more serious oral health conditions. Their study emphasizes that dental apps need to integrate not only basic reminders and education but also advanced features like personalized tracking and healthcare provider communication to improve users' oral health effectively. This aligns with our findings, where we identified the need for apps to go beyond basic functions and include features that offer personalized advice, track oral hygiene progress, and enable communication with dental professionals.

Lastly, our study underscores the need for advanced features beyond basic tracking and reminders. Few apps incorporated features like progress tracking, adaptive feedback, or real-time interventions based on user behavior. This is consistent with *Chen et al. (2021)*, who found that

only a few dental apps included advanced features like data evaluation and adaptive feedback. Incorporating such features could provide users with a more personalized and engaging experience, helping them improve their oral health behaviors more effectively.

Our study's findings align with *Ventola (2014)*, who highlights the role of mobile devices in healthcare, particularly in improving communication, providing real-time access to data, and supporting decision-making. This is relevant to dentistry, where mobile apps can assist in managing patient records and enhancing communication. However, *Ventola (2014)* also notes the lack of validated, evidence-based content and personalized features in healthcare apps, a gap that we found in many dental apps as well.

*Ventola (2014)* further discusses healthcare professionals' reluctance to adopt new technologies due to concerns over integration and validation. This hesitation may explain the absence of advanced features in many dental apps, such as real-time tracking, personalized feedback, and integration with dental providers, all crucial for improving patient outcomes. Overcoming these barriers will allow dental app developers to create more effective tools for both professionals and patients.

Our study aligns with *Pascadopoli et al. (2023)*, who found that many dental apps provide basic features like timers and reminders but lack advanced functionalities such as personalized feedback and integration with healthcare providers. This gap is evident in our study, where only 28% of apps offered personalized feedback. The *Pascadopoli et al. (2023)* review also highlighted the need for evidence-based content, which our findings corroborate, as many apps failed to address critical topics like gum health and diet. Additionally, both studies emphasize the importance of incorporating social features and real-time feedback to enhance user engagement and promote sustained oral health behavior change.

In conclusion, while many of the dental apps we evaluated provided basic functions like timers and reminders, substantial room for improvement exists in terms of content quality, personalization, and user engagement. Future dental apps should focus on integrating evidence-based, expert-reviewed content, offering personalized feedback based on user data, and incorporating social features and communication tools to improve engagement. Additionally, incorporating advanced features like adaptive feedback and real-time interventions would significantly enhance the effectiveness of these apps in promoting long-term oral health behaviors. By addressing these gaps, developers can create more effective, evidence-based tools that improve oral health outcomes.

### **Strengths and Limitations**

This study provides an up-to-date evaluation of dental health apps using validated rating instruments, offering insights into both user-perceived quality and technical capabilities. A strength of our approach is the systematic coverage of apps across two major platforms and the

use of multiple raters to enhance objectivity in scoring. By applying the MARS tool, we ensured a comprehensive assessment of app quality facets, and by using the IMS functionality framework, we could directly compare our findings with those from other app reviews (like the sleep app study) that used the same criteria. The combination of these assessments in a single study is relatively novel in the dental app space and contributes to the literature by identifying not just how good apps are, but exactly in what ways they are lacking or excelling.

However, several limitations must be acknowledged.

- First, the app market is rapidly evolving. App availability and features can change with updates, and new apps may have emerged. We attempted to mitigate this by choosing popular and well-reviewed apps at the time, but the list is not exhaustive. Second, our search strategy, while broad, may have missed some relevant apps, especially those not explicitly labeled with obvious keywords.
- We also limited to English-language apps, so our results may not generalize to apps in other languages or regions that could offer different features. Third, the MARS evaluation, although standardized, is ultimately a subjective process.
- We tried to minimize bias by using three independent reviewers and resolving differences, but some degree of subjectivity in what is considered “engaging” or “informative” is unavoidable. Moreover, MARS gives equal weight to each domain; depending on a user’s priorities (e.g., a user might value information over entertainment), our “overall” scores might not align with every user’s perspective of what makes an app good.

Additionally, the IMS functionality scoring we used treats each functionality as present or absent with equal weight. In practice, certain functionalities might be more important than others for improving health outcomes. For example, a reminder (alert) function might be more crucial for promoting daily behavior than a communication function, but our scoring does not differentiate importance. We also noted some ambiguities in categorizing functionalities for dental apps – e.g., what qualifies as a true “intervention” can be debatable. We relied on the definitions from prior work *Choi et al., 2018*, but future studies might refine these criteria for specific domains like dentistry. Lastly, we did not directly evaluate the effectiveness of these apps in changing oral health behavior or outcomes. An app might score well on MARS yet still fail to help users improve their brushing habits (or vice versa). Our study was an **app-centric evaluation** (focus on design and features), not an **outcome study**. We recommend that follow-up research test the impact of top-rated dental apps in real user populations (for example, do children who use a brushing game have better plaque indices after several weeks than those who don’t?).

## **Recommendations for App Developers and Stakeholders**

Our findings lead to several actionable recommendations for developers of mobile dental applications and related stakeholders:

- **Incorporate Evidence-Based Content:** Developers should engage dental professionals or reference clinical guidelines to ensure the information in apps is accurate and comprehensive. Important topics like gum disease prevention, the role of diet in oral health, and proper use of fluoride should be covered in educational sections. Currently, many apps omit such content or provide unverified tips. Including an expert-reviewed oral health FAQ or leveraging content from trusted sources (ADA, CDC, etc.) could greatly enhance the information quality scores and user trust.
- **Enhance User Engagement Thoughtfully:** While some apps successfully use gamification (points, animations, music) to engage users, these elements should be balanced with educational value. Introducing simple games or reward systems (e.g., unlocking badges for consistent brushing or a progress avatar that “grows” with good habits) can motivate users, especially children, to return to the app regularly. However, engagement is not just about fun graphics; personalization can also boost engagement. For instance, allowing the app to tailor its messaging (“Good job, you’ve improved this week!”) or adjust difficulty can make the experience feel more rewarding and less monotonous.
- **Expand Functionality to Promote Behavior Change:** Developers could differentiate their apps by adding functionalities that many current apps lack. For example, **progress tracking** with visual trends can help users see their improvement (or identify lapses), which is a known motivator. Only around half the apps we reviewed kept historical records. Even a simple calendar log of when the user brushed or flossed can reinforce the routine. Another feature is **personalized feedback** – if an app detects the user hasn’t flossed in several days, it could suggest focusing on flossing, or if a smart brush reports always missing a certain tooth quadrant, the app could alert the user or provide a tip specifically for that. These kinds of feedback loops make the app more of a “coach” than just a timer.
- **Integrate Communication Features Cautiously:** Given the low adoption of communication functions in current apps, adding the ability to share data or communicate could be a competitive advantage. For example, an app might generate a summary report of the user’s brushing habits that can be shared with their dentist or orthodontist before an appointment. This could facilitate more personalized discussions during visits (“I see you often skip night brushing on weekends, let’s talk about why”). Even peer support could be beneficial – perhaps a family of users could sync their apps and have a friendly competition or reminders for each other. Of course, implementing such features requires careful attention to privacy and data security (sharing should always be user-initiated and compliant with health data protection standards). Developers should ensure that any data

transmission is encrypted and transparent to the user.

- **Usability and Design:** Although many apps fared well in basic usability, there were instances of cluttered interfaces or technical hiccups (some user reviews we noted complained of crashes or confusing menus in certain apps, which also reflected in lower MARS functionality scores for those apps). Following established **user-centered design principles** and conducting usability testing with target users (including children for pediatric-oriented apps) can catch these issues. Simple design improvements like larger touch targets for buttons (for kids or older adults), high-contrast text for readability, and an intuitive layout of features can significantly impact user satisfaction. Since our study and others have pointed out that aesthetics and engagement often lag behind functionality in scores, investing in professional graphic design and a more engaging user interface could pay dividends in setting an app apart.
- **Validation and Efficacy:** Finally, we recommend that app developers collaborate with researchers or public health entities to formally evaluate their apps' impact on oral health outcomes. This goes beyond our study's scope, but it is worth noting: an app that genuinely helps improve users' brushing frequency or technique could be of great value to dental professionals and health systems. Conversely, apps that are not effective (or worse, provide misinformation) could be harmless entertainment at best or counterproductive at worst. Publishing studies or at least gathering user data on outcomes (with consent) would allow developers to iterate and improve the app's behavior change strategies.

## CONCLUSION

Mobile dental apps represent a promising aid for improving oral hygiene and patient engagement in dental care, but our evaluation indicates that current offerings have significant room for growth. The typical app provides basic functions like timers and tips, which users do find helpful, but misses opportunities to leverage personalization, data analytics, and connectivity. By learning from successes in other mHealth domains and heeding the shortcomings identified in this review, developers can create the next generation of dental apps that are not only fun or novel to use but also substantively help users achieve better oral health outcomes. For end-users and dental practitioners, being aware of the strengths and limitations of existing apps (as identified by standardized measures like MARS) can guide the selection of the most suitable app for one's needs. In the meantime, stakeholders such as dental associations could play a role in curating or even certifying high-quality apps to encourage their use as adjuncts to professional care. Ultimately, well-designed mobile apps, grounded in behavior change theory and dental

science, could become a valuable component of preventive dentistry – helping to instill good oral hygiene habits between visits and empowering patients in their oral health self-management.

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