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Quality Evaluating Mobile Health Apps for Oral Hygiene Management Using the Mobile Application Rating Scale (MARS): A Systematic Review of Smartphone App Markets

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Abstract

Background: Mobile health applications provide a valuable tool for promoting oral hygiene self-care and preventing conditions, such as gingivitis and dental caries. This review aimed to systematically evaluate mobile applications designed for oral hygiene across all age groups, assessing their quality using the Mobile App Rating Scale.

Methods: A systematic search was conducted in the Apple App Store and Google Play Store to identify mobile applications focused on oral hygiene. Two independent reviewers assessed the quality of the selected apps using the mobile app rating scale. Additionally, the relationships between mobile app rating scale scores, app-specific dimensions, Apple App Store user ratings, and the last update date were analyzed using Pearson and Spearman correlation coefficients.

Results: A total of 21 oral hygiene-related applications were included in the review. The overall mean mobile app rating scale score was 2.48 (SD = 0.77), with scores ranging from 1.2 to 3.9. The reviewed apps were generally of poor quality. The highest-rated mobile app rating scale dimension was information (mean = 2.59, SD = 0.62), followed by functionality, engagement, and aesthetics. Pearson correlation analysis revealed a strong association between the functionality and information dimensions of the mobile app rating scale with app-specific dimensions.

Conclusion: The overall quality of mobile health applications for oral hygiene was suboptimal, with few apps meeting established quality and content standards. Many lacked access to evidence-based information, which is crucial for promoting effective oral hygiene practices. To enhance user trust and improve health outcomes, developers should adhere to evidence-based guidelines and best practices in app design and development.

Keywords: Oral health, Oral hygiene, Evidence-based, Toothbrushing, Health Education

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Introduction

Oral diseases, such as dental caries, periodontal disease, and oral cancer, affect nearly 3.9 billion people globally, causing pain, infection, and tooth loss, especially in vulnerable groups (1-7). These conditions reduce quality of life and cost $442 billion annually (3, 4). Risk factors include socioeconomic status (SES), poor oral hygiene, diet, dental visits, hormonal changes, plaque, systemic diseases, and stress (7, 8). Empowering individuals through effective self-care is crucial for prevention (9).

The rise of smartphones enables mobile health (mHealth)

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↑What is "already known" in this topic:
Oral diseases are common and reduce the quality of life. mHealth apps can improve oral hygiene; nonetheless, most lack evidence-based content, user-centered design, and comprehensive quality evaluation. Previous studies focused mainly on children or specific conditions.

→What this article adds:
This study's systematic review reveals significant gaps in app quality, including a lack of evidence-based content, low user engagement, and insufficient usability. Additionally, the study offers a practical, multidimensional framework to guide future app development to improve user adherence in health digital interventions.

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applications to provide scalable, cost-effective education with interactive, multimedia-based content, real-time monitoring, and personalized feedback (10-14). These tools address limitations of traditional clinic-based education, which can be time-consuming, costly, and less accessible (5). mHealth literacy refers to the ability to find, understand, and effectively utilize necessary health information through digital tools, such as smartphones and mobile apps. It varies by age, education, cognitive skills, digital experience, and health knowledge (15, 16). Older adults often have lower mHealth literacy due to sensory and digital limitations, while children and adolescents have strong digital skills but may struggle to evaluate health information (17).

By 2021, the global number of smartphone users had reached 6.6 billion, with many health apps promoting oral hygiene, particularly for children and orthodontic patients (5, 18, 19). Systematic reviews indicate that mHealth interventions can enhance brushing, reduce plaque, and prevent gingivitis (20-30). Apps that utilize gamification, behavioral prompts, and parental involvement have been shown to enhance oral hygiene behaviors (31). Many oral hygiene apps lack user-centered design (UCD), evidence-based content, and thorough quality evaluations, failing to meet user needs. This highlights the need for a systematic assessment using standardized tools, as key features such as graphical interfaces, navigation, reminders, and credible information vary. Involving users and applying UCD, usability, and user experience (UX) are essential for apps' effectiveness and adherence (32-34).

This study uses the Mobile App Rating Scale (MARS), a standardized tool, to assess the quality, engagement, functionality, and information credibility of oral hygiene apps (13). Unlike prior research focused mainly on children (19, 35, 36) or specific conditions (5), this study evaluates apps for oral hygiene self-care across all age groups. Previous evaluations addressed specific markets (37), information accuracy (12), and usability in limited groups (38), but overall app quality and effectiveness remain underexplored. This systematic review uses the MARS tool to evaluate oral hygiene mHealth apps, examining app features and quality across core domains. We identify common strengths and weaknesses and propose practical recommendations to guide the development of effective, evidence-based applications.

Methods

This systematic review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (39) and involved 4 steps: app identification, selection, quality evaluation, and data analysis.

Search Strategy and Eligibility Criteria

On September 22, 2024, a comprehensive search was conducted in the Apple App Store and Google Play Store for English-language mobile apps focused on oral hygiene across all ages. Search terms included "Oral health," "Oral hygiene," "Oral and dental hygiene," "Dental hygiene," and "Dental health," and Medical Subject Headings (MeSH) related keywords. Each keyword was entered separately without Boolean operators, as these app stores do not support advanced search syntax. These platforms were selected due to their dominance in the global app market and their status as the most widely used commercial app stores (13, 40).

Only free apps compatible with Android or iOS were included. Excluded were apps developed for dental professionals, e-commerce platforms, those focused solely on orthodontics or implants, unrelated to oral hygiene education, designed for oral cancer diagnosis or treatment, requiring login or toothbrush connectivity, nonfunctional, or targeting seminars, exams, or dental literature.

Apps Selection and Data Extraction

Two reviewers (K.H.D. and N.A.S.) independently screened app names/descriptions, removed duplicates, and evaluated eligible apps. Data were extracted into a standardized Excel sheet (version 2016) containing app metadata, such as name, platform, developer, country of origin, target age group, update date, user rating, number of installs (for Android only), cost, category, and language. All stages of identification and evaluation were conducted independently by 2 researchers. Disagreements were resolved through discussion or, if necessary, by a third reviewer.

Quality Evaluation

App quality was evaluated using the validated MARS tool (41), covering engagement, functionality, aesthetics, information quality, along with subjective impressions and potential impact of health behaviors. Two trained health information technology experts independently rated each app after at least 30 minutes of use; a third reviewer resolved disagreements. Ratings were recorded in Excel for analysis.

Data Analysis

MARS items were rated on a 5-point Likert scale (1 = inadequate to 5 = excellent), excluding not applicable items from the mean. Overall MARS scores were the average of rated items and classified as unsuitable (1–2), poor (2–3), acceptable (3–4), good (4–5), or excellent (5) (42). Quantitative data were expressed as mean ± SD; categorical data as frequencies and percentages.

Pearson or Spearman correlations assessed relationships between MARS subscales, app-specific impact, user star ratings (Apple only), and update dates, with normality tested via the Shapiro-Wilk test (43). A Bonferroni correction was applied to reduce the risk of type I error from multiple tests. Apps lacking user ratings or update history were excluded. Analyses were conducted using SPSS Version 24, with a significance level set at $P \leq 0.0028$. The interpretation of the correlation coefficient was as follows (44):

- 0.00–0.10: Negligible correlation
- 0.10–0.39: Weak correlation
- 0.40–0.69: Moderate correlation
- 0.70–0.89: Strong correlation
- 0.90–1.00: Robust correlation

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Results

This section presents the key findings of the study, structured according to the research objectives:

- (O1): App Selection and Basic Information of Included Apps
- (O2): Features of Oral Hygiene Applications
- (O3): Quality Evaluation of Mobile-Based Apps for Oral Hygiene

Apps Selection and Basic Information of Included Apps (O1)

Out of 606 initially identified apps (434 from the Apple App Store and 172 from Google Play Store), 579 remained after duplicates were removed. After excluding 429 unrelated apps, 150 were downloaded and assessed, with 129 excluded based on eligibility criteria. When both professional and free versions existed, the free version was evaluated. Finally, 21 apps met the inclusion criteria and were analyzed. The selection process is illustrated in Figure 1.

Table 1 presents general details of the 21 included oral hygiene apps. Six were exclusive to the Apple App Store, 3 to the Google Play Store, and 12 were available on both platforms. In the Apple App Store, 67% (14/21) of apps had ratings of 4 stars or higher. Moreover, 80% (17/21) of apps had been updated within the past 2 years. The top-rated apps in the Apple App Store were Oral Hygiene Coach, Otis Dental, and Brush the Tooth Companion, each with a 5-star rating. The lowest-rated apps were Text2floss (Apple) and Philips Sonicare for Kids and Chomper Chums (Google Play).

Installation data was only available for Google Play apps, with Oral-B having over 5 million downloads and Otis Dental having the fewest downloads. All 21 apps were free, though five offered in-app purchases. About 52% were English-only, and 43% supported multiple languages. Most apps fell into Health and Fitness (85.7%), followed by Education (9.5%) and Medical (4.8%). About 62% (13/21) of apps targeted all ages. Four apps were designed for users aged 12 and older, while four focused on children under 12, divided into specific age groups: 2 for children under 5 years, 1 for 6– to 8–year–olds, and one for 4– to 11–year–olds.

All 21 apps targeted oral health and well-being; 14% (3/21) featured entertainment, 57% supported behavior change, 67% included goal-setting mechanisms, 71% provided educational content, 52% included assessment tools, and 48% offered personalized feedback. Most apps (67%) had no affiliations; 14% were university-linked, 9.5% were connected to commercial organizations, one app was linked to a non-governmental organization, and only Brush DJ was government-affiliated, having been approved by the UK National Health Service (NHS). Approximately 52% (11/21) of apps provided reminders for brushing, dental visits, and toothbrush replacement; 19% required login and password protection.

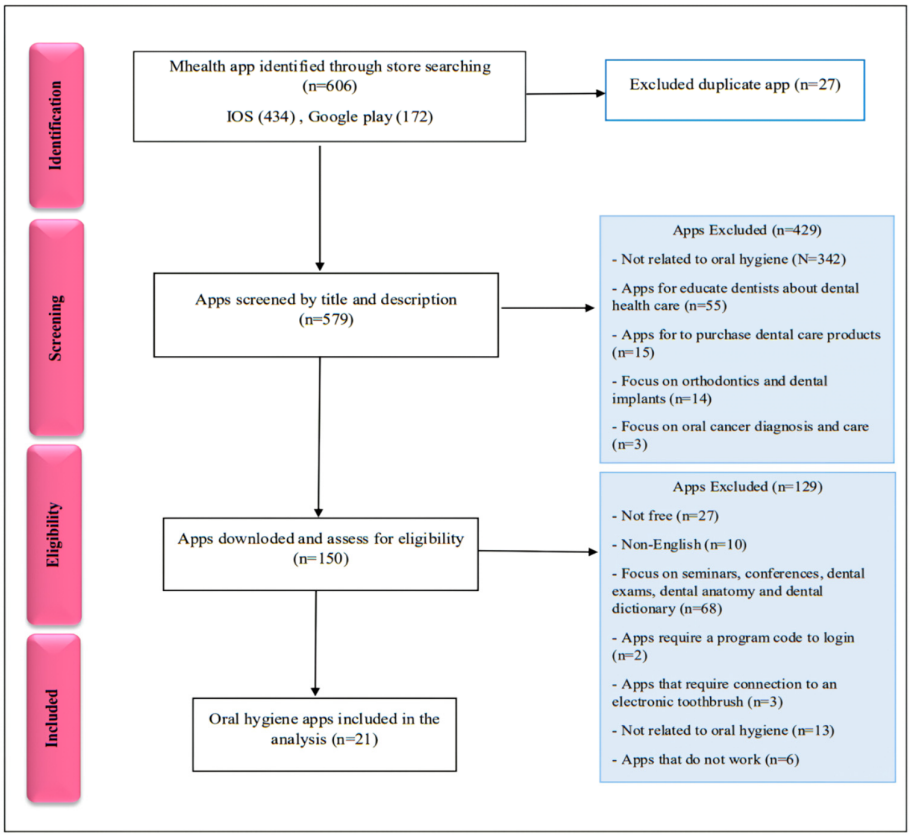

Figure 1. Flow diagram of the app selection process

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Table 1. General information on selected oral hygiene apps

App name	Developer	Country of origin	Target Age Group	Last Update	Operating system	Star Rating (out of 5)		Number of installs a	Cost	Category	Languages
						IOS	Android				
Oral hygiene coach	Reev Tech Inc	United States (USA)	Adolescents, Young Adults, Adults (≥12)	2019	IOS	5 Highest	N/R[b]	N/R	Free	Health & Fitness	English
Brush | The Tooth Companion	Colby Mehmen	N/R	All ages (≥4)	2023	IOS	5 Highest	N/R	N/R	Free (In-App Purchases)	Health & Fitness	English
Text2floss	Global Smile Health	USA	All ages (≥4)	2021	IOS	3.7 Lowest	N/R	N/R	Free	Health & Fitness	Multiple
Brushout	Alexandr Moscaliuc	USA	All ages (≥4)	2024	IOS	4.8	N/R	N/R	Free (In-App Purchases)	Health & Fitness	Multiple
Toothbrushing daily guide	Lucas Yamashita	Canada	All ages (≥4)	N/R	IOS	N/R	N/R	N/R	Free (In-App Purchases)	Health & Fitness	English
QBrush	Quigless Innovations	USA	Young Adults, Adults (≥17)	2021	IOS	N/R	N/R	N/R	Free	Health & Fitness	English
Teeth brushing and reminders	Alex Mit	Chisinau, Moldova	All ages (≥4)	2023	Android	N/R	N/R	10.000	Free	Education	English
Teeth brushing timer	Teia Martynenko	Ukraine	All ages (≥4)	2024	Android	N/R	N/R	1000	Free	Health & Fitness	English
Brush teeth reminder	Typers	Türkiye	All ages (≥4)	2024	Android	N/R	4.2	100.000	Free	Health & Fitness	English
Otis dental	Brash Inc	San Francisco, USA	Adolescents, Young Adults, Adults (≥12)	2023	IOS / Android	5 Highest	N/R	10 Lowest	Free	Health & Fitness	English
Quip: oral care companion	quip NYC	Brooklyn, USA	Adolescents, Young Adults, Adults (≥13)	2024	IOS / Android	4.8	N/R[b]	10.000	Free	Health & Fitness	English

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Table 1. General information on selected oral hygiene apps

App name	Developer	Country of origin	Target Age Group	Last Update	Operating system	Star Rating (out of 5)		Number of installs a	Cost	Category	Languages
						IOS	Android				
Philips sonicare for kids	Philips	Netherlands	Children (6–8 years old)	2024	IOS / Android	4.7	3.9 Lowest	1.000.000	Free	Health & Fitness	Multiple
Chomper Chums®	United Concordia Dental	Pennsylvania, USA	Children (4-11 years old)	2023	IOS / Android	4.3	3.9 Lowest	100.000	Free	Health & Fitness	English
Oral-B	P&G Health Care	Ohio, USA	All ages (≥4)	2024	IOS / Android	4.8	4.4	+ 5M Highest	Free	Health & Fitness	Multiple
Brush DJ	Benjamin Underwood	United Kingdom	All ages (≥4)	2023	IOS / Android	4.6	4.2	100.000	Free	Health & Fitness	Multiple
Dental Coach	Maatschap Parodontologie Praktijk Friesland	Netherlands	All ages (≥4)	2024	IOS / Android	N/R	N/R	1000	Free	Medical	N/R
Truthbrush	Candibell	Massachusetts, USA	All ages (≥4)	2024	IOS / Android	4.5	4.6	10.000	Free	Health & Fitness	Multiple
Mimizaur: tooth brushing timer	Shorokh Natalya	Kazakhstan	Children (0-5 years old)	2024	IOS / Android	4.7	4.3	100.000	Free (In-App Purchases)	Health & Fitness	Multiple
Colgate Connect	Colgate-Palmolive Company	New York, USA	All ages (≥4)	2024	IOS / Android	4.8	N/R	100.000	Free	Health & Fitness	Multiple
Brush teeth: all clean?	concappt media	Hamburg, Germany	Children (0-5 years old)	2024	IOS / Android	4.2	N/R	1000	Free (In-App Purchases)	Education	Multiple
Mood brush- tooth brush timer	Ahancer Co., Ltd.	Thailand	All ages (≥4)	2024	IOS / Android	4.6	N/R	1000	Free	Health & Fitness	English

[a] Number of installs is only for applications available in the Google Play Store
[b] Not Reported (information was not found in app stores)

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Table 2. Technical characteristics of the 21 oral hygiene-related mobile apps

Category	Characteristic	App (n = 21), n (%)
App Focus	Increase Happiness/Well-being	21(100)
	Behaviour Change	12 (57)
	Goal Setting	14 (67)
Theoretical background/ Strategies	Entertainment	3 (14)
	Assessment	11 (52)
	Feedback	10 (48)
	Information/Education	15 (71)
	Monitoring/Tracking	7 (33)
	Goal setting	5 (24)
	Advice /Tips /Strategies /Skills training	9 (43)
	CBT - Behavioural (positive events)	7 (33)
Affiliations	Unknown	14 (67)
	Commercial	2 (9.5)
	Government	1 (4.8)
	NGO	1 (4.8)
	University	3 (14)
Technical aspects of app	Allows sharing (Facebook, Twitter, etc.)	4 (19)
	Has an app community	1 (4.8)
	Allows password-protection	4 (19)
	Requires login	4 (19)
	Sends reminders	11 (52)

Four apps allowed sharing of oral hygiene progress, but only Brush DJ had an in-app user community (Table 2).

Features of Oral Hygiene Applications (O2)

Among the 21 apps, 13 common features were identified (Figure 2). All apps included a toothbrushing timer. Other frequent features were brushing reminders & push notifications (47.6%), rewards systems (28.5%), flossing tracking (24%), fluoride mouthwash use (24%), oral hygiene tips and correct brushing coaching (each 19%), dentist checkup and toothbrush replacement reminders (each 14.3%), syncing data with other apps (14.3%), appointment booking (9.5%), and diet/nutrition and self-care reminders (each 4.76%).

The apps with the most oral hygiene features were Colgate Connect and Otis Dental (7/13 each), followed by Brush DJ (6/13). Chomper Chums uniquely rewarded children with virtual coins for brushing their teeth twice daily,

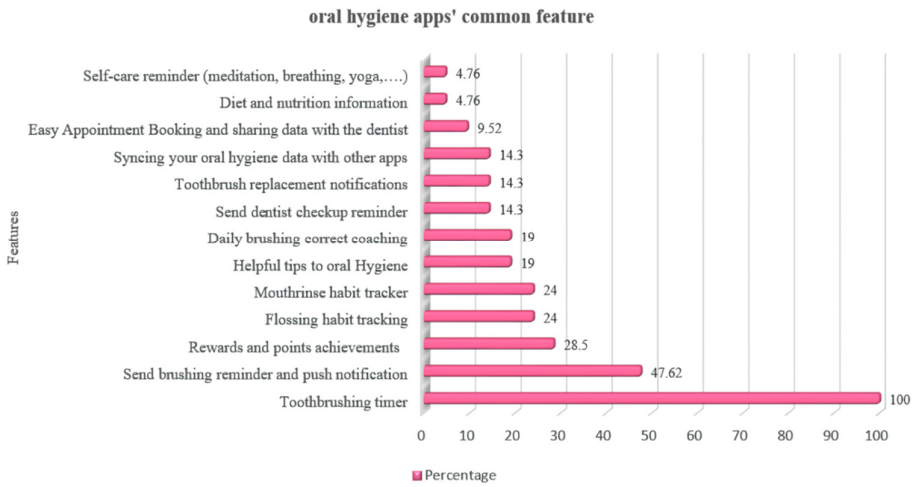

Figure 2. Common features of oral hygiene-related applications.

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which could be spent on healthy foods, promoting good habits. A study highlighted mHealth apps for dietary monitoring in oral health, tracking sugary food and drink intake, and helping users identify unhealthy habits linked to tooth decay using behavior change strategies (45). Many oral hygiene apps offer personalized reminders for brushing, flossing, using mouthwash, replacing toothbrushes, and scheduling dental checkups. Studies show that such reminders via text messages significantly improve oral hygiene, reducing Plaque Index (PI) and Gingival Index (GI) compared to controls (46, 47).

Quality Evaluation of Mobile-Based Apps for Oral Hygiene (O3)

Figure 3 shows the mean MARS scores for 21 apps, with an overall average of 2.48 (SD = 0.77), indicating poor quality. Scores ranged from 1.2 (Mood Brush-Toothbrush Timer) to 3.9 (Colgate Connect). The highest scores were in information, functionality, and engagement, while app-specific impact and subjective quality scored the lowest. Objective quality ratings were consistently higher than subjective ones. A few apps, such as Colgate Connect, Otis Dental, and Chomper Chums, showed acceptable performance across domains, while most lacked interactivity, personalization, and credible evidence. Only Oral-B and Brush DJ scored highest on scientific evidence, supporting their effectiveness in improving oral health behaviors (48, 49) and reducing plaque and gingivitis (50, 51). Most apps lack clinical validation and were not rated for evidence.

Strengths were observed in the accurate app descriptions (mean = 3), entertainment (2.9), and performance (2.9), while weaknesses included low credibility (1.8), poor graphics (2.1), limited customization, and low visual appeal (2.2). Most health apps lack clinical trial validation, highlighting the need for more research to confirm their effectiveness in promoting health outcomes. Detailed scores are in Appendix 1 and 2.

Correlation Between MARS Scores, App-Specific Dimension, User Ratings, and Update Dates

Eighteen bivariate correlations were tested between MARS subscales (engagement, functionality, aesthetics, information, subjective quality, total score) and three external variables: app-specific impact, user star ratings, and update status. After applying the Bonferroni correction ($\alpha = 0.0028$), significant strong correlations were observed only between functionality ($r = 0.81$), information ($r = 0.77$), and total score ($r = 0.88$) and the app-specific dimensions. Other correlations between MARS subscales and user ratings, as well as update dates, were not statistically significant after adjustment (Table 3). Findings indicate that functionality and information quality strongly influence the app-specific dimension, reflecting changes in user awareness and behavior. The absence of correlation between MARS scores, user ratings, and last update suggests that user ratings and previous updates may not always accurately reflect an app's actual quality, high performance, and engagement.

Discussion

This study provides a comprehensive evaluation of the current landscape of oral hygiene mobile applications using the MARS framework. It is the first systematic review assessing apps across all age groups on both major platforms (Android and iOS). Among the 21 identified apps, most had

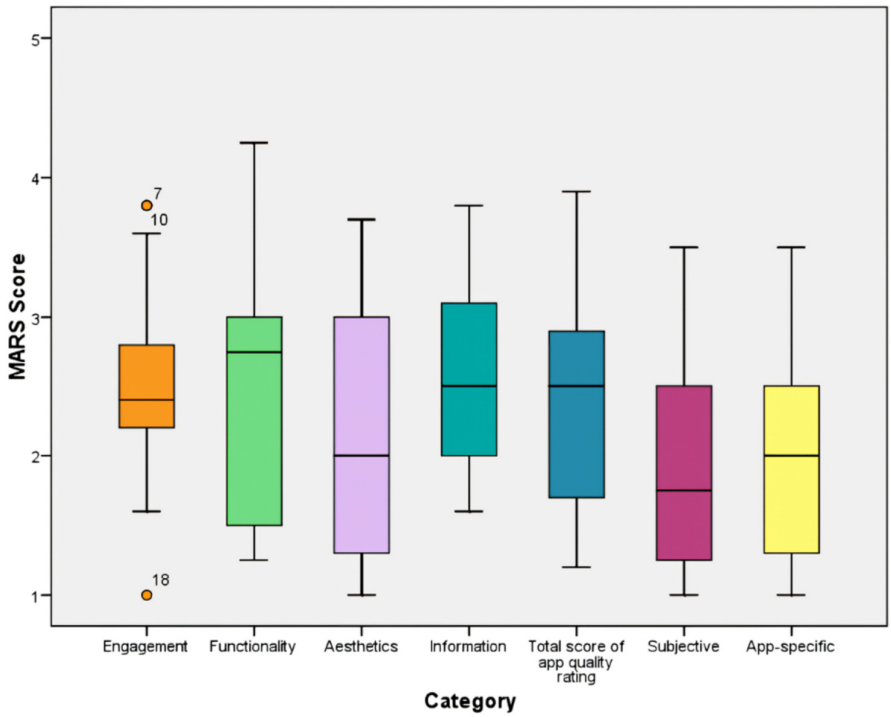

Figure 3. Box plot of Mobile App Rating Scale dimension scores (n=21)

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Table 3. Correlation Coefficient between MARS scores, app-specific, user star rating, and last update

Variable 1[a]	Variable 2[b]	Correlation Type	r / ρ	Raw p-value	Bonferroni Adjusted p[c]	Statistically Significant
Engagement	App-specific	Pearson	0.73	0.0002	0.0036	No sig [d]
Functionality	App-specific	Pearson	0.81	<0.0001	<0.001	Sig [e*]
Aesthetics	App-specific	Pearson	0.65	0.001	0.018	No sig
Information	App-specific	Pearson	0.77	<0.0001	<0.001	Sig *
Total objective quality	App-specific	Pearson	0.88	<0.0001	<0.001	Sig *
Subjective quality	App-specific	Pearson	0.69	0.0007	0.0126	No sig
Engagement	User star rating	Pearson	0.49	0.009	0.162	No sig
Functionality	User star rating	Pearson	0.57	0.004	0.072	No sig
Aesthetics	User star rating	Pearson	0.52	0.006	0.108	No sig
Information	User star rating	Pearson	0.54	0.005	0.090	No sig
Total objective quality	User star rating	Pearson	0.61	0.002	0.036	No sig
Subjective quality	User star rating	Pearson	0.58	0.003	0.054	No sig
Engagement	Update	Spearman	0.21	0.202	3.64	No sig
Functionality	Update	Spearman	0.18	0.273	4.91	No sig
Aesthetics	Update	Spearman	0.25	0.132	2.38	No sig
Information	Update	Spearman	0.19	0.242	4.36	No sig
Total objective quality	Update	Spearman	0.27	0.101	1.82	No sig
Subjective quality	Update	Spearman	0.22	0.189	3.40	No sig

[a] Variable 1: MARS subscale including Engagement, Functionality, Aesthetics, Information, Total objective quality, Subjective quality
[b] Variable 2: External Var including App-specific dimension, User star rating, Update
[c] P-value≤ 0.0028 is statistically significant
[d] No Significant Correlation
[e*] Significant Correlation

limited functionality, primarily focusing on toothbrushing timers, with few incorporating evidence-based educational content. Only a small number of apps demonstrated balanced strengths across key dimensions, including engagement, functionality, aesthetics, and information. These findings highlight the need for more user-centered and evidence-informed design practices in the development of oral hygiene apps.

This study's findings are consistent with prior research on oral health apps. Previous reviews reported that functionality and aesthetics often score highest in app quality (37). Less than half of dental caries prevention apps demonstrated good quality, highlighting the importance of collaborative design processes, evidence-based content, and interactive features in enhancing app quality (5). Additionally, many high-quality oral hygiene apps for children effectively improve knowledge, attitudes, and behaviors, with gamification boosting engagement and motivation for self-care (19, 35).

Most apps scored low on the evidence-based criterion, lacking scientifically validated content and clinical evaluations, which raises concerns about their credibility. Only Oral-B and Brush DJ were supported by randomized controlled trials. Previous research also found poor overall quality of apps and limited educational content (38). High-quality, accurate information is essential for user trust and engagement, as users tend to use apps with reliable, evidence-based data (52). Low subjective quality and poor engagement in oral hygiene apps can lead to high dropout rates, limiting their effectiveness in promoting behavior change and potentially increasing healthcare costs (53). Credible sources and endorsements from healthcare professionals are vital for building user trust and app adoption. Developers should prioritize scientific accuracy, usability, and engaging design to enhance credibility (54). This study found only seven apps developed by reliable sources, highlighting the need for stricter evaluation and regulation in mobile health.

Various tools have been developed to evaluate mHealth apps, differing in criteria, dimensions, and methods. Usability-focused tools like System Usability Scale (SUS), mHealth Apps Usability Questionnaire (MAUQ), Health Information Technology Usability Evaluation Scale (Health-ITUES), Perceived Usefulness (PU) and Perceived Ease of Use (PEU) scales, and ISO/IEC 9126-1 assess factors such as ease of use, usefulness, attractiveness, learnability, operability, understandability, and user satisfaction (55-57). Nielsen's usability checklist complements these tools by providing a heuristic-based evaluation of mHealth app interfaces through 10 criteria, including visibility of system status, match between the system and the real world, user control and freedom, consistency and standards, help users recognize, diagnose, and recover from errors, error prevention, recognition rather than recall, flexibility and efficiency of use, aesthetic and minimalist design, and help and documentation. Addressing these usability factors can improve app quality and effectiveness (58).

While usability-focused tools evaluate ease of use, they often overlook broader aspects, such as engagement and content validity. Quality-based tools like MARS and the User version of the Mobile App Rating Scale (uMARS) evaluate multiple domains—including engagement, functionality, aesthetics, and information quality—providing a comprehensive view of mHealth app performance (41, 59). The ENLIGHT checklist adds assessment of persuasive design and behavior change principles, which help identify user interface issues and enhance user engagement and adherence, ultimately supporting effective behavior change and improved health outcomes (60).

Compared to other tools, MARS offers a standardized, validated, and widely accepted framework for evaluating mHealth apps, integrating usability, content quality, and user engagement (59). Its international validation and application across various health domains, including stroke (61), low back pain (62), pregnancy (63, 64), type 2 diabetes (65, 66), suicide prevention (67), and mental health (68), enable meaningful comparisons with other studies.

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Recommendations for the Future Design of Mobile-Based Health Applications

Based on the current study findings and prior evidence, a four-dimensional conceptual model is proposed for future mHealth app design, covering: design principles, technical/material factors, health-related considerations, and personal/social factors, each with defined subcategories (Figure 4).

1. mHealth Application Design Principles

The first dimension highlights the need for high-quality, user-friendly design to sustain engagement and ensure clinical usability, as poor design can hinder effectiveness and risk patient safety (69). The MARS framework, used here, aligns with core mHealth design principles for quality evaluation. The MARS "Engagement" dimension includes gamification, feedback, and motivational notifications that boost user adherence and long-term use (70, 71). This study found that most oral hygiene apps scored poorly in this area, indicating a lack of effective motivational features.

Research indicates that complex interfaces and excessive text can hinder user interaction. Simplifying navigation and adding appealing visuals enhances usability, aligning with MARS's "Functionality" domain, which assesses navigation, performance, and responsiveness. Features like gesture controls and adaptive interfaces can especially benefit apps for diverse users (72). Usability evaluation and quality assurance are vital during development and after deployment (73), focusing on effectiveness, flexibility, safety, and customization to boost user satisfaction (74). Personalizing content and user experiences through feedback and goal-setting tools helps maintain engagement, aligning with MARS's engagement and information domains (33, 75).

2. Technical and Material Factors

The second dimension emphasizes essential technical and logistical aspects for reliable mHealth app development, including privacy, data protection, user trust, credibility, affordability, user training, technical support, security testing, and expert involvement. Given the sensitivity of health data, robust security measures such as encryption, multifactor authentication, and role-based access control (RBAC) are crucial throughout the development process (76, 77). Many mHealth apps lack proper security testing, risking user data breaches. Involving cybersecurity experts can strengthen protection and build trust (78). Cost also hinders adoption, as users often resist paying for apps; therefore, freemium or free models may enhance accessibility, particularly for underserved groups (54).

3. Health-Related Factors

The third dimension focuses on health-specific considerations such as the involvement of healthcare professionals, users' eHealth literacy, and health awareness. Higher eHealth literacy improves app engagement, trust, and effective use, while low literacy increases the risk of misinformation and poor health outcomes (54, 79). Our findings underscore the importance of incorporating verified, evidence-based content in mHealth apps, especially for users with low eHealth literacy. Trustworthy content boosts user engagement, aligning with MARS's "Engagement" domain. Involving healthcare professionals in design and evaluation ensures clinical accuracy and enhances user trust (80).

Figure 4. Conceptual model of mHealth applications design principles

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4. Personal and Social Factors

The final dimension considers individual and social factors affecting mHealth app acceptance and use, such as age, gender, digital skills, and SES. Younger users tend to adopt health technologies more easily, whereas older adults often face challenges such as lower digital literacy and physical limitations (54). These findings align with research identifying age and digital competence as key predictors of app engagement (81). Socioeconomic disparities also impact access to mHealth apps, as individuals from lower socioeconomic backgrounds may lack access to smartphones, data plans, or digital skills. To promote equity, inclusive design elements such as simple interfaces, offline functionality, and language options are vital. Targeted digital training and distributing apps via public health systems can further enhance accessibility and adoption (82).

Limitations and Future Suggestions

Our systematic review highlights the promising potential of mHealth apps to enhance oral hygiene across all age groups. However, several limitations must be acknowledged when interpreting these results:

- Language and Cost Constraints: Only free English-language apps were reviewed, restricting generalizability; future studies should include paid and non-English apps for broader insight.
- Appraisal Team Size: Assessment by only two raters limits reliability; involving a larger, multidisciplinary team, such as dental professionals, behavioral scientists, and software developers, would improve evaluation quality.
- Clinical Evidence Gap: Few apps (n = 2) had RCT validation; more clinical trials are needed to support effectiveness claims and generalizability.
- Sample and Design Constraints: Small sample (21 apps) and cross-sectional design limit temporal generalizability and real-world use; larger longitudinal studies are recommended.
- Search Strategy Challenges: Lack of standardized app-store search methods hampers reproducibility; validated search protocols should be developed for future reviews.

Conclusion

This study systematically identified and evaluated oral hygiene mHealth apps for all ages, finding most to be of "unsuitable" to "poor" quality in terms of content accuracy, functionality, engagement, and overall quality. These results underscore the need for future app designs to adhere to mHealth development principles and incorporate evidence-based healthcare practices. To enhance effectiveness, developers should work closely with researchers, healthcare professionals, security experts, and end-users. Design improvements should address age-specific needs, including gamification and interactive content for children, personalized, evidence-based content for adolescents, simplified usability and reminders for adults, and enhanced accessibility features such as larger fonts and voice commands for older adults. Tailoring app design and content to the needs of each age group is crucial for maximizing effectiveness and user satisfaction. This study offers a foundational framework to guide future development of higher-quality, evidence-based mHealth oral hygiene apps for all ages.

Authors' Contributions

All authors contributed to the review. F.S., S.K., and S.N. conceived the study's ideas and design. F.S., S.K., S.N., and Gh.A. performed literature screening, data extraction, and quality evaluation. F.S., S.K., S.N., and M.A. analyzed and interpreted the collected data. F.S. and S.K. wrote the first draft. F.S., S.K., and S.N. were involved in the revision of the manuscript. All authors have read and approved the final submitted manuscript.

Ethical Considerations

This study was derived from a PhD thesis approved by the Research Committee of the Iran University of Medical Sciences (IUMS), under the ethical code: IR.IUMS.REC.1402.197.

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Conflict of Interests

The authors declare that they have no competing interests.

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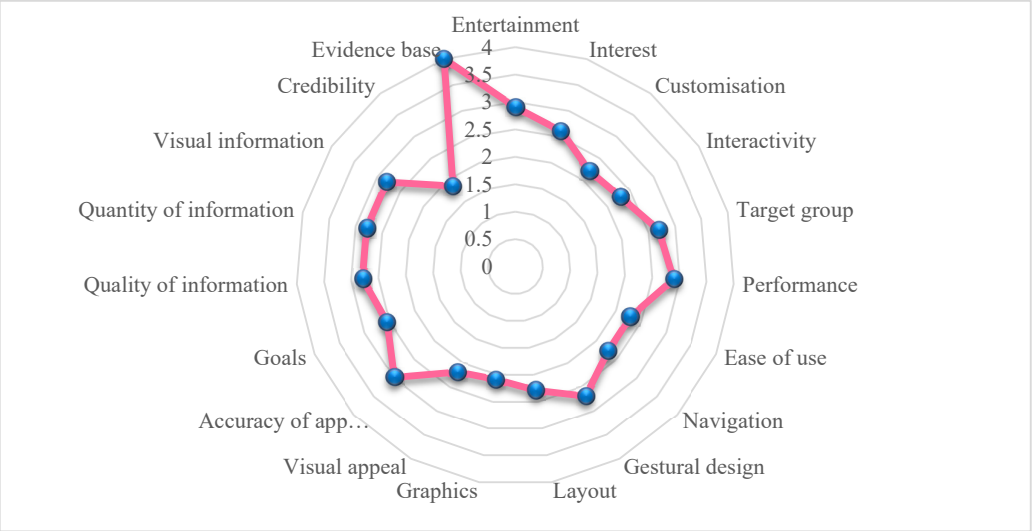
Appendix 1. Mean scores of Mobile App Rating Scale (MARS) dimensions

No.	App Name	MARS Engagement (1.0-5.0)	MARS Functionality (1.0-5.0)	MARS Aesthetics (1.0-5.0)	MARS Information (1.0-5.0)	Mean objective score (Total) (1.0-5.0)	Subjective Quality (1.0-5.0)	App-specific score (1.0-5.0)
1	Quip: oral care companion	2.6	3.0	2.3	2.7	2.65	2.0	2.7
2	Truthbrush	2.4	2.75	2.0	2.3	2.4	1.75	2.5
3	Oral-B	2.4	2.5	2.0	2.4	2.3	1.75	2.0
4	Oral Hygiene Coach	1.6	1.5	1.0	2.2	1.55	1.0	2.0
5	Philips Sonicare For Kids	3.4	3.0	3.0	3.0	3.1	2.25	2.3
6	Mimizaur: Tooth Brushing Timer	1.8	1.5	1.3	2.0	1.65	1.25	1.3
7	Colgate connect	3.8	4.25	3.7	3.8	3.9	3.5	3.0
8	Text2Floss	2.6	3.0	3.0	3.1	2.9	1.75	2.3
9	Brushout	2.4	2.75	2.7	3.0	2.7	2.0	2.7
10	Otis Dental	3.8	3.75	3.7	3.5	3.7	2.5	3.5
11	Toothbrushing daily guide	1.8	1.25	1.0	2.0	1.5	1.0	1.3
12	Dental coach	2.8	2.25	2.0	3.3	2.6	1.0	1.0
13	Brush the tooth companion	1.8	1.5	1.0	2.0	1.6	1.25	1.2
14	Qbrush	2.4	2.75	2.0	2.0	2.3	1.5	1.2
15	Chomper chums	3.6	4.0	3.3	3.3	3.55	3.0	3.0
16	Brush DJ	3.6	3.5	3.0	3.1	3.3	3.0	2.1
17	Brush teeth: all clean?	2.2	1.5	1.3	1.7	1.7	1.5	1.3
18	Mood brush- tooth brush timer	1.0	1.25	1.0	1.6	1.2	1.0	1.0
19	Teeth brushing and reminders	2.8	3.25	3.0	2.7	2.9	2.5	1.8
20	Teeth brushing timer	2.2	2.0	2.0	2.3	2.1	1.5	1.0
21	Brush teeth reminder	2.6	2.5	2.3	2.5	2.5	2.5	2.0
Mean (SD)		2.55 (0.75)	2.55 (0.91)	2.21 (0.89)	2.59 (0.62)	2.48 (0.77)	1.88 (0.73)	1.96 (0.75)



Appendix 2. The average score of each MARS objective item

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