Patient focused oral hygiene Apps: An assessment of quality (using MARS) and knowledge content

Abstract

Introduction: Smart phone apps can be a valuable means for education and prevention to improve the health of children, adolescents and adults. A recent review of apps has revealed that there are over 1,000 patient focused oral hygiene apps available on the Apple App store and Google Play (Android) store.

Objective: The purpose of this research is to objectively assess the quality of 20 commercially available patient focused oral hygiene apps using the Mobile App Rating Scale (MARS). Furthermore, the accuracy of oral hygiene related information contained within the apps will be assessed.

Methods: Apps meeting inclusion criteria were evaluated for: (1) quality using the MARS tool and (2) information accuracy using an 8-item evidence-based checklist relating to important aspects in the prevention of caries and periodontal disease.

Results: The mean app quality score was 3.4/5 (2.3-4.9). On average, of the four MARS subscales assessed 'functionality' had the highest mean score (4) and 'information' had the lowest (2.9). With regard to the accuracy of information contained within these apps only 2 were found to contain accurate information for all 8 items of the checklist. The majority (60%) of the apps (n=13) did not contain information relating to at least 50% or more of the items present.

Conclusions: Currently available apps appear to be functional, however there is a need to improve engagement, aesthetics and most importantly information content of apps.

In brief

- To assess the quality and knowledge content of the 20 most commonly used and commercially available patient focused oral hygiene apps
- To highlight important areas that need to be considered when developing patient focused oral hygiene apps
- To highlight the importance of scientific evidence in informing the content of oral hygiene apps

Introduction

Despite dental caries and periodontal disease being preventable, it is estimated that these conditions are highly prevalent affecting approximately 3.5 billion people worldwide.[1] Oral health is integral to overall health with oral disease contributing to unnecessary pain and suffering.[2] Routine oral hygiene, including daily tooth brushing and interdental cleaning, is important for preventing oral disease and maintaining good oral health.[3] Previous research indicates that improvement in dental plaque control are greater when oral hygiene instructions are provided verbally and accompanied with written and visual illustrations in comparison to verbal instructions alone.[4]

Smart phones offer a further advancement in this area as they may be used to deliver low-cost oral health promotion at a population level. Smart phones enable instant access to information, anywhere at any time and may therefore be more engaging and accessible than traditional methods of delivering healthcare information, for example leaflets. In recent times, there has been a rapid increase in the number of consumer-facing health promotion apps,[5] there are currently over 97,000 mobile apps that are related to health and fitness and the top ten rated health apps are downloaded approximately 4 million times a day.[6]

Emerging literature is highlighting that the use of smart phones can improve adherence to oral hygiene advice.[4,7,8,9] There are an ever-increasing number of patient focused oral hygiene apps available, a review of apps in July 2018, revealed that 1075 apps were available on the Apple App Store and Google Play (Android) store.[10] Although subjective user ratings and reviews are available on the app stores there is often no objective measure of app quality reported. The most commonly used tool for assessing a healthcare apps quality is the Mobile Application Rating Scale (MARS),[11] MARS is an evidence based, objective, multidimensional measure for rating the quality of mobile health apps.[12] The MARS tool contains 19 items divided into four sections that assess the following domains:

1. Engagement

2. Functionality

3. Aesthetics

4. Information quality

The 19 items are scored using a 5-point Likert scale (1-inadequate, 2-poor, 3-acceptable, 4-good, and 5-excellent). The final MARS quality score is calculated as a mean score of the subscales. A subjective quality section evaluating the assessor's overall satisfaction may also be completed, however, this score is not included in the overall mean quality score and thus strengthens the objectivity of the MARS. Additionally, an app-specific subscale that assesses the perceived effect on the user's knowledge, attitudes, and intentions to change as well as likelihood of changing the identified targeted behaviours may be completed.

Although the MARS tool has been used in the healthcare research to assess the quality of apps,[13,14,15,16] to date there have been no published articles reporting the use of MARS to assess oral hygiene apps. Furthermore, the authors are unaware of any published article reporting the accuracy of information content within oral hygiene apps. It is particularly important that the information provided to patients is accurate and conforms to relevant guidelines, for example, the "*Delivering better oral health–an evidence-based toolkit for prevention*".[17]

Given the availability of patient targeted apps that can be directly accessed by the public there is an urgent need to assess the quality of these apps including the accuracy of information contained within these apps.

Aims

The aims of this paper are to:

1) Assess the quality of 20 patient focused oral hygiene apps using the MARS tool and
2) Assess the accuracy of the information content within these apps

Methods

Search methods

The methodology for identifying oral hygiene apps has been detailed in a previous article,[10] in summary, the following terms were entered into the Apple App store and Google Play (Android) store search functions on 25-07-2018: oral hygiene, dental hygiene, tooth brushing, teeth cleaning, dental flossing and interdental brushing. The apps categorised as being focused on the provision of oral hygiene instructions were utilised in this paper. To obtain an equal mix

of Apple and Android apps, the first ten apps identified on each platform were included, therefore, a total of 20 apps were included.

Quality assessment

Two researchers (M.O.S and A.A.) completed MARS training as outlined in the original MARS publication and accompanying resources.[12] It was intended that any disagreement in MARS scores would be discussed with the aim of reaching a consensus. If this was not possible, an experienced MARS user had agreed to be consulted to mediate and achieve a consensus. For the purposes of this paper the subjective score and the app-specific subscale have not been reported in order to strengthen the objectivity of app assessment. In any case these elements do not affect the overall MARS quality score for an app.

Accuracy of information content

Given that there is no comprehensive resource to assess the knowledge content that should be contained within oral hygiene related apps, the authors developed an 8-item checklist relating to the important aspects in relation to the prevention of caries and periodontal disease using appropriate guidelines and reviews.[18,19,20,21,22,23,24] The checklist is demonstrated in Table 1.

The authors rated the content of all apps utilising the checklist summarised in Table 1. Each checklist item was scored using the following 4-point scale:

- A: Information present, accurate
- B: Information present, incomplete (i.e. no inaccurate information but the information present is incomplete, for example, stating that Fluoride toothpaste should be used however, failing to provide the recommended fluoride concentration)
- C: Information present, not accurate
- D: Information not present

It was intended that any disagreement would be discussed with the aim of reaching a consensus. If this was not possible, a third researcher had agreed to be consulted to mediate and achieve a consensus in cases of disagreement.

Results

Table 2 summarises the MARS scores for the included apps. Apps 1-10 were those Apps retrieved from the Google Play (Android) store and 11-20 are those retrieved from the Apple App store.

The overall mean MARS score for all apps assessed was 3.4 (range 2.3 to 4.9). Of the four MARS subscales, 'functionality' had the highest mean score 4 (2.8-5) and 'information' had the lowest 2.9 (2-4.9). The mean scores for the remaining MARS domains are as follows:

- Engagement 3 (range 1.8-4.8)
- Aesthetics 3.5 (range 1.7-5)

Table 3 presents the assessment of information content. Interestingly, only two apps were found to contain accurate information for all 8 items of the checklist. Additionally, two apps had no information present for any of the 8 items despite the suggestion that they were related to the provision of oral hygiene instruction within their descriptions. The majority of the apps (n=13) did not contain information relating to at least 50% or more of the checklist items.

The majority of apps contained accurate information in relation to brushing duration (n=16), frequency (n=14) and interdental cleaning (n=11). However, 15 apps did not provide information related to the timing of tooth brushing, 14 did not state the recommended fluoride concentration of toothpastes, 14 did not provide advice on rinsing after brushing and 8 did not provide information in relation to mouthrinse use. Furthermore, only 25% of apps (n=5) provided accurate information in relation to toothbrush head size.

Discussion

Traditional approaches to gauge the quality of an app include assessing user opinions and/or satisfaction, this can be obtained from the app description on the app stores. However, this does not represent an objective measure of app quality. This study is the first to evaluate the objective quality of commercially available patient focused oral hygiene apps using a validated assessment scale – the mobile application rating scale. Individual app names have not been stated in this research in order to avoid endorsing/criticising individual apps. It was found that apps scored highly for 'functionality', however, there is a need to consider other important areas linked to an apps quality including engagement, aesthetics and most importantly information content.

The mean overall quality score for Apple apps was slightly higher than Google play apps, 3.7 and 3.1 respectively. Google Play apps scored highest for 'functionality' (3.9) and lowest for 'engagement' (2.5). Whereas the Apple apps scored highest for 'functionality' (4.1) and lowest for 'information' (3). Approaches to improving an apps engagement may involve customisation, this includes providing the user the option to add prompts and change appearance.

The information content of an app relating to health care is arguably the most important domain as this may affect patient safety.[10] The mean MARS 'information' score of the oral hygiene apps assessed was 2.9 (1.8 to 4.9). This was the lowest score of all the domains assessed, this is of concern and suggests that members of the public may be accessing information that is inaccurate and, in some cases, misleading. A more detailed assessment of the apps revealed that many apps omitted items considered essential for the provision of effective oral hygiene advice, the items most often missing were: the recommended fluoride content of toothpastes, brushing time and advice relating to rinsing after brushing. Only two of the apps assessed completely fulfilled the 8-item checklist used in this paper. Alarmingly, one app contained information in relation to toothpaste content and mouthrinse advice that were completely inaccurate. The developers also stated to "use apple cider vinegar, take your finger and rub apple cider vinegar on your teeth for about one minute".

Given the findings of this research there is a need for the dental profession to actively engage with app developers to ensure that apps aimed at patients contain accurate information and that they are targeted to appropriate patient groups. Furthermore, it is particularly important to identify the source of app development and the evidence base supporting an app prior to recommending it to a patient. A useful resource is the NHS online NHS app library[25], this is a database of healthcare apps that have been approved by the NHS. To be listed on the NHS app library an app developer must evidence that the proposed app meets appropriate standards relating to:[26]

- Eligibility
- Clinical safety
- Data protection
- Security and usability

At present there is only dental app is contained on the library.

Study limitations:

It is important to highlight that the checklist utilised for assessing knowledge content within apps was focused on oral hygiene information provision in the UK. Some of the apps identified may not have been targeted at a UK patient base however, they were accessible from the UK.

Additionally, this research provides a snap shot of the available oral hygiene apps in late 2018, the number of available apps is increasing year on year, apps are also updated and removed as necessary. It is therefore necessary to assess the availability and quality of individual apps as and when recommending these to patients.

Conclusions

This paper highlights that a lack of regulation in app development means that there is a risk that patients may access inaccurate information via oral hygiene apps and, in some cases, this may be misleading and detrimental to health. Therefore, evaluation, validation, and quality assessment of healthcare apps is essential prior to recommending these to patients.

Currently available apps appear to be functional, however there is a need to improve engagement, aesthetics and most importantly information content.

Declarations:

Ethics approval and consent to participate

Not applicable.

Consent for publication:

Not applicable.

Availability of data and material:

Not applicable.

Competing interests:

The authors declare there are no competing interests.

Funding:

Mohammad Owaise Sharif was awarded the Royal College of Surgeons of England Faculty of Dental Surgery 70th Anniversary Research Fellowship. This funding has supported this project.

Authors contributions:

MOS conceived this study. MOS and AA conducted the data analysis and developed this manuscript.

References

1. Kassebaum NJ, Smith AGC, Bernabe E, Fleming TD, Reynolds AE, Vos T, et al. Global, Regional, and National Prevalence, Incidence, and Disability-Adjusted Life Years for Oral Conditions for 195 Countries, 1990-2015: A Systematic Analysis for the Global Burden of Diseases, Injuries, and Risk Factors. *Journal of Dental Research*. 2017; **96**:380-7.

2. Petersen PE, Bourgeois D, Bratthall D, Ogawa H. Oral health information systems--towards measuring progress in oral health promotion and disease prevention. *Bulletin of the World Health Organization*. 2005; **83**:686-93.

3. Kumar S, Tadakamadla J, Johnson NW. Effect of Toothbrushing Frequency on Incidence and Increment of Dental Caries: A Systematic Review and Meta-Analysis. *Journal of Dental Research*. 2016; **95**:1230-6.

4. Ay ZY, Sayin MO, Ozat Y, Goster T, Atilla AO, Bozkurt FY. Appropriate oral hygiene motivation method for patients with fixed appliances. *The Angle Orthodontist.* 2007; **77**: 1085-9.

5. Krebs P, Duncan DT. Health App Use Among US Mobile Phone Owners: A National Survey. *JMIR mHealth and uHealth*. 2015;**3**:e101.

6. Future of Healthcare. Available at https://ymedialabs.com/future-of-healthcare. (accessed on 23/01/2018).

7. Underwood B, Birdsall J, Kay E. The use of a mobile app to motivate evidence-based oral hygiene behaviour. *Br Dent J*. 2015; **219**: E2.

8. Zotti F, Dalessandri D, Salgarello S, Piancino M, Bonetti S, Visconti L, et al. Usefulness of an app in improving oral hygiene compliance in adolescent orthodontic patients. *The Angle Orthodontist*. 2016; **86**:101-7.

9. Bowen TB, Rinchuse DJ, Zullo T, DeMaria ME. The influence of text messaging on oral hygiene effectiveness. *The Angle Orthodontist*. 2015;**85** :543-8.

10. Parker K, Valiji Bharmal R, Sharif MO. The availability and characteristics of patient focused oral hygiene apps. *British Dental Journal.* (In Press).

11. Kim BY, Sharafoddini A, Tran N, Wen EY, Lee J. Consumer Mobile Apps for Potential Drug-Drug Interaction Check: Systematic Review and Content Analysis Using the Mobile App Rating Scale (MARS). *JMIR mHealth and uHealth*. 2018;**6** :e74.

12. Stoyanov SR, Hides L, Kavanagh DJ, Zelenko O, Tjondronegoro D, Mani M. Mobile app rating scale: a new tool for assessing the quality of health mobile apps. *JMIR mHealth and uHealth*. 2015;3(1).

13. Mani M, Kavanagh DJ, Hides L, Stoyanov SR. Review and Evaluation of Mindfulness-Based iPhone Apps. *JMIR Mhealth Uhealth*. 2015; **3**:e82.

14. Bardus M, van Beurden SB, Smith JR, Abraham C. A review and content analysis of engagement, functionality, aesthetics, information quality, and change techniques in the most popular commercial apps for weight management. *Int J Behav Nutr Phys Act*. 2016; **13**:35.

15. Antezana G, Bidargaddi N, Blake V, Schrader G, Kaambwa B, Quinn S, Orlowski S, Winsall M, Battersby M. Development of an online well-being intervention for young people: an evaluation protocol. *JMIR Res Protoc*. 2015; **4**:e48.

16. Patel R, Sulzberger L, Li G, Mair J, Morley H, Shing MN, O'Leary C, Prakash A, Robilliard N, Rutherford M, Sharpe C, Shie C, Sritharan L, Turnbull J, Whyte I, Yu H, Cleghorn C, Leung W, Wilson N. Smartphone apps for weight loss and smoking cessation: Quality ranking of 120 apps. *N Z Med J*. 2015; **128**:73-6.

17. Delivering better oral health: an evidence-based toolkit for prevention. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/605266/Delivering_better_oral_health.pdf. (accessed on 23/01/2019).

18. Prevention and management of dental caries in children. Available at http://www.sdcep.org.uk/wp-content/uploads/2018/05/SDCEP-Prevention-and-Management-of-Dental-Caries-in-Children-2nd-Edition.pdf. (accessed on 28/12/2019).

19. Dental interventions to prevent caries in children. Available at https://www.sign.ac.uk/assets/sign138.pdf. (accessed on 23/01/2019).

20. Guidelines for periodontal screening and management of children and adolescents under 18 years of age. Guidelines produced in conjunction with the British Society of Periodontology and British Society of Paediatric Dentistry. Available at https://www.bspd.co.uk/Portals/0/Public/Files/Guidelines/bspd-perio-guidelines-for-the-under-18s-2012.pdf. (accessed on 23/01/2019).

21. Delivering better oral health: an evidence-based toolkit for prevention. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/605266/Delivering_better_oral_health.pdf. (accessed on 28/12/2019).

22. Walsh T, Worthington H, Glenny AM, Appelbe P, Marinho VC, Shi X. Fluoride toothpastes of different concentrations for preventing dental caries in children and adolescents. *Cochrane Database Syst Rev*. 2010; 1:CD007868.

23. Marinho VC, Higgins JP, Sheiham A, Logan S. Combinations of topical fluoride (toothpastes, mouthrinses, gels, varnishes) versus single topical fluoride for preventing dental caries in children and adolescents. *Cochrane Database Syst Rev*. 2004; 1:CD00278.

24. Marinho VC, Chong LY, Worthington HV, Walsh T. Fluoride mouthrinses for preventing dental caries in children and adolescents. *Cochrane Database Syst Rev*. 2016; 7:CD002284.

25. NHS Apps Library. Available at https://apps.beta.nhs.uk/ (accessed on 08/03/2019).

26. NHS Apps Library – How we assess apps. Available at https://apps.beta.nhs.uk/how-we-assess-apps/ (accessed on 08/03/2019).

Code	Item
Brushing duration	Brush teeth for at least two minutes with fluoridated toothpaste
Brushing frequency	Brush at least twice a day
Brushing time	Brush last thing at night and at least on one other occasion
Fluoride content	Use pea-size amount (smear of toothpaste for children up to 3 years of age) of fluoridated toothpaste (1350-1500 ppm fluoride).
Rinsing	Spit out after brushing and do not rinse to maintain fluoride concentration levels
Mouthrinse	Use fluoride containing mouth rinse daily (0.05% NaF) at a different time to brushing (indicated in high caries risk individuals)
Toothbrush size	Small tooth brush head of medium texture
Interdental cleaning	For small spaces between teeth use dental floss, for larger spaces use interdental or single tufted brushes

Table 1. An evidence based checklist for assessing information relating to the prevention of caries and periodontal disease

Table 2. Mobile Application Rating Scale (MARS) scores for the included apps.

App	Engage (5)	Function (5)	Aesthetics (5)	Information (5)	Overall (5)
1	3.2	4.5	4	2.8	3.6
2	2.4	4.5	3.3	3	3.3
3	1.8	2.8	1.7	2.8	2.3
4	2.2	4	3.3	3.2	3.2
5	2.2	4	3.3	3.5	3.3
6	2.6	3	3.7	2.2	2.9
7	1.8	4	2.3	2	2.5
8	2.4	4.5	2.7	4.2	3.5
9	3	3.3	3.3	2.8	3.1
10	3.2	4.3	4	3.3	3.7
Mean scores (Google Play)	**2.5**	**3.9**	**3.2**	**2.9**	**3.1**
11	4.6	4.8	4.7	3.9	4.5
12	4	4.5	4.7	3.3	4.1
13	2.2	3	2.7	2	2.5
14	3.4	4.5	3.7	2.5	3.5
15	4	4	4	1.8	3.5
16	2.8	4	4.3	3	3.5
17	3.2	4	3.7	3.6	3.6
18	3.2	4	3.7	3	3.5
19	4.8	5	5	4.9	4.9
20	2.8	3.5	2.7	2.4	2.9
Mean scores (Apple App)	**3.5**	**4.1**	**3.9**	**3**	**3.7**
Overall Mean scores	**3**	**4**	**3.5**	**2.9**	**3.4**

App code	1- Brushing duration	2- Brushing frequency	3- Brushing time	4- Fluoride content	5- Rinsing	6- Mouthrinse	7- Tooth brush size	8- Interdental cleaning
1	A	A	D	D	D	D	D	D
2	A	D	D	D	D	B	D	A
3	D	A	D	A	D	A	D	A
4	A	D	D	C	D	C	D	A
5	A	A	A	D	D	D	D	A
6	A	A	A	D	A	A	D	A
7	D	A	D	D	D	A	A	A
8	A	A	A	A	A	A	A	A
9	D	A	D	B	D	B	A	A
10	A	D	D	D	D	D	B	A
11	A	A	D	D	D	D	D	D
12	A	A	D	D	A	A	D	A
13	D	D	D	D	D	D	D	D
14	A	A	D	D	D	D	D	A
15	A	A	D	D	D	D	D	D
16	A	D	D	D	D	D	D	D
17	A	A	A	B	B	B	B	D
18	D	D	D	D	D	D	D	D
19	A	A	A	A	A	A	A	A
20	A	D	D	D	B	B	A	D

Table 3. The knowledge content of apps included. Each criteria of the evidence based checklist (table 1) was scored as follows: A: Information present, accurate, B: Information present, incomplete, C: Information present, not accurate and D: Information not present.