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Patients' oral health behaviour modifying mobile application development and research protocol for its usability assessment

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Abstract

Background. There is a lack of mobile applications monitoring the periodontal status of patients and updating the dentist or the patient about dental health during the interval between visits.

Aim. The article is aiming to explain the development of „Mobile dental hygienist app" and to describe the protocol assessing the usability of the app.

Methods. The mobile application usability assessment study will be conducted according to the study plan. Starting with the selection of patients by inclusion criteria, a pilot study is conducted, followed by the main study with three stages (T0; T1; T2).

Results. The newly developed mobile application titled "Mobile dental hygienist" is available to two types of users: the patient and the oral care professional. A conversation with a specialist and self-evaluation questionnaire are available choices for the patients on the menu. Dental hygienist receives information from the patient in case the patient writes a message in the interview field or if he answers the questionnaire question in the affirmative. "Mobile dental hygienist app" installed in personal mobile devices could be useful in improving self – evaluation, the status of dental hygiene and oral health in general.

Conclusions. Technology innovations can potentially improve tooth brushing quality in children and adult persons and increase self-awareness in oral health. Future research should continue to evaluate mobile applications as part of intervention approaches to improve oral health behaviours and outcomes in vulnerable populations.

Keywords: mobile application, oral health behaviour, research protocol, usability assessment.

1. Introduction

Mobile devices are considered as useful means to deliver health interventions because of their widespread adoption, powerful technical capabilities, portability – people tend to have their mobile phones on them at most times and form strong emotional attachments to them. People spend more time with their mobile phones than with their partners or at work, meaning health intervention can be delivered anytime and anywhere [1].

Some features of smartphones that make them suitable for behavioural interventions include: (1) they are portable devices that are extremely popular among people specially adolescents. (2) Smartphone applications (apps) are a more economical and favourable way of intervention. (3) The capability of smartphones for a convenient connection facilitates the distribution of health-related information and provision of behavioural interventions [2].

Chronic conditions are an increasing challenge for individuals and the health care system. Smartphones and health apps are potentially promising tools to change health-related behaviours and manage chronic conditions. – One of the population-based surveys has found that 61.25 % (2538/4144) of participants used a smartphone. Compared with nonusers, smartphone users were younger, did more research on the Internet, were more likely to work full-time and more likely to have a university degree and had a higher health-related quality of life and health literacy. Among smartphone users, 20.53 % (521/2538) used health apps. The most common app characteristics were planning (264/521, 50.7%), reminding (188/521, 36.1 %), prompting motivation (179/521 34.4 %), and the provision of information (175/521, 33.6 %). Significant associations were found between feedback or monitoring and adherence to doctor's advice. Health app use may reflect a user's motivation to change or maintain health behaviours [3].

Long-term health management is challenging for the rapidly growing number of patients with chronic diseases. Smartphone interventions offer promising solutions. The studies found that the smartphone intervention was a completely or at least partially effective tool to assist in managing some chronic diseases. With the help of health-related smartphone apps, patients with chronic conditions (1) felt secure in the knowledge that their illnesses were closely monitored, (2) participated in their own health management more effectively, and (3) felt that they had not been forgotten by their doctors and were taken good care of even outside the hospital/clinic [4].

In the US, 56 % of citizens own a smartphone capable of connecting to the internet and downloading content [5]. About a quarter of children use their smartphones more than 5 hours a day, and about 46 % of teens aged 12-17 years surf the internet for 4 hours a day (browsing from their smartphones or computers) [6].

1.1. Mobile applications use for patient education in dental medicine

Maintenance of self-care behaviours such as oral hygiene can delay the onset of orofacial diseases (primary prevention) or decrease or slow down their effects when they become chronic (secondary or tertiary prevention). In the first case, interventions concern the field of health education, while in the second they consist of patient education actions and/or programmes. Patient education actions can be short, while the programmes are made up of several sessions over time. The review of the recent scientific literature on patient education in dentistry and dental hygiene puts into evidence the limited number of

publications on this topic, despite the need to use patient education as a strategy of secondary or tertiary prevention in several chronic oral diseases and conditions. It has been shown, through the analysis of a limited number of studies, that patient education can bring real benefits to the patient at both the bio clinical and psycho-cognitive levels: overall, it allows them to better understand their disease and the treatment and to improve their self-care behaviour. The systemic literature review has revealed some specific educational strategies being implemented in patient education, such as computer-assisted instruction in 3D video format, YouTube, Webchat, face to face education using motivational interviewing techniques, the practice of manual dexterity and a short, structured diary [7]. Also, new technology such as a Smart Mirror, which have been developed to keep user fit and healthy [8].

Recently, the novel coronavirus (COVID-19) pandemic has highlighted the need for remote communication when patients and dentists cannot meet in person. Gingivitis is very common and characterized by red, swollen, bleeding gums. Gingivitis heals within 10 days of professional care and with daily, thorough oral hygiene practices. If left untreated, however, its progress may lead to teeth becoming mobile or lost. Of the many medical apps currently available, none monitor gingivitis. The study aimed to present a characterization and development model of a mobile health (m-Health) app called iGAM, which focuses on periodontal health and improves the information flow between dentists and patients. iGAM is the first mHealth app for monitoring gingivitis using self-photography. iGAM facilitates the information flow between dentists and patients between check-ups and may be useful when face-to-face consultations are not possible (such as during the COVID-19 pandemic) [9].

Due to apps being largely unregulated, the quality and accuracy of the information provided can be variable. In total, 1,075 apps were identified with fewer apps available on the App Store than on Google Play. The 20 most popular apps for each search term focused on providing oral hygiene information, were free of charge and were developed after 2015. No apps contained information regarding whether they were approved by official organisations and if effectiveness or acceptability testing had been conducted. App ratings were variable and unrelated to the quality and accuracy of the information. Due to a lack of professional regulation, there is a risk that patients may access inaccurate information via apps. Therefore, evaluation, validation, and quality assessment of healthcare apps is needed before recommending these to patients [10].

The aim of the article is to explain the development of Mobile dental hygienist app and to describe the protocol assessing the usability of the newly developed app.

2. Methods

2.1. Development of Mobile Dental Hygienist Mobile Application

Mobile Dental Hygienist (further MDH) application was created by following the recommendations for mobile application creation, adopted by the FDI General Assembly September 2018 in Buenos Aires, Argentina [11] stating that dental health apps should be: developed following thorough scientific literature analysis; using native language of users; ensuring data safety; informative about purpose of the app (diagnosis, treatment, education or self-assessment); developed by dental professionals and clearly declaring financial interests of creators. The team of investigators consisted of three dental hygienists (two of them have PhD in public health), public health specialist,

occupational therapist, PhD in education, dental hygiene student and information technology student. The MDH app was created after scientific literature analysis, using the data bases PubMed Medline with key words e-health, dental apps, mHealth, Tele-dentistry, app usability etc. The team of investigators created five questions for oral health status self–evaluation, which were introduced in this application. The five questions representing main indicators of oral health status (presence/absence of gingival bleeding, edema, redness, bad breath, soft plaque and calculus). The questions are illustrated with pictures, having only two answer options YES/NO in Lithuanian language. MDH app is not used for diagnosis and treatment of periodontal diseases, and the patients using this app receive this important information in a process of downloading it. The app is developed for educational and scientific purposes, so it is free from advertising and developers have no financial interests. For the purpose of verifying the employee's personal login and the use and management of data granted only to him, user access is restricted with a login name and password that are known only to the user and the person administering the app.

The MDH app is available for two types of users: the patient and the oral care professional. In the first window of the MDH app, a user selection is possible, going to the login field. The patient can choose one out of three functions: a conversation with a specialist or questionnaire or additional information. The specialist can choose one out of two functions: a patients' list or additional information. Dental hygienist receives information from the patient in case the patient writes a message in the interview field or if he gives at least one affirmative answer to the self-evaluation question. In the conversation field, the specialist can contact the patient himself (Fig.1).

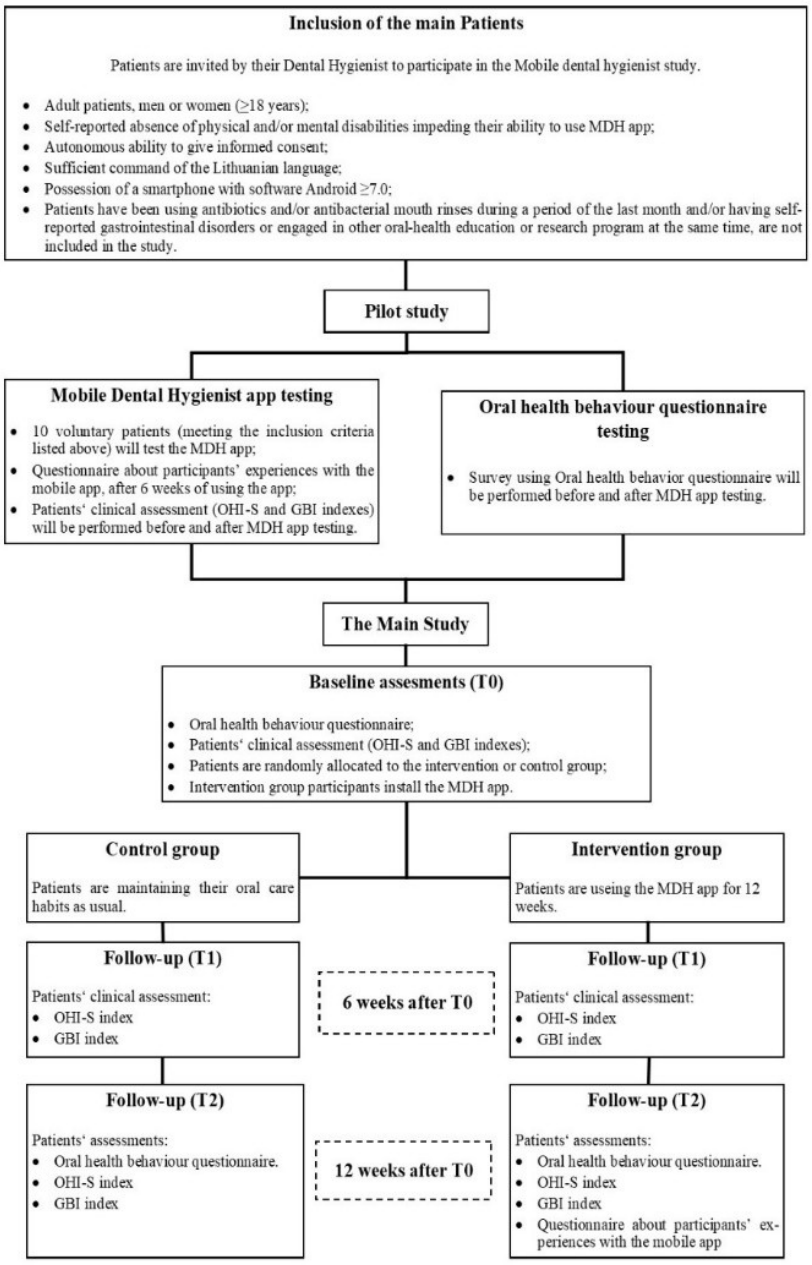
2.2. Requirements for Research Environment

Patients will be examined by assessing OHI-S (Oral Hygiene Index-Simplified) and GBI (Gingival Bleeding Index) in a dental chair by dental hygienist or dental hygiene students supervised by a registered dental hygienist. In the examination area high noise level, loud conversations should be avoided. Subjects should not be permitted to crowd around the examiner. A complete examination of an adult patient may take between 15 and 20 minutes. The examination will be done in dental chair using plane mouth mirror, explorer, and non-waxed dental floss [12].

2.3. Research Design

The study will be conducted according to the research design (Fig. 2). Starting with the selection of patients by inclusion criteria, a pilot study is conducted, followed by the main study with three stages (T0; T1; T2).

Figure 2. *Research design*



2.4. Pilot study

The purpose of the pilot study is to test the MDH app and oral health behavior questionnaire. 10 voluntary patients will participate in this pilot study. All ten participants will be using the MDH app for 6 weeks. Before downloading the app to their smartphones and after 6 weeks of using the app, participants will be clinically assessed (OHI-S and GBI indexes) (Fig. 2).

Questionnaire about participants' experiences with the MDH app will be given to participants of a pilot study (after 6 weeks of using the app). This questionnaire will assess acceptability, operability, attractiveness of the app; users' perceptions of several components of the app, intention to use the app, perceived effectiveness, and usability. This questionnaire will use the following 6-point scale: 0: not applicable, 1: very bad, 2: bad, 3: neither good, nor bad, 4: good, 6: very good. Changes to the app will be done according to this evaluation after the pilot study (if participants of the pilot study report any changes needed). The same questionnaire will be given to an intervention group participants in T2 stage of a main study (Fig. 2).

The *Oral health behavior questionnaire* will be administered to the participants during pilot study too. The first part of the questionnaire includes questions on the participants' demographic background and any possible confounding variables (age, sex, education level and smoking status). The second part of the questionnaire contains questions with both single-response and multiple-response items on oral-health behaviors and their psychosocial factors. This questionnaire was derived from earlier study that tested the effect of a smartphone application on oral-health behavior and oral hygiene in adolescents with fixed orthodontic appliances [13]. Participants will be asked to report the frequency with which they use a toothbrush, a proxy brush, dental floss, toothpicks, mouth rinse, and other dental aids. It will use the following 7-point scale: 1: less than twice a month or never, 2: twice a month, 3: once a week, 4: two to three times weekly, 5: once daily, 6: twice daily, and 7: three times daily or more. For the analysis, these response options will be recalculated to establish the weekly frequencies of each of the oral-health behavior. The same questionnaire will be given to an intervention and control groups' participants in stages T0 and T2 of a main study (Fig. 2).

2.5. Baseline assessments in the main study

The main study participants will be included in the study following the inclusion criteria (Fig. 2). Randomization to the intervention group or control group will be performed at the patients' level. A researcher who is not involved in data collection or analysis, will use random sequence generator (http://www.random.org) to allocate patients in a random sequence to the intervention or control group (30 participants in each group). In a separate room after completion of the baseline assessments (Fig.2), an independent researcher will inform each participant to which group he/she has been allocated. The persons assigned to an intervention group, will be assisted in installing the MDH app on their smartphone and will be provided with an information on how to use it.

2.6. Clinical assessment

Clinical assessment of participants of the study will be performed at T0, T1 and T2 stages of the study (Fig. 2). Many plaque index systems have been used to help improve patients' oral hygiene. A good index system for daily practice must be simple and versatile, so that it is easily understood by inexperienced examiners and can be reproduced by different clinicians [14]. Two indexes were chosen

to be performed to assess patients' oral health – OHI-S and GBI.

Simplified Oral Hygiene Index (OHI-S) will be used to evaluate patients' oral hygiene status. The OHI-S, like the OHI, has two components, the Debris Index and the Calculus Index. The six surfaces examined for the OHI-S are selected from the 4 posteriors and 2 anterior teeth. Criteria for classifying debris: 0 no debris or stain present; 1 soft debris covering not more than 1/3 of the tooth surface or presence of extrinsic stain without other debris regardless of surface area covered; 2 soft debris covering more than 1/3 but not more than 2/3 of the exposed tooth surface; 3 soft debris covering more than 2/3 of the exposed tooth surface. Criteria for classifying calculus: 0 No calculus present; 1 Supragingival calculus covering not more than third of the exposed tooth surface; 2 Supragingival calculus covering more than one third but not more than two thirds of the exposed tooth surface or the presence of individual flecks of subgingival calculus around the cervical portion of the tooth or both; 3 Supragingival calculus covering more than two third of the exposed tooth surface or a continuous heavy band of subgingival calculus around the cervical portion of the tooth or both.

Gingival bleeding is an objective, easily assessed sign of inflammation that is associated with several periodontal diseases [15].

Gingival Bleeding Index (GBI) [16]. This index enables to determine the presence of disease by observing bleeding of the gingiva. Bleeding upon flossing indicates disease and this will help determine the gingival/oral condition of the patient's mouth.

Analysis plan of the study results

The participants' characteristics will be summarized using descriptive statistics (mean, standard deviation, frequency). Two analyses will be performed: 1) to evaluate the overall intervention effect, 2) to evaluate the intervention effect at different follow-up times.

Ethical Considerations

The study protocol must be approved by the local Bioethical Committee, ensuring the confidentiality and informed consent of the investigated persons.

3. Discussion

The article describes the protocol to evaluate the usability effectiveness of the Mobile dental hygienist app. We hypothesize that this app will cause greater improvements in oral health behavior and oral hygiene outcomes (presence of dental plaque, gingival bleeding), and finally motivate to take better oral hygiene daily routine.

By making study objectives and methods known, the publication of the study protocol will improve the eventual usefulness of the study [17].

The process evaluation will provide additional insight into the effective ingredients of the intervention and into the feasibility of the intervention for the target group. Understanding of these issues will underlie the post-trial adjustments necessary to enhancing the effectiveness of Mobile dental hygienist app.

As we mentioned earlier, there is a lack of apps that monitor gingivitis. Now in 2020, there are no available mHealth apps that monitor the periodontal status of patients, update the dentist or the patient about dental health during the interval between visits. To our knowledge, this is one of the first studies evaluating technology innovations which could improve and increase self –evaluations in oral health in Lithuania.

This app will offer the patient not only to answer into 5 questions, but also help them to contact with dental hygienist for suggesting what to do next. First, offers to evaluate oral health status; second,

dental hygienist receives the data, professionally evaluates them; third, offers a solution to improve patients' oral health condition.

We hope this system will gain very high appreciations from both dental hygienists (or other dental professionals) and patients who will confirm its usefulness in dental services field. This system could significantly help to rearrange patient appointments, especially for those with sudden worse of oral health. If dental hygienist could monitor patients' data regularly, the occurrence of many problems related with oral health could be reduced.

Good oral-health behavior should be maintained continuously over a long period of time. As habit-formation takes an average of 66 days [18], we expect that our intervention will be long enough to guarantee a long-term behavior change.

We should also mention some limitations of the study. Data on oral-health behavior and its psychosocial factors will be self-reported. Self-reported measures are prone to bias. One more limitation is that the participants in the control group might also undergo some changes in oral health behavior, which may conceivably be induced by questions about their behavior. Behavior can be increased or changed simply if questions are asked about participants' behavior [19].

"Mobile dental hygienist" installed in personal mobile devices could be useful in improving self – evaluation, the status of dental hygiene and maybe we can say even whole oral health. In addition, all data can be used for further development and improvement of the program and even further research works.

4. Conclusions

Technology innovations can potentially improve tooth brushing quality in children and adult persons and increase self-awareness in oral health. Innovative means need to be designed to achieve long-term, sustained improvements in tooth brushing and oral health. Future research should continue to evaluate mobile applications as part of intervention approaches to improve oral health behaviours and outcomes in vulnerable populations.

References

1. Underwood B, Birdsall J, Kay E. (2015). The Use of a Mobile App to Motivate Evidence-Based Oral Hygiene Behaviour. *British Dental Journal*, 219(4), 2.

2. Farhadifard H, Soheilifar S, Farhadian M, Kokabi H, Bakhshaei A. (2020). Orthodontic patients' oral hygiene compliance by utilizing a smartphone application (Brush DJ): a randomized clinical trial. *BDJ Open*, 6 (24). doi: 10.1038/s41405-020-00050-5.

3. Ernsting C, Dombrowski S, Oedekoven M, Sullivan J O, Kanzler M, Kuhlmey A, Gellert P. (2017). Using Smartphones and Health Apps to Change and Manage Health Behaviours: A Population-Based Survey. *Journal of Medical Internet Research*, 19(4), 101. doi: 10.2196/jmir.6838.

4. Wang J, Wang Y, Wei Ch, Yao N A, Yuan A, Shan Y, Yuan Ch. (2014). Smartphone interventions for long-term health management of chronic diseases: an integrative review. *Telemedicine Journal and e- Health*, 20(6), 570-83. doi: 10.1089/tmj.2013.0243.

5. Panova T, Carbonell X. (2018). Is smartphone addiction really an addiction? *Journal of Behavioral Addictions*, 7(2), 252-259.

6. Kaur N, Gupta M, Malhi P, Grover S. (2019). Screen Time in Under-five Children. *Indian Pediatrics*, 56(9), 773-788.

7. Albano MG, d'Ivernois JF, Andrade V, Levy G. (2019). Patient education in dental

medicine: A review of the literature. *European Journal of Dental Education*, 23(2), 110-118.

8. Safa M, Meenakshi K, Saranya G, Geetha G, Dr.Karpagaselvi S. (2020). Enhancing Smart Mirror with Human Health Care Perspective towords Intelligence in IoT Based Environment. *2020 2nd International Conference on Power, Energy, Control and Transmission Systems.*

9. Tobias G, Spanier AB. (2020). Developing a Mobile App (iGAM) to Promote Gingival Health by Professional Monitoring of Dental Selfies: User-Centered Design Approach. *Journal of Medical Internet Research*, 8(8), 19433. doi:10.2196/19433.

10. Parker K, Bharmal RV, Sharif MO. (2019). The availability and characteristics of patient-focused oral hygiene apps. *British Dental Journal*, 226(8), 600-604. doi:10.1038/s41415-019-0197-7.

11. FDI Policy Statement Toolkit, 2019. https://www.fdiworlddental.org/sites/default/files/2021-02/FDIPolicy_Statement_Toolkit-2019_EN.pdf

12. World Health Organization. (2013). Oral Health Surveys. Basic methods. 5th Edition.

13. Scheerman JFM, van Meijel B, van Empelen P, et al. (2018). Study protocol of a randomized controlled trial to test the effect of a smartphone application on oral-health behaviour and oral hygiene in adolescents with fixed orthodontic appliances. *BMC Oral Health*, 18(1), 19. doi:10.1186/s12903-018-0475-9.

14. Park Se-Ho, Cho Sung-Hee, Han Ji-Young. (2018). Effective professional intraoral tooth brushing instruction using the modified plaque score: a randomized clinical trial. *Journal of Periodontal Implant Science*, 48(1), 22–33. doi: 10.5051/jpis.2018.48.1.22.

15. Newbrun E. (1996). Indices to Measure Gingival Bleeding. *Journal of periodontology*. doi:10.1902/jop.1996.67.6.555.

16. Carter HG, Barnes GP. (1974). The Gingival Bleeding Index. *Journal of Periodontology*, 45(11), 801-805.

17. Godlee F. (2001). Publishing study protocols: making them more visible will improve registration, reporting and recruitment. *BMC News Views*, 2(1), 4.

18. Gardner B, Lally P, Wardle J. (2012). Making health habitual: the psychology of "habit-formation" and general practice. *The British Journal of General Practice*, 62(605), 664–6. doi:10.3399/bjgp12X659466.

19. Wilding S, Conner M, Sandberg T, Prestwich A, Lawton R, Wood C, Miles E, Godin G, Sheeran P. (2016). The question-behavior effect: a theoretical and methodological review and meta-analysis. *European Review Social Psychology*, 27, 196–230.