

Mobile applications for dental education and assistance: an integrative review

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Received Dec. 9, 2017. Approved July 29, 2018.

ABSTRACT

This study aimed to identify the current state of the art and trends of research using mobile applications in Dentistry through an integrative review. SciELO, LILACS and PubMed databases, using the terms "mobile application", "Dentistry" and "informatics", and in Google Scholar, to cover the gray literature, with the same terms in the Portuguese language, without time limitation were searched. The titles and abstracts of all articles found were read independently by two researchers. Studies based on primary data that were related only to oral health, whose medium of information was smartphones, in the English, Portuguese and Spanish languages were included. Also, articles published in scientific journals were analyzed in relation to the items assigned in the STROBE Statement checklist. There were 911 studies. After reading all the titles and abstracts, 897 were excluded, totaling 14 studies for reading in full. Nine articles were included in the study, classified in studies with a professional focus (6) and studies with an academic focus (3). The data described in the studies have shown the increasing adoption the applications use as educational and assistance resources. The creation of mobile applications directed to Dentistry is appropriate, both in teaching, as a new possibility to build knowledge, and for professional use, since the global dissemination of the use of mobile devices is undeniable.

Descriptors: Mobile application. Dentistry. Informatics.

1 INTRODUCTION

Mobile technology is an increasing practice in society, and the widespread use of smartphones have allowed a new exchange, delivery and obtaining information profile among the users of this service¹. This ubiquitous use of the smartphone among most demographic groups has created opportunities for practitioners to implement several real-time health-related interventions using universally available resources². Thus, developing mobile application solutions provides an effective means of delivering tools as well as reaching the desired target audience, either professionals and/or patients³.

In Dentistry, the increasing demand in the use of these technologies aims to facilitate the daily practice of the dental professional, be it as manager, clinician, researcher or university professor⁴. A large part of health professionals' tasks consists of processing information: obtaining and recording patient's data, consulting their colleagues in the profession, researching specific scientific literature, diagnostic procedures, treatment planning and strategies, interpretation of examinations or guiding epidemiological studies^{1,5}. In this context, the use of mobile devices can enhance as well as expedite these activities, optimizing the work time of these professionals and providing benefits to the general population.

Furthermore, the literature has highlighted the benefit of using information and communication technologies as an educational tool, in Dentistry. The traditional way of teaching has been sharing place with e-learning courses, simulators of clinical procedures, real-time communication software, among others. The importance of these tools is the ability to allow students to search and select information, independently learn and solve problems⁶.

Thus, the aim of this study has been to identify, through an integrative literature review, the current state of the art and the research trends which use mobile applications in Dentistry.

2 METHODS

For the development of this study an integrative review was carried out aiming at apprehending in the national and international scientific literature on "mobile applications related to oral health". No date filters were searched in the databases SciELO, LILACS, PubMed and Google Scholar, during May 2017.

For the search strategy, the following terms were used in the Descriptors in Health Sciences (DeCS): "mobile application", "Dentistry" and "informatics", with the boolean operator "AND" between each word. Equivalent terms in Portuguese ("mobile applications", "Dentistry", "computing") were also searched in Google Scholar. Indexed articles, theses, dissertations as well as end-of-graduation course manuscripts were all included, with cross-sectional as well as before and after intervention designs.

Two researchers independently read the titles and abstracts of all articles found. Inclusion criteria consisted of primary data related only to oral health, whose information medium was smartphones in English, Portuguese and Spanish. Studies from the literature review and those not related to the theme were excluded. In addition, articles published in scientific periodicals were analyzed in relation to the checklist items of the STROBE Statement. At the end of the published manuscripts analysis, for this study, the interpretation of the findings was performed and the synthesis is presented in tables with the year of publication, place of research, methodology used and results found.

3 RESULTS

From the initial combined database search, 911 documents were retrieved, which after removal of duplicate studies, resulted in 909. No studies identified in other sources such as books or references of the studies found in the database were included. After reading all the titles and abstracts, respecting the inclusion and exclusion criteria, 14 studies were chosen for reading in full. For descriptive analysis, only 9 studies were included. The flowchart presented as figure 1 summarizes the searching.

The studies were classified according to the focus of their planning: professional performance (n = 6) or academic (n = 3) (tables 1 and 2).

All systems with an academic focus were tested by Dentistry undergraduate students. However, only one paper reported the period in which these students were enrolled (4th semester)⁹. In the study carried out by Warmling et al.⁷, the students used the application to study the determinants of caries disease in school attendance, applying the questionnaire which seeks to know the profile of the individual in addition to the oral examination and the subjective perceptions of the professional. The students observed that it would be easier if the application was used in the adult population, due to the difficulties of the children in answering questions such as address and socioeconomic situation. In addition, they suggested that an odontogram and an image bank be included in the application in order to support the diagnosis.

In the study developed by Arus et al.⁸, the authors have created an application in order to enhance the interpretation of the

temporomandibular joint evaluated by magnetic resonance imaging (MRI). The students who used the application were divided into two groups: Test (interactive learning) and Control (conventional learning), for later evaluation of their performance using objective tests, composed of questions related to the position and alterations of temporomandibular joint structures in RM images of a database.

The students' responses were compared to the gold standard (evaluation of three specialists in the field). The conventional learning methodology included theoretical and practical classes in which students evaluated, interpreted, and discussed the same tests used in the Test group, with discussions between students and a professor as moderator. In the Test group, users only interacted with the software, interactions with a professor were not allowed. In response, the Control group (conventional learning) demonstrated better performance. However, when compared with initial assessments, the two groups were found to have significantly improved their performance.

In the study carried out by Pereira et al.⁹, which consisted of the development of a virtual simulator of local anesthesia using the inferior alveolar nerve block technique, 23 volunteer students tested the application using the software freely and the data and technical evolution was collected during one week. As a result, it was observed that the students reported feeling more comfortable and safer to perform the technique in patients after the use of the application. This was shown in the success rate evaluation of these students, which after a week rose from 22.6% to 56.5%.

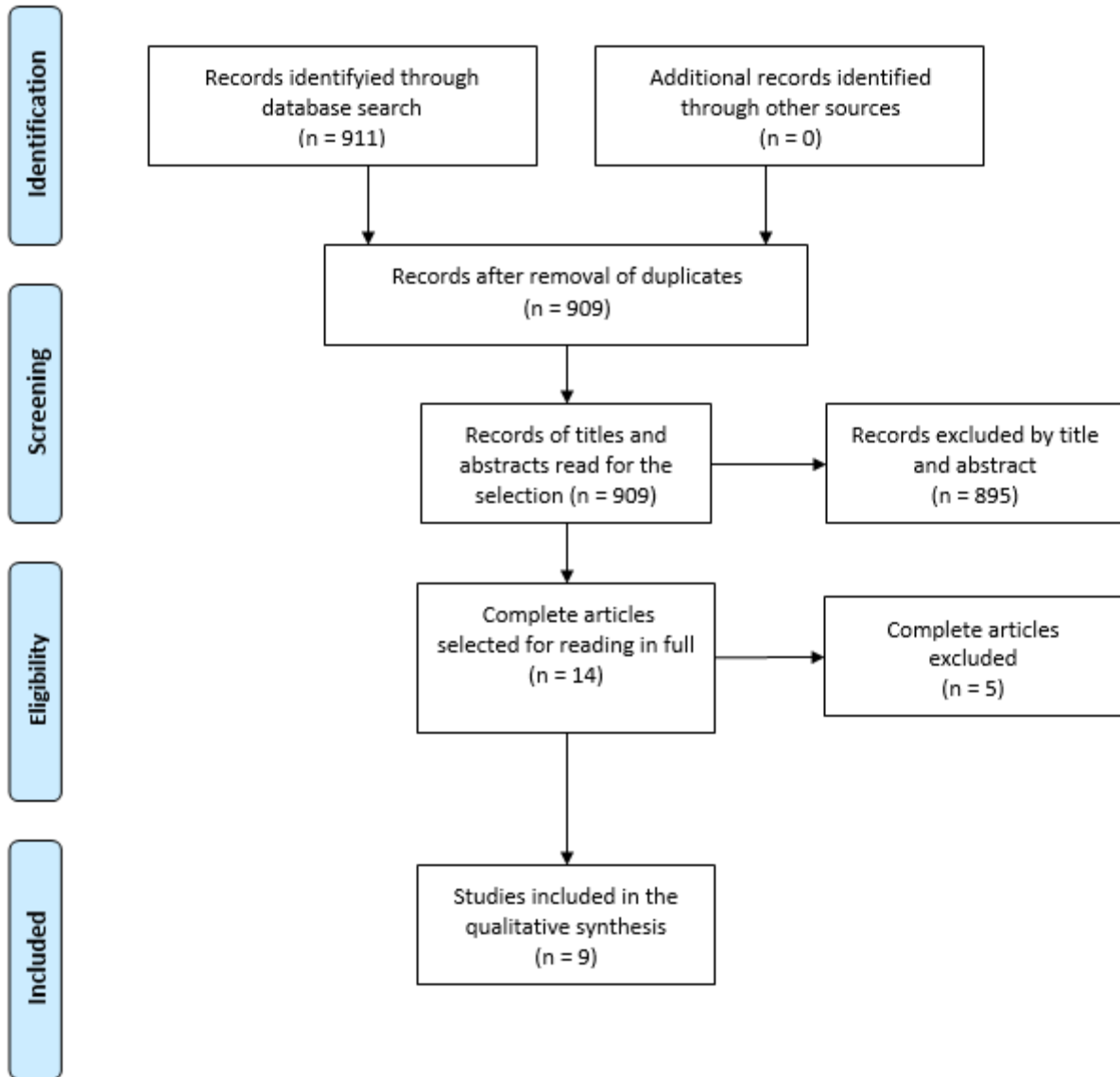


Figure 1. Fluxogram of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)

Table 1. Studies with academic focus, according to authors/year/country, methodology and results

Academic Focus Studies		
Authors/Year/Country	Methodology	Results
Warmling <i>et al.</i> , 2012 ⁷ (Brasil)	Application for teaching-learning of determinants of dental caries. Used by undergraduate students in Dentistry in attendance to schoolchildren	Perception of users: quick and easy to use application, which also pleased the respondents. However, the students suggested its use in the adult population due to some difficulties in the children's responses.
Arus <i>et al.</i> , 2012 ⁸ (Brasil)	Application for the interpretation of MRI of the temporomandibular joint. Tested by dental students. The effectiveness of the use of the object was observed through objective school tests.	Control group presented better performance. However, when compared with initial assessments, the two groups were found to have significantly improved their performance.
Pereira and Ranali, 2016 ⁹ (Brasil)	Dental local anesthesia simulator for teaching and training of the technique of inferior alveolar nerve block.	After a week of use, the average success rate of students increased from 22.6% to 56.5% ($p < 0.001$).

In this category, two studies were found which aimed at collecting and storing data from oral evaluations obtained at home visits. In the research carried out by Forsell *et al.*¹⁰, a mobile system called MobilDent was developed from the needs reported by field workers at Oral Care AB (Sweden). Another study with the same approach was carried out by Figueiredo *et al.*¹², including GPS - Global Positioning System in order to assist in the homecare location, which facilitates the subsequent visits, reducing the work involved in territorialization, thus providing faster assistance in more complicated cases management.

Only four studies reported an assessment of the applicability of systems. The study of Farias and Pereira¹³ aimed to analyze Bolton's dental mass discrepancy by comparing digital (two-dimensional) analysis with manual (gold-standard) analysis of 75 pairs of gypsum models. In the study developed by Gomes *et al.*¹⁴, this evaluation was made through comparisons between the data

collected by the application and standard tests. In both comparisons, the applications presented great accuracy regarding the standard method.

In Stein *et al.*¹⁴ research, who have created a system for the exchange of information between patients and dentists in cases of dental emergencies and Figueiredo *et al.*¹², who have developed an application for geolocation data collection and storage, the applicability tests consisted of meetings between researchers in order to analyze the systems functioning.

The usability of applications, i.e., their easy use, has been tested in three studies. In the oral cancer screening system¹⁴, 55 individuals exposed to cancer risk factors were allocated to the test. In the application created by Stein *et al.*¹⁵, usability was tested with 20 potential users who simulated dental emergency while the dental mass discrepancy¹⁰ analysis system was tested by 30 orthodontists. All users of these systems reported the app to be of ease usage since they were self-explanatory.

Table 2. Professional focus studies, according to authors/year/country, methodology and results

Professional focus studies		
Authors/ Year/Country	Methodology	Results
Forsell <i>et al.</i> , 2008 ¹⁰ (Sweden)	Data collection and storage in home visits. Based on needs reported by workers during field work. Available on Windows Mobile Platform (Microsoft). No usability testing was reported.	The application was used from January 2006 to March 2008 for more than 40,000 oral evaluations. Users reported the system to be self-explanatory.
Souza <i>et al.</i> , 2013 ¹¹ (Brazil)	Prototype of an oral care application for patients with special needs. Available on IOS and Android platforms. So far, its usability has not been evaluated.	According to the authors, it is essential to choose the appropriate platforms as well as emphasize the interdisciplinary work, between health professionals and the ones from technological development
Figueiredo <i>et al.</i> 2013 ¹² (Brazil)	Data collection and storage with geolocation to be used in homecare visits. Android platform. No applicability tests were reported with patients, only interdisciplinary meetings to discuss the system improvement.	The authors highlight the importance of dentists and computer professionals teamwork.
Farias and Pereira, 2013 ¹³ (Brazil)	Application for analysis of Bolton's dental mass discrepancy. The digital (two-dimensional) analysis of the software was compared with the manual (gold standard) analysis of 75 pairs of gypsum models. The system was assessed by 30 orthodontists. Mutliplatform (Java)	Greater specificity of the application: to exclude people who do not have a clinically identified discrepancy. The software proved to be 6 minutes faster than in manual analysis. One hundred percent (100%) of orthodontists liked the application and 93% would use it.
Gomes <i>et al.</i> , 2016 ¹⁴ (Brazil)	Application for oral cancer screening composed of two steps: a questionnaire focused on the predisposition of cancer and obtaining photos and videos. Fifty-five individuals with cancer risk factors were recruited for usability testing; the data from these patients, collected by the application and by standard tests were compared. Android Platform.	When comparing the application use with the standard exams, the mean sensitivity was 91%, specificity of on average 90.5%, and mean accuracy of 90.90%
Stein <i>et al.</i> , 2016 ¹⁵ (USA)	Exchange of information system (photos and reports) between patients and dentists in cases of dental emergencies. It consisted of 4 phases: (1) quality evaluation of intra-oral images captured by smartphones, (2) development and (3) refinement of the prototype, and (4) evaluation through usability tests and satisfaction with 20 potential users. Android platform.	The quality of oral conditions images is satisfactory in different models of smartphones. During the refinement of the prototype, some ambiguous or redundant words and selection options were found, and when asked about when the pain started, response options were no accurate; these issues have been corrected. All participants successfully completed the simulation of a case report in less than 4 minutes and reported being satisfied with the application.

Regarding user satisfaction, all the studies found positive responses. In addition, no user reported difficulty in dealing with applications. In two studies, the authors^{11,12} strongly emphasized the importance of interdisciplinary and interchangeable projects involving areas of Computer Science and Dentistry.

4 DISCUSSION

The results of the present integrative review have shown an important increase in the use of mobile applications in the health and its applicability within Dentistry and education, as well.

According to studies related to teaching-learning students have usually shown positive attitudes regarding the use of technologies as teaching tools¹⁶. Therefore, it is essential to encourage the use of Information Technology Communication as a pedagogical enhancing tool in dental education, supported by the student's knowledge construction and the development of new skills such as innovation, creativity, autonomy, and communication¹⁷. It is clear that the use of these technologies will not replace the professor himself. However, a new teaching profile is required since technologies will enhance traditional methodologies⁶. The professor tends to become the stimulator of the student's curiosity leading them to research the most relevant information¹⁷. However, it is necessary to point out that all this technology adds value to the already consecrated and fundamental presential role of the professor⁶.

In the study by Arus et al., the conventional learning group (Control), which included theoretical and practical classes with a professor as moderator, demonstrated better performance than the group that only interacted with the

smartphones. Therefore, the traditional teaching method is not obsolete and personal interaction - *the professor presential role* - must always be encouraged and stimulated, even with the advancement of technology⁶, in the didactic-pedagogical relationship. In the same study, both groups significantly improved their performance when compared to the initial and final evaluations. Since the smartphone information capture and transmission has been increasing, professionals can use such devices as a complementary feature in their clinical decisions in countries where teleconsultation is allowed^{19,20}. In the study by Stein et al^{19,20}, the application for dental emergencies showed excellent usability results. However, it is worth mentioning that, although such systems may be useful to support remote treatments in Dentistry, no technological device could ever and completely replace the physical examination of the patient^{21,22}.

Previously, oral health assessments were only paper-based records - handwriting or printed sheets - which contained address lists, medical records, and health promotion materials²³. Nowadays, the software has accounted for this routine, reducing time and errors in data records, such as the use of the Mobident system¹⁰, which eliminated 70,000 sheets of paper per year, as well as increased the number of patients to be assisted in a shorter time.

Android operating system seems to be the first choice, which can be explained by the great diversity of devices from different hardware and manufacturers running on this system, not restricted to just one brand in the mobile market, promoting greater dissemination and popularization of software²⁴.

Two studies^{11,12} highlighted the importance that health professionals allied to specific

professionals in the area of technological development create applications once these are complementary areas.

Dental surgeons can expose their needs to add health and well-being to their patients, while professionals systematize these ideas in the form of applications, promoting greater quality in system management and clinical outcomes¹¹. Often healthcare professionals, by themselves, can not promote new technologies to their tasks and activities. Likewise, computer science professionals find it difficult to become aware of the needs and desires of society²⁵. Thus, the need to combine the knowledge of these two areas is of utmost importance and also a contributory issue for the population's life quality.

To investigate the clinical use of the system is necessary in order to determine the effectiveness of implementing a healthcare application³. However, some studies have not reported such tests. Smartphones users have presented increasing ease in handling the application, which shows the profile of the current society every day more adapted to the smartphones. This fact leads to the possibility of expanding these systems, reaching a greater number of users who promote health.

This integrative review may not have been able to cover all available scientific evidence regarding the use of mobile applications for Dentistry, due to the increasing production of scientific knowledge on the subject. Moreover, more consistent studies should be carried out in order to analyze the long-term impact of the use of these technological resources on oral health outcomes.

5 CONCLUSION

The studies of this review have confirmed the increasing need to create systems focused on

Dentistry and other health areas, in order to better reach the target audience, due to the undeniable global use of mobile devices. In Dentistry teaching, these resources lead to possible knowledge construction, both by students and professors. Traditional teaching methodology should not be neglected once they are not yet substitutable, as the studies have shown. Identifying professionals' and students' needs regarding technical training is essential to design and implement new and appropriate technologies, according to the necessary demands.

RESUMO

Aplicativos móveis para ensino e assistência odontológica: uma revisão integrativa

Este estudo teve como objetivo identificar o estado da arte atual e as tendências de pesquisas que utilizam aplicativos móveis na Odontologia por meio de uma revisão integrativa. Realizaram-se buscas nas bases de dados SciELO, LILACS e PubMed, utilizando os termos “*mobile application*”, “*Dentistry*” e “*informatics*”, e no Google Acadêmico, para abarcar a literatura cinza, com os mesmos termos na língua portuguesa, sem período de tempo determinado. Os títulos e resumos de todos os artigos encontrados foram lidos por dois pesquisadores de forma independente. Foram incluídas pesquisas oriundas de dados primários e que estivessem relacionados apenas à saúde bucal, cujo meio de informação fosse *smartphones*, nas línguas inglesa, portuguesa e espanhola. Além disso, os artigos publicados em periódicos científicos foram analisados em relação aos itens atribuídos no *checklist* do *STROBE Statement*. Foram encontrados 911 estudos. Após a leitura de todos os títulos e resumos, foram excluídos 897, totalizando 14 estudos para leitura na íntegra. Nove artigos foram incluídos no estudo, classificados em estudos com foco profissional (6) e estudos com foco acadêmico (3). Os dados descritos nos estudos deixam claro a crescente adoção do uso dos aplicativos como

recursos educacionais e assistenciais. A criação de aplicativos móveis direcionados à Odontologia é apropriada, tanto no ensino, como uma nova possibilidade de construir conhecimento, quanto para o uso profissional, já que é inegável a disseminação global do uso de dispositivos móveis.

Descritores: Aplicativos Móveis. Odontologia. Informática.

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