

Original Research

Young portuguese adults' perception of mobile apps for motivation to oral health care



Joana Costa^{1,*} , Sónia Mendes¹ 

¹ Universidade de Lisboa, Faculdade de Medicina Dentária, Unidade de Investigação e Ciências Orais e Biomédicas (UICOB), Lisbon, Portugal

ARTICLE INFO

Article history:

Received 30 May 2023

Accepted 21 May 2024

Available online 25 June 2024

Keywords:

Mobile applications

Motivation

Oral health

Young adult

ABSTRACT

Objectives: To study the perception of young Portuguese adults about using mobile applications as a complement to oral health motivation.

Methods: This cross-sectional descriptive study applied an online questionnaire to Portuguese individuals between 18 and 20 years old. The questionnaire was developed based on a literature review and assessed by a panel of experts before its application. It collected information about oral hygiene behaviors and the perception of using mobile apps for oral health motivation, including opinions on important functionalities. Variables' absolute and relative frequencies were calculated.

Results: The sample included 213 participants. About 73.2% of the participants considered oral health motivational mobile apps useful, but only 6.1% indicated having already used one. The most valued functionalities were information about oral diseases (86.9%), appointment reminders (85.4%), and a toothbrushing timer (84.5%).

Conclusions: Most of the participants found oral health apps useful as a complement to oral health motivation. However, only a small minority reported having used these apps before. The functionalities evidenced in this study may be helpful for the development of mobile apps since they can be more directed to the population's expectations. Apps may be another way for healthcare professionals to motivate their patients to engage in oral health self-care. (Rev Port Estomatol Med Dent Cir Maxilofac. 2023;65(2):59-65)

© 2024 Sociedade Portuguesa de Estomatologia e Medicina Dentária.

Published by SPEDM. This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

* Corresponding author.

E-mail address: joanac@campus.ul.pt (Joana Costa).

<http://doi.org/10.24873/j.rpemd.2024.06.1220>

1646-2890/© 2024 Sociedade Portuguesa de Estomatologia e Medicina Dentária. Published by SPEDM.

This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Perceção de jovens adultos sobre aplicações móveis para a motivação dos cuidados de saúde oral

R E S U M O

Palavras-chave:

Aplicações móveis
Motivação
Saúde oral
Jovem adulto

Objetivos: Estudar a perceção de jovens adultos portugueses sobre o uso das aplicações móveis como complemento da motivação para a saúde oral.

Métodos: Estudo descritivo transversal, com aplicação de um questionário online a indivíduos portugueses, com idade entre os 18 e os 20 anos. O questionário foi desenvolvido com base numa revisão da literatura e avaliado por um painel de peritos antes da sua aplicação. Recolheu informação sobre os comportamentos de higiene oral e sobre a perceção da utilização de aplicações móveis para a motivação para a saúde oral, incluindo opiniões sobre funcionalidades mais ou menos importantes. Foram calculadas as frequências absolutas e relativas das variáveis.

Resultados: A amostra incluiu 213 participantes. Cerca de 73,2% dos participantes consideraram as aplicações móveis de motivação para a saúde oral úteis, no entanto apenas 6,1% referiu já ter utilizado uma. As funcionalidades mais valorizadas foram: informação sobre doenças orais (86,9%), lembretes de consulta (85,4%) e temporizador de escovagem dos dentes (84,5%).

Conclusões: A maioria dos participantes considerou a utilização de uma aplicação de saúde oral útil como complemento à motivação para a saúde oral, no entanto apenas uma pequena minoria referiu ter utilizado estas aplicações anteriormente. As funcionalidades evidenciadas neste estudo podem ser úteis para o desenvolvimento de aplicações móveis, de modo a serem mais direcionadas para as expectativas da população. A utilização de aplicações pode ser mais uma forma de os profissionais de saúde motivarem os seus pacientes para o autocuidado em saúde oral. (Rev Port Estomatol Med Dent Cir Maxilofac. 2024;65(2):59-65)

© 2024 Sociedade Portuguesa de Estomatologia e Medicina Dentária.

Publicado por SPEMD. Este é um artigo Open Access sob uma licença CC BY-NC-ND (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Oral diseases continue to be a public health problem with a significant social and economic impact due to their high prevalence.^{1,2} Good oral health includes the ability to speak, smile, smell, taste, touch, chew, swallow, and convey countless emotions through facial expressions without any pain or discomfort. Therefore, the impact of oral diseases on an individual's daily life can influence their basic needs, which in turn may be reflected in essential psychological, physical, and social attributes.^{3,4}

The daily disorganization and removal of oral biofilm are essential to prevent oral diseases. Thus, one of the most important functions of the oral health professional is to motivate and provide patients with instructions for its correct removal, reinforcing it regularly. The habit of regularly visiting an oral health professional is still infrequent in the Portuguese population.⁵ In this scenario, technology can be used to complement the oral health appointment as a tool to remind patients, frequently and over time, of the instructions given during the appointment.

There has been an intense technological revolution in recent decades,⁶ further enhanced in recent years by the pandemic.⁷ Nowadays, technology highly influences the daily routines of populations, especially among young adults.⁸ Smartphones are extensively used in the daily routines of

most individuals, involving numerous mobile software applications (apps).⁶ By 2021, it was estimated that a total of 230 billion apps had been downloaded globally.⁹ In 2018, Portugal was the 27th European country with the highest smartphone usage rate.¹⁰ In Portugal, smartphone usage increased from 27% in 2012 to 84.2% in July 2020,¹¹ and, in 2022, it was estimated that the number of monthly active smartphone users was 6.51 million individuals — more than half of the Portuguese population.¹²

The use of health apps to improve and maintain health care, usually called Mobile Health or MHealth, has been increasing.^{13,14} The adoption and use of apps can be an innovative way to improve health care by promoting good, closer, faster communication with the health professional and, on the other hand, allowing individuals to monitor their own health through quick access to useful information anytime and anywhere.^{15,16}

The use of apps designed to promote oral health seems to have satisfactory results, but there are still few studies on the impact of their use.¹⁷ Moreover, one study has reported a lack of rigor among these apps and that they do not always meet the users' needs.¹⁸ There are no published studies assessing the use, effectiveness, and acceptability of this type of app in the Portuguese population. Therefore, this study aims to understand the perception of young Portuguese adults about using apps as a complement to motivate oral health care.

Material and Methods

This cross-sectional descriptive study was approved by the Ethics Committee of a Portuguese Dental School. The target population was young Portuguese individuals aged between 18 and 20 years. Data was collected using an online questionnaire. All individuals who answered the questionnaire, had a smartphone, were responsible for their daily oral hygiene care, and had Portuguese nationality were included in the study. All participants consented to their participation on the first page of the questionnaire, under a brief text explaining the aims and procedures of the study.

The questionnaire was developed based on a literature review¹⁹⁻²⁵ and surveys aimed to evaluate health-oriented mobile applications, such as the Mobile App Rating Scale,²⁶ Jakob Nielsen's usability heuristics,²⁷ and the Net Promoter Score.²⁸ To test face and content validity, before its application, the questionnaire was reviewed by two oral hygienists with experience in questionnaire research to verify the relevance, clearness, and content of the questions. After that expert validation, a pre-test was made on six individuals who met the inclusion criteria.

The final questionnaire included two sections. The first was created to characterize the sample and collect information about daily oral hygiene behaviors and self-perception of oral health. The second section collected data about the respondent's opinions on using apps related to oral health.

A link to the questionnaire was shared on social media between March and May 2022 in several groups that could include individuals from the target population. It was shared several times and at different hours to obtain more responses.

Statistical analysis was performed in the Statistical Package for Social Sciences (SPSS® 27.0), and all variables' absolute and relative frequencies were calculated.

Results

The sample included 213 participants, most female (66.7%) and higher education students (51.6%). Table 1 shows the sample's characterization according to sociodemographic characteristics and oral health behaviors. Regarding the perception of oral health, most participants considered having "good" oral health (59.6%). About 58.0% reported a previous oral disease, most frequently dental caries (48.8%), followed by gingivitis (14.1%). As for the regularity of oral health appointments, 38.5% of the participants indicated that they visited the oral health professional twice or more a year, and 2.8% never went to an oral health appointment. About 9.0% of the participants said they never received oral health education at dental appointments. Most participants reported using a manual toothbrush (78.4%), brushing their teeth twice or more a day (81.7%), and using a complementary tool for oral hygiene (62.0%) (Table 1).

Regarding the perception of using apps related to oral health, most participants considered it could be useful to improve oral health care (73.2%). The features most frequently indicated as useful were "Information about oral diseases" (86.9%), "Oral health appointment reminders" (85.4%), and

Table 1. Characterization of the sample according to sociodemographic characteristics and oral health behaviors (n=213).

		%	n
Gender	Female	66.7	142
	Male	33.3	71
Academic qualifications	9 years of education or less	0.9	2
	Less than 12 years of education	35.7	76
	12 years of education	11.7	25
	Higher education student	51.6	110
Oral health perception	Very bad	0.0	0
	Bad	0.5	1
	Reasonable	23.5	50
	Good	59.6	127
	Very good	16.4	35
Previous oral diseases	Yes	58.2	124
	No	41.8	89
Oral health appointment	Never	2.8	6
	Less than once per year	21.6	46
	At least once per year	37.1	79
	Twice or more per year	38.5	82
Received oral health education in oral health appointment	Yes	87.8	187
	No	9.4	20
	Never attended an appointment	2.8	6
Toothbrush	Manual	78.4	167
	Electric	21.6	46
Frequency of toothbrushing	Less than once a day	1.9	4
	Once a day	16.4	35
	Twice or more a day	81.7	174
Use of complementary tools for oral hygiene	Yes	62.0	132
	No	38.0	81

"Toothbrushing timer" (84.5%) (Figure 1). The "Other" category indicated in Figure 1 included "Register how many times we brush and floss our teeth," "Reminder not to push too hard when brushing my teeth," and "Show clinics near me."

Most participants reported never using any app for oral health care motivation (93.9%). All who reported having experience with oral health-related apps used an app associated with a company brand. Most (92.3%; n=12) used the Oral-B® app, and 7.7% (n=1) used the Disney magic timer app. They were asked to rate their experience with the corresponding app, and 46.2% reported it was a good experience, indicating the following as the main positive aspects: toothbrushing monitoring, toothbrushing timer, and gamification. On the other hand, the negative aspect most frequently indicated was that it was not practical (Table 2).

Discussion

This study allowed us to assess young Portuguese adults' perception of oral health-related apps and understand which features they considered the most useful in this type of mobile application. We selected the age range between 18 and 20 years because adolescents/young adults are among the population

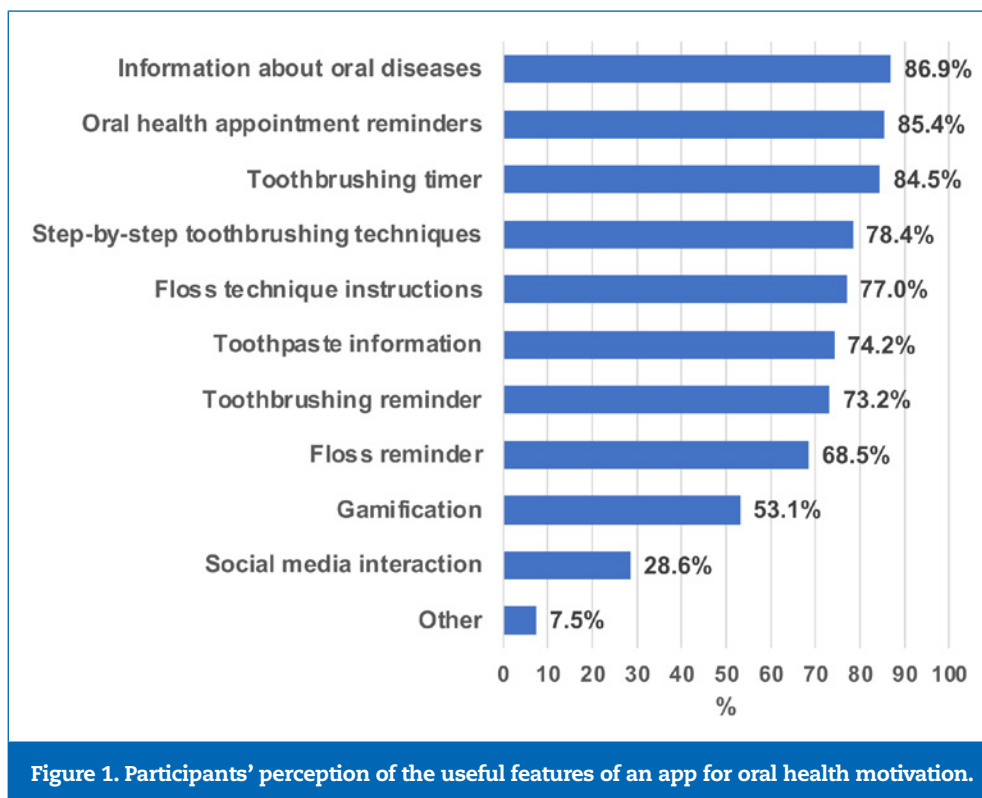


Table 2. Positive and negative aspects of the apps used.

Positive aspects	% (n)	Negative aspects	% (n)	App used
Toothbrushing technique	23.1 (3)	Not practical	23.1 (3)	Oral B®
Toothbrushing timer	15.4 (2)	Price	7.7 (1)	Oral B®
Gamification	15.4 (2)	Poor development	7.7 (1)	Disney magic timer
Dynamics	7.7 (1)	Use limitations	7.7 (1)	Oral B®
Pressure sensor	7.7 (1)	Must carry the smartphone with me	7.7 (1)	Oral B®
Brushing log	7.7 (1)			Oral B®
Innovation	7.7 (1)			Oral B®

who most frequently use smartphones in their daily routine,^{8,29} and, thus, are most likely to use an app as a complement to motivate for oral health care.

Constant motivation is required to eliminate risky behaviors and promote behavior change.^{1,30} The way knowledge is provided and acquired and the follow-up over time can promote behavior change.³¹ Some studies indicate that change can be achieved more successfully through a regular and interactive approach, with visually attractive materials that include messages associated with images and demonstrations.³¹⁻³³ Therefore, apps can be valuable tools to motivate individuals for oral disease prevention as they can provide this regular and interactive approach to patients, providing real-time toothbrushing reminders and instructions.^{18,34,35} The study results reinforce this possibility, as most participants considered useful using an app as a complement to oral health. These apps may have an

even more prolific action if they are articulated with the oral health professional, promoting better communication between the professional and the patient and using the various features to the patient's specific oral health situation.³⁶

These apps may increase adherence and motivation to improve oral hygiene self-care through several features, such as information on oral diseases and oral hygiene, a timer, and a record of toothbrushing frequency. Gamification is highlighted as a feature that can encourage greater frequency of app use and consistency over time.⁶

In this study, the feature perceived as most useful was the information on oral diseases on the app, which reveals a possible lack of information about oral diseases in the population studied. On the other hand, it indicates young people's awareness of this fact, showing that they are willing to acquire this type of knowledge and recognize that technology can be an

ally for oral health education. Knowledge about diseases and the consequences of poor oral hygiene are referred to as important factors that favor behavior change due to promoting the individual's need and motivation to change.³⁷

According to Bandura's self-efficacy theory,³⁸ behavior change is based on the individuals' beliefs about their own abilities to exercise control over events that affect their daily lives. In oral health, MHealth apps can be a good tool to improve the self-effectiveness of individuals who use them, particularly in more technical procedures such as toothbrushing and dental flossing. Thus, combining oral health appointments with the use of MHealth apps may improve the understanding of oral hygiene instructions provided by the professional and, consequently, improve oral health self-care.³⁹

The internet is currently widely used for information searches, with oral health being no exception. The 2022 Oral Health Barometer⁴⁰ found that 7.5% of the Portuguese population used the internet, more specifically generalist websites, as the first option to search for oral health information, 18.5% as the second option, and 21.1% as the third option. It is important that users are well-informed, and an app, if built based on scientific evidence, can direct its user to credible and correct information. The problem is that there are no regulations for the development of apps,⁶ there may be incorrect information, and not all oral health information applies to all cases.

Reminders for oral health appointments, a toothbrushing timer, step-by-step toothbrushing techniques, and instructions on dental flossing were also frequently mentioned as important features by the participants. The high percentage of responses regarding these various features may indicate some lack of confidence in daily oral hygiene self-care and the need to improve the population's oral health literacy. The role of oral health professionals is essential in this aspect of oral health education, and technology will be useful as a complement to promote oral health.

A study by Mendiola et al.⁴¹ concluded that users give importance to apps that are easy to use, save time, and provide specific instructions for maintaining a given condition. This last feature aligns with this study's results, which indicated that explaining toothbrushing or dental flossing techniques is important. Although social media connection and gamification are present in apps with the highest number of downloads,^{27,42} in this study, these features were not the most highlighted, even though a significant number of participants indicated them.

Despite considering that apps related to oral health are useful, only a few participants in this study reported already using one and, in all cases, an app associated with their electric toothbrush company brand. These results show that young Portuguese adults still do not look for apps to improve their oral health unless they are associated with a purchased product. The indication by the oral health professional of an app that can support and promote oral health in a more frequent and sustained way might be a path to explore in this population to improve their oral health literacy, behaviors, and other oral health indicators. Moreover, the positive and negative aspects reported by this study's participants should be considered when developing apps related to oral health motivation and promotion in the Portuguese population.

Some studies that analyzed the impact of oral health motivation apps concluded that using these apps contributed to improved oral health indicators. In a 4-week study, there were significant improvements in the plaque index of adults using an app that provided real-time step-by-step toothbrushing instructions, compared to adults using an app that only recorded toothbrushing frequency.³⁴ Another study⁴³ showed that using a motion-sensing device attached to a manual toothbrush and associated with an app that allowed real-time visualization of step-by-step toothbrushing led to significant improvements in the plaque index.

Despite the results obtained in this study, it should be noted that instructions and information alone do not change behaviors; they are a part of the strategy. Behavior change also depends on internal beliefs³⁸ and the demands and expectations of an individual's life routine.⁴⁴ So, the involvement of the oral health professional in oral health behavioral change is fundamental, and the oral health professional must explain to patients why behavioral changes need to happen and how they can do it.⁴⁵ Apps can be another method for healthcare professionals to motivate their patients to engage in oral health self-care.

This study has some limitations, namely its convenience sample and the methodology for data collection by online questionnaire, so the extrapolation of its conclusions should be cautious. However, it represents an exploratory study that contributes to the research of this theme in the Portuguese population.

Conclusions

Most participants found oral health MHealth apps a useful complement for oral health motivation. However, only a small minority reported having used these apps before. The features most frequently considered useful were information about oral diseases, oral health appointment reminders, a toothbrushing timer, and step-by-step toothbrushing instructions. The functionalities highlighted and the positive and negative aspects mentioned by the participants who had already used these kinds of apps may be useful for developing apps more focused on the population's expectations.

Conflict of interest

The authors have no conflicts of interest to declare.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that they have followed their work center protocols on access to patient data and for its publication.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Joana Costa: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Validation, Writing – original draft. **Sónia Mendes:** Conceptualization, Methodology, Supervision, Validation, Writing – review & editing.

ORCID

Joana Costa  0009-0009-3213-8526

Sónia Mendes  0000-0001-8831-5872

REFERENCES

- Petersen P, Ogawa H. The global burden of periodontal disease: towards integration with chronic disease prevention and control. *Periodontol* 2000. 2012;60:15-39.
- Vergnes J, Mazevet M. Oral diseases: a global public health challenge. *Lancet* 2020;395(10219):186.
- World Health Organization (WHO). Global oral health status report: towards universal health coverage for oral health by 2030. WHO 2022. Available from: <https://www.who.int/publications/i/item/9789240061484>. Accessed 27 May, 2023.
- Glick M, Williams DM, Kleinman DV, Vujicic M, Watt RG, Weyant RJ. A new definition for oral health developed by the FDI World Dental Federation opens the door to a universal definition of oral health. *J Am Dent Assoc*. 2016;147:915-7.
- Direção-Geral da Saúde. III Estudo Nacional de Prevalência das Doenças Orais 6, 12, 18, 35-44 e 65-74 anos. 2015 p. 63-93. Available from: <https://www.ond.pt/content/uploads/2017/12/epidemiologico2015omd.pdf>. Accessed 27 May, 2023.
- EParker K, Bharmal RV, Sharif MO. The availability and characteristics of patient-focused oral hygiene apps. *Br Dent J*. 2019;226:600-4.
- Topic: Mobile app usage. Statista. 2021. Available from: <https://www.statista.com/topics/1002/mobile-app-usage/#dossierKeyfigures>. Accessed 28 April, 2023.
- Nielsen. Millennials Are Top Smartphone Users. 2016. Available from: <https://www.nielsen.com/us/en/insights/article/2016/millennials-are-top-smartphone-users/#:~:text=When%20looking%20at%20smartphone%20owners%20by%20age%2C%20penetration,making%20smartphones%20nearly%20ubiquitous%20among%20these%20generational%20segments>. Accessed 20 March, 2023.
- Ceci L. Annual number of mobile app downloads worldwide 2021. Statista 2022. Available from: <https://www.statista.com/statistics/271644/worldwide-free-and-paid-mobile-app-store-downloads/>. Accessed 25 April, 2023.
- Barroso M. Cerca de 73 habitantes em cada 100 têm internet no telemóvel. *Jornal Expresso*, 2019. Available from: <https://expresso.pt/economia/2019-05-21-Cerca-de-73-habitantes-em-cada-100-tem-internet-no-telemovel>. Accessed 27 May, 2023.
- 7,2 milhões de portugueses usam smartphone. *Marktest*, 2021. Available from: <https://www.marktest.com/wap/a/n/id-2700.aspx>. Accessed 25 May, 2023.
- Statista Forecast of smartphone user numbers in Portugal from 2015 to 2022 (in million users). Statista, 2022. Available at: <https://www.statista.com/statistics/566177/predicted-number-of-smartphone-users-in-portugal/>. Accessed 25 May, 2023.
- Silver L, Huang C, Taylor K, Researcher S, Cohn S, Cornibert S. In Emerging Economies, Smartphone and Social Media Users Have Broader Social Networks Digital technology users say they more regularly interact with people from diverse backgrounds for media or other inquiries. Pew Research Center, 2019. Available from: <https://www.pewresearch.org/internet/2019/08/22/in-emerging-economies-smartphone-and-social-media-users-have-broader-social-networks/>. Accessed 26 May, 2023.
- Ryu S. Book Review: mHealth: New Horizons for Health through Mobile Technologies: Based on the Findings of the Second Global Survey on eHealth (Global Observatory for eHealth Series, Volume 3). *Healthc Inform Res*. 2012;18:231-3.
- Garside J. Ofcom: sixyearolds understand digital technology better than adults. 2014. Available from: <https://www.theguardian.com/technology/2014/aug/07/ofcom-children-digital-technology-better-than-adults>. Accessed 25 May, 2023.
- Jahns R. 500m people will be using healthcare mobile applications in 2015. 2010. Available from: <https://research2guidance.com/500m-people-will-be-using-healthcare-mobile-applications-in-2015-2/>. Accessed 25 May, 2023.
- Tiffany B, Blasi P, Catz SL, McClure JB. Mobile Apps for Oral Health Promotion: Content Review and Heuristic Usability Analysis. *JMIR Mhealth Uhealth*. 2018;6:e11432.
- McKay FH, Cheng C, Wright A, Shill J, Stephens H, Uccellini M. Evaluating mobile phone applications for health behaviour change: A systematic review. *J Telemed Telecare*. 2018;24:22-30.
- Zahid T, Alyafi R, Bantan N, Alzahrani R, Elfirt E. Comparison of effectiveness of mobile app versus conventional educational lectures on oral hygiene knowledge and behavior of high school students in Saudi Arabia. *Patient Prefer Adherence*. 2020;14:1901-9.
- Hamilton ME, Coulby WM. Oral health knowledge and habits of senior elementary school students. *J Public Health Dent*. 1991;51:212-9.
- Silva AM, Hedge S, Nwagbara BA, Calache H, Gussy MG, Nasser M, et al. Community-based population-level interventions for promoting child oral health. *Cochrane Database Syst Rev*. 2016;9:CD009837.
- Al Subait AA, Alousaimi M, Geeverghese A, Ali A, El Metwally A. Oral health knowledge, attitude and behavior among students of age 10-18 years old attending Jenadriyah festival Riyadh; a cross-sectional study. *Saudi J Dent Res*. 2016;7:45-50.
- Peltzer K, Pengpid S. Oral health behaviour and social and health factors in university students from 26 low, middle and high income countries. *Int J Environ Res Public Health*. 2014;11:12247-60.
- Angelopoulou M, Kavvadia K, Oulis C, Reppa C. Oral hygiene facilitators and barriers in greek 10 years old schoolchildren. *Int J Clin Pediatr Dent*. 2015;8:87-93.
- O'Mullane DM, Baez RJ, Jones S, Lennon MA, Petersen PE, Rugg-Gunn AJ, et al. Fluoride and oral health. *Community Dent Health*. 2016;33:69-99.
- Chen R, Santo K, Wong G, Sohn W, Spallek H, Chow C, et al. Mobile apps for Dental Caries Prevention: A Systematic Search and Quality Evaluation. *JMIR Mhealth Uhealth*. 2021;9:e19958.
- Mendiola MF, Kalnicki M, Lindenaeur S. Valuable features in mobile health apps for patients and consumers: content analysis of apps and user ratings. *JMIR Mhealth Uhealth*. 2015;3:e40.
- UserTesting. California: User Testing: c2018. UserTesting platform; 2016. Available from: <https://www.usertesting.com/platform>. Accessed 25 May, 2023.
- Fjeldsoe BS, Marshall AL, Miller YD. Behavior change interventions delivered by mobile telephone short-message service. *Am J Prev Med*. 2009;36:165-73.

30. Nolen SL, Giblin-Scanlon LJ, Boyd LD, Rainchuso L. Development and Testing of a Smartphone Application Prototype for Oral Health Promotion. *J Dent Hyg.* 2018;92:6-14.
31. O'Brien MAT, Freemantle N, Oxman AD, Wolf F, Davis DA, Herrin J. Continuing education meetings and workshops: Effects on professional practice and health care outcomes. *Cochrane Database Syst Rev.* 2001;(2):CD003030.
32. Zotti F, Zotti R, Albanese M, Nocini PF, Paganelli C. Implementing post-orthodontic compliance among adolescents wearing removable retainers through Whatsapp: a pilot study. *Patient Prefer Adherence.* 2019;13:609-15.
33. Ay ZY, Sayin MO, Ozat Y, Goster T, Atilla AO, Bozkurt FY. Appropriate oral hygiene motivation method for patients with fixed appliances. *Angle Orthod.* 2007;77:1085-9.
34. Shida H, Okabayashi S, Yoshioka M, Takase N, Nishiura M, Okazawa Y, et al. Effectiveness of a digital device providing real-time visualized tooth brushing instructions: a randomized controlled trial. *PLoS One.* 2020;15:e0235194.
35. Alkadhi OH, Zahid MN, Almanea RS, Althaqeb HK, Alharbi TH, Ajwa NM. The effect of using mobile applications for improving oral hygiene in patients with orthodontic fixed appliances: a randomised controlled trial. *J Orthod.* 2017;44:157-63.
36. Luxton DD, McCann RA, Bush NE, Mishkind MC, Reger GM. mHealth for mental health: Integrating smartphone technology in behavioral healthcare. *Professional Psychology: Research and Practice.* 2011;42:505-12.
37. Kwasnicka D, Dombrowski SU, White M, Sniehotta F. Theoretical explanations for maintenance of behaviour change: a systematic review of behaviour theories. *Health Psychol Rev.* 2016;10:277-96.
38. Bandura A. Self-efficacy: toward a unifying theory of behavioral change. *Psychol Rev.* 1977;84:191-215.
39. Tonizazzo P, Nodari D, Muniz FW, Weidlich P. Effect of mHealth in improving oral hygiene: a systematic review with meta-analysis. *J Clin Periodontol.* 2019;46:297-309.
40. Ordem dos Médicos Dentistas (OMD). Barómetro da saúde oral. 7a edição. Portugal; OMD 2022. Available from: <https://www.ond.pt/2022/11/barometro-saude-2022/>. Accessed 25 May, 2023.
41. Gans C, Schlueter N, Preiss S, Klimek J. Tooth brushing habits in uninstructed adults – frequency, technique, duration and force. *Clin Oral Investig.* 2009;13:203-8.
42. Curry D. Most Popular Apps (2022). *Business of Apps*, 2022. Available from: <https://www.businessofapps.com/data/most-popular-apps/>. Accessed 26 May, 2023.
43. Kay E, Shou L. A randomised controlled trial of a smartphone application for improving oral hygiene. *Br Dent J.* 2019;226:508-11.
44. Suvan JE, Sabalic M, Araújo MR, Ramseier CA. Behavioral strategies for periodontal health. *Periodontol* 2000. 2022;90:247-61.
45. Arlinghaus KR, Johnston CA. Advocating for Behavior Change With Education. *Am J Lifestyle Med.* 2017;12:113-6.