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Design and evaluation of screening and self-care (mobile) application for oral and dental problems and emergencies

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A B S T R A C T

Introdution: Although oral and dental diseases may occur in unexpected or even emergency conditions, but some of the diagnosis and treatments can be algorithmically done following some guidelines. The development and implementation of a system that provides users with a record of history and a proposal of required actions can be not only efficiently practical, but also virtually simple.

Materials and method: A system made up of web and mobile apps is proposed and evaluated for screening and self-care of oral and dental problems and for providing advice on dental emergencies and therapeutic measures. This system was developed and made available to users under the name of 'Dandanyar'. The data were then collected from Dandanyar users and analyzed based on the selected statistical population for evaluating their satisfaction.

Results: The evaluation results showed that more than 90 % of specialists had a positive attitude towards application effectiveness. On the other hand, clients expressed their satisfaction with various aspects of the application in more than 80 % of cases.

Conclusion: The importance of using such systems is highlighted in the Covid-19 pandemic condition where certain health protocols must be followed. For instance, people must avoid unnecessary traveling and limit their referrals to medical centers especially dental clinics due to the high volume of aerosols produced during dental treatment procedures.

1. Introduction

Usually, in medical and dental care environments, emergency and acute care departments are dealing with the maximum load of clients, thereby requiring the most timely and accurate clinical service. Hence, health care systems have always been looking for strategies to reduce the congestion and thus optimize the level of service quality in these departments.[1] In the case of oral and dental problems such as acute pain or trauma, less access to round-the-clock dental services may lead patients to self-medication, incorrect choice of treatment, or inappropriate use of drugs like antibiotics. This issue is more controversial in deprived areas, situations where there is a lack of health centers or prevalence of infectious diseases such as Covid-19 related home quarantine. The unawareness about the problems that can be personally managed may cause patients' concern, unnecessary referral to emergency medical centers, and additional cost of medical care. It may also result in waste of time and energy for medical staff.[2] Accordingly, one useful solution can be creating automatic algorithms that allow patients' self-triage (personal triage) before their referral to medical centers. The patients will be informed of their need for either going or not going to these centers and guided through effective personal care, home remedies, or even medication. There are a growing number of self-triage tools designed and developed based on computerized clinical algorithms for different medical care or problems such as pediatric emergency, primary care, abdominal pains, flu-like illnesses, and sexual health disorders.[1,3] However, there is a lack of such practical tools related to chronic oral and dental problems to provide patients with guidance on personal care and information about medical care centers (see Figs. 6–24).

As the coronavirus disease quickly reached the state of emergency, World Health Organization declared the Covid-19 as pandemic status on March 11, 2020.[4] Though exposure to infected particles in air is the primary factor in transmitting this new disease, the span of air infection and the way of virus transmission was still controversial in beginning of outbreak.[5–8] On March 15, 2020, an article was published by New York

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Times that depicted a striking schematic picture of dentists as staff members who are at a higher risk of exposure to Covid-19 infection than nurses and general practitioners. Most guidelines recommend that dentists make the urgent and cancel non-urgent patient appointments to prevent the spread of Covid-19. Those guidelines cut down on interpersonal contact, waiting time in dental clinics, and underlying conditions of transmission of Covid-19.[9,10] Due to the global situation affected by the coronavirus pandemic where patients delay their dental treatments and confuse with referral/non-referral to dental centers, we aimed to design and develop a screening and self-care application for oral and dental problems. Our attempts were made to diagnose dental emergencies (during epidemics of diseases such as coronavirus) and provide a suitable tool applicable to smartphones for patients with dental problems. The application sought to discuss dental problems in terms of being an emergency and requiring referral to dental centers and provide primary care after identification of patients' overall condition. Therefore, unnecessary referrals to these centers are avoided and patients are offered specialized guidance on their problems. The main purpose of the current study was to design, develop, and evaluate a screening and self-care application for dental emergency diagnosis (in the epidemic condition of Covid-19 and post-corona) and user satisfaction. The application covered the dental emergencies including pain, swelling, wound, bleeding, trauma, and change in the sense or the shape of neck.

2. Materials and Methods

For this article, a system was designed virtually, developed in the form of a mobile application for screening and self-care of oral and dental problems, and evaluated in terms of its effectiveness to diagnose dentistry emergencies. Having obtained the code of ethics IR.TUMS.DENTISTRY.REC.1399.071, we explain the study method and steps. The mobile application system design, implementation, and evaluation as well as the effectiveness results are given in the following.

Step 1 - Design of screening logic and general algorithm and preparation of self-care content for oral and dental diseases and emergencies

In the design of this application, existing algorithms in the literature were utilized such as "instructions for emergency dental care during coronavirus pandemic" announced by Iran Ministry of Care, Health, and Medical Education and the latest version of "Management of Acute Dental Problems during Covid-19 Pandemic" algorithm presented on March 30, 2020 by Scottish Dental Clinical Effectiveness Program.[11,12] The 2013 version of "Scottish government and NHS education for Scotland" algorithm[13] was used to diagnose and ratify self-care protocol on oral health problems. Moreover, ADA (American Dental Association) guidelines[14] were followed for emergency dental procedures during the Covid-19 pandemic.

Regarding oral and dental diseases, dental emergencies, and also primary care and treatments under epidemic conditions of infectious diseases like coronavirus pandemic, the model and the emergency dental care triage algorithm were finally adopted and logically organized in the form of a set of decision trees. That is, a set of different scenarios indicates the sequence of primary care and the actions that the patient should follow (immediate referral/referral/non-referral). Being in complete and exact accordance with scientific principles, this procedure was carried out by the patient themselves with acceptable accuracy and minimum requirements for special care facilities or equipment. In other words, the user was independently able to enter required data for the triage algorithm with no need of specialized medical facilities, radiographic tests or measurements. At this stage of design, in addition to screening logic and emergency dental care triage algorithm, each user was provided with scientific and practical content in the form of personalized scenarios with respect to their personal condition.

Step 2 – Design and implementation of (software) system application for screening, self-care, and diagnosis of oral and dental diseases and emergencies

The self-care system of screening for oral and dental diseases and emergencies were designed and implemented in the following two directions:

Server side: is a web-based operating system to store and manage data on the server and process results on various cases. The datasets were also collected for future data-driven research including oral and dental hygiene. To implement this web system as backend, DBMS SQL or MySQL server was used accompanied with PHP and to run it, CentOS 7 was the required platform on the server side.

User side: is a mobile app on the Android platform that interacts with the user (patient) step by step based on the algorithm and the decision tree selected at the first study stage. It achieves the overall diagnosis for oral and dental diseases and triage for emergency dental care with initial actions suggested to be taken by the patient for the required treatment. For instance, it offers services such as locating the nearest medical center or making an online appointment if needed. React development framework was used for implementation of mobile app on the Android platform with possible extension to an executable version on the iOS platform.

Additionally, necessary information obtained from this diagnostic process (protecting users' privacy) was sent to the server for performance evaluation and stored for future research. Among agile software development methodologies, the XP method with Scrum project management discipline was selected and used to design system software. This selection was based on the coordinates (dimensions) of the proposed design (technical, managerial and executive), technical complexity of the system, previous experience of developing similar systems, and required tools for system development. In this regard, we also considered the need for an experienced technical team, rapid system development, and continuous feedback from users.

In the requirements engineering phase, general and basic system requirements were defined as Backlog items regarding used methods in system development (agile XP and Scrum methods) and opinions of dental specialists. In the first step of design, some of these requirements were documented and applied to the following steps. In fact, the emergency dental care triage algorithm for implementation and content production for the patient condition or self-care questionnaire were of specialized domain requirements. In the final step of the developmental process, continuous feedback was received from the specialists on the system intermediate versions.

Step 3 - Evaluation of (software) system for screening, self-care, and diagnosis of oral and dental diseases and emergencies

The link to download and install "Dandanyar" system was placed on the www.dandaanyar.com web page (Fig. 1).

After registration, users could use either the mobile or the web version of application (Fig. 2).

This system consists of two main parts.

- Front-end: The Android version of the mobile application
- Back-end: The web version of the application that provides content configuration capabilities for the system administrator and includes a database for data collection, storage, and analysis.

The front-end part presents a home page for system introduction, user registration, and then user authentication for logging into their account. The user was guided through the six different modes available in the guidelines according to the type of problem he/she has (pain, swelling, wound, bleeding, trauma, and change in the sense or the shape

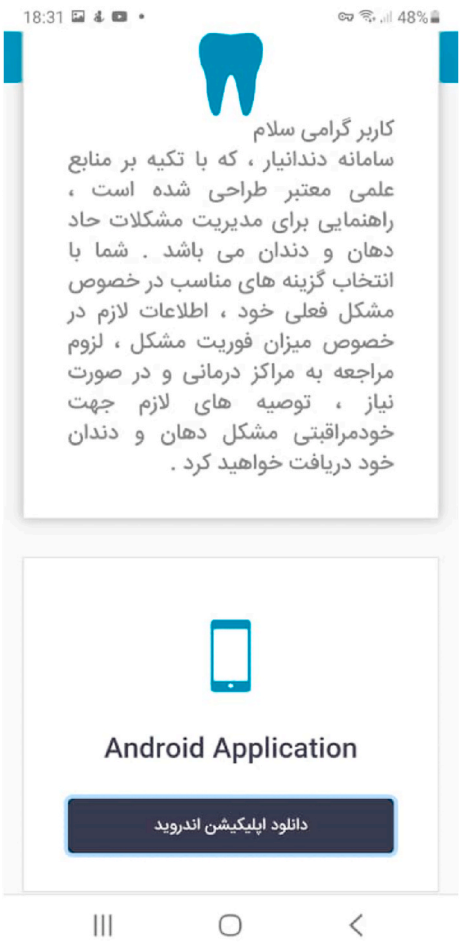

Fig. 1. The application web page with the download link.

of neck). The user chooses one of the paths (Fig. 3), answers questions one by one following the guidelines, and receives medical diagnosis and advice after self-declaration (Fig. 4). In case of either an emergency or non-emergency problem, diagnosis is displayed in red or green background respectively (Fig. 4). Moreover, self-care recommendations are displayed in blue (Fig. 4) (see Fig. 5).

In order to evaluate the level of user satisfaction (both specialist physicians and patients) with the system, two groups of 27 specialist physicians and 70 patients (young and old, male and female)

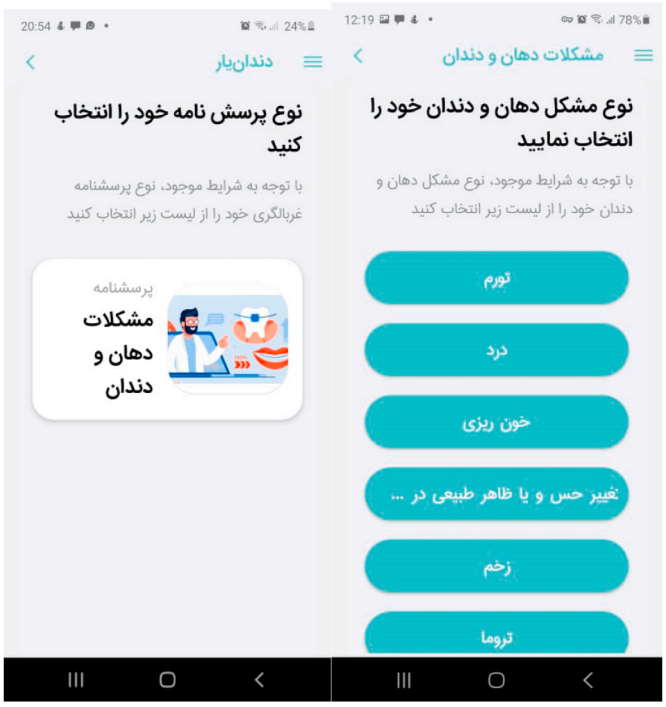

Fig. 3. The selection of six possible pathways for different types of oral and dental problems.

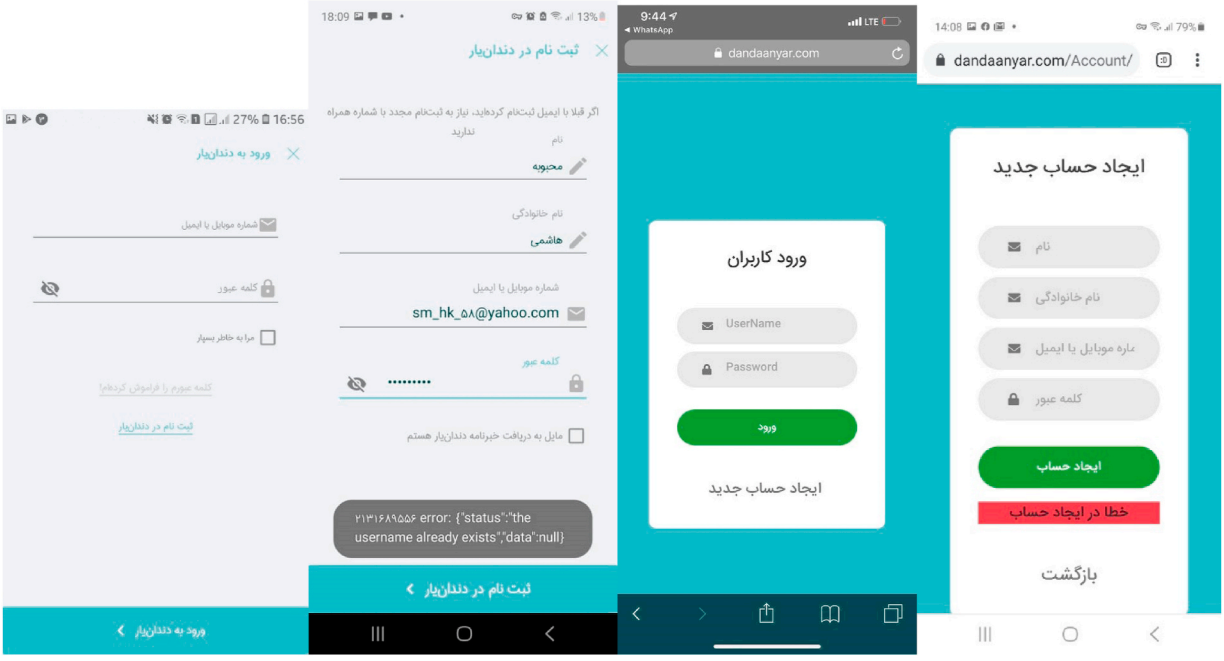

Fig. 2. The sign-in and sign-up page.

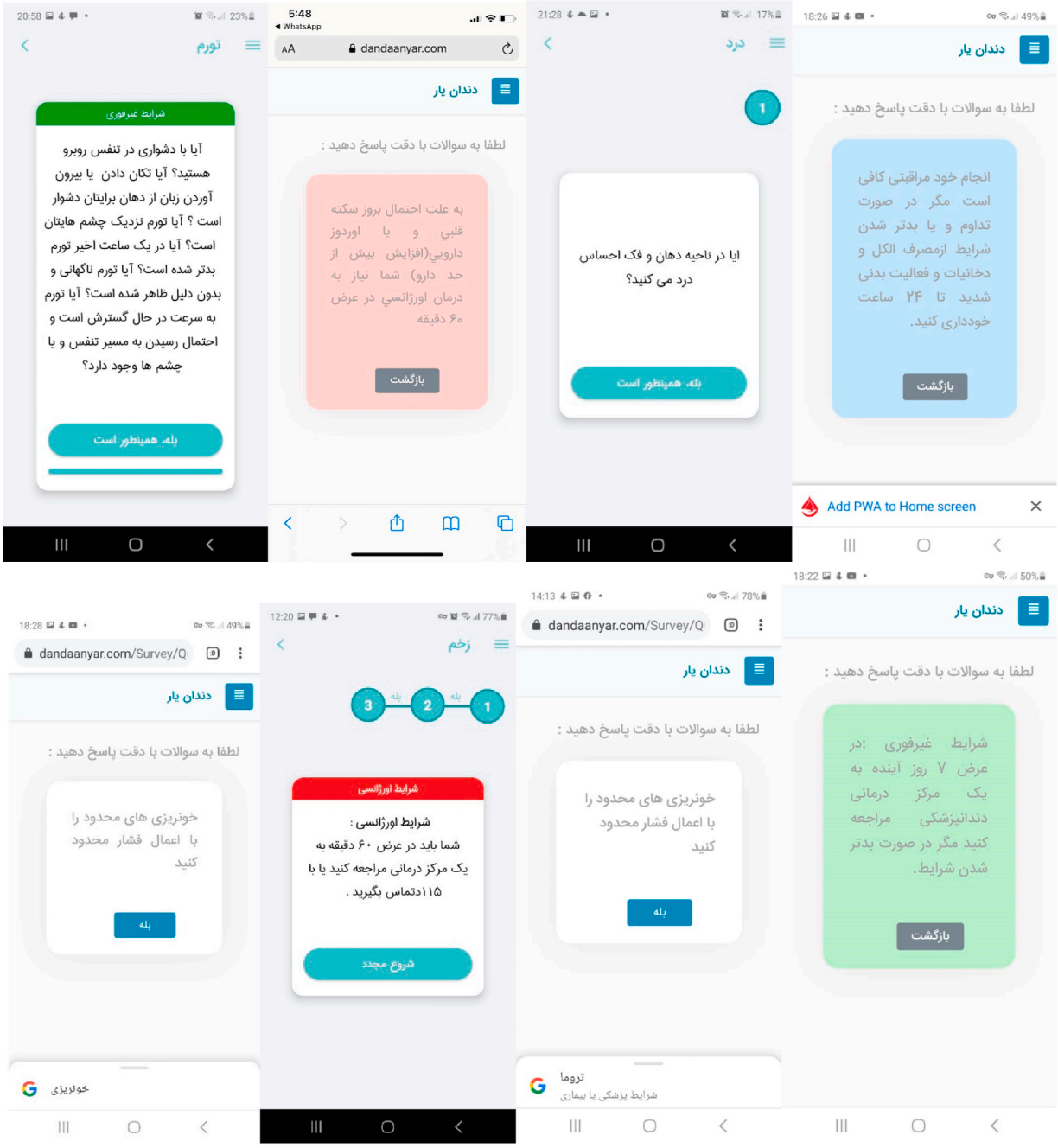

Fig. 4. The application pages through the procedure of question-answering followed by the user to take medical diagnosis and advice.

participated in the study as the target population. The self-care mobile application for oral and dental diseases and emergencies (Dandanyar system) Fig. 6-9 was installed on the participants' smartphones. Their level of satisfaction was investigated via a questionnaire composed of 10 items (around system applicability and usefulness, effectiveness and diagnostic accuracy, ease of use, visual appeal, and user-friendliness) after a period of one month using the program. Another Fig. 10checklist of ten options (diagnostic validity, comprehensiveness, efficiency, scientific accuracy, applicability, visual appeal, and user-friendliness) was also distributed among dentists to evaluate the application effectiveness.

The two descriptive variables of "system evaluation by dental specialists" and "clients' satisfaction" were respectively investigated by two validated questionnaires of "performance assessment" and "satisfaction measurement". The content validity was quantitatively tested by content validity ratio (CVR) and content validity index (CVI). 10 Fig. 11-24 professors of dentistry were asked to express their opinions on the items using the options "necessary", "useful but unnecessary", and "unnecessary". The responses were then calculated according to CVR formula and scored on a Likert scale ranging from "unrelated", "relatively related", "related", and "completely related" by 10 specialists. Three criteria of simplicity, relevance, and clarity were considered and CVI was calculated from the sum of scores on each item divided by the total number of specialists. In case that the CVI score was greater than 0.78, the related item was confirmed. Fig. 16The scale replicability (reliability) was not testable due to the changing condition of patients. Having validated the questionnaires, we conducted performance assessment and satisfaction measurement as follows:

Dentists were selected from a range of dental specialties including oral and diagnostic diseases, endodontics, restorative dentistry, oral and

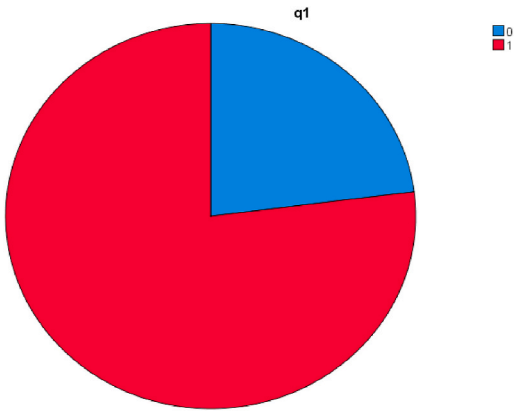

Fig. 5. The percentage using the system for oral and dental problems by patients (blue: no, red: yes). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

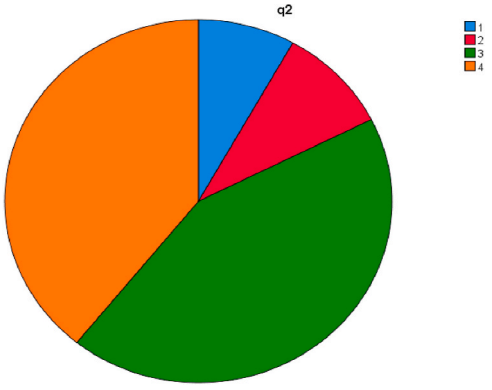

Fig. 6. The clarity and comprehensibility of the system questions and explanations from the patient point of view (blue: low, red: medium, green: high, orange: very high). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

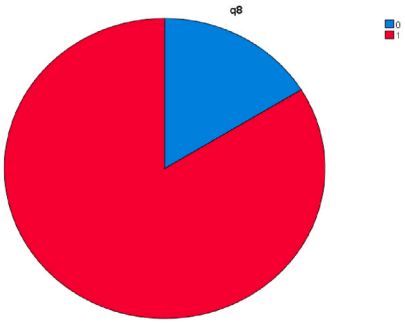

Fig. 7. The usefulness of the system in offering advice on emergency dental care referrals from the patient point of view (blue: no, red: yes). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

maxillofacial surgery, periodontics, and pediatrics. They were asked to use Dandanyar app, examine at least one patient per day, and complete the checklist at the end of the month. The dentists would be excluded from the study if they used the application less than 5 times due to negligence rather than other reasons lik not being user friendly. Finally, they filled out "performance assessment" questionnaire at the end of the month.

The patients who referred to the Oral Medicine Department of

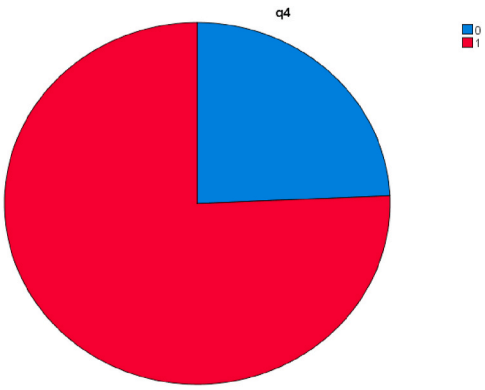

Fig. 8. The usefulness of the system from the patient point of view during coronavirus pandemic (blue: no, red: yes). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

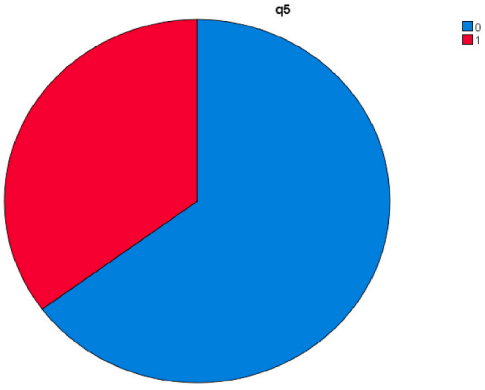

Fig. 9. Troubleshooting in using the application (blue: no, red: yes). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

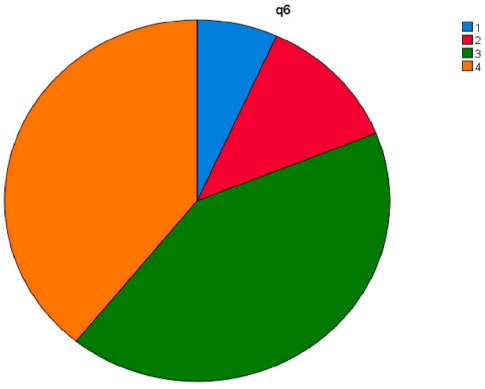

Fig. 10. The visual appeal of the system from the patient point of view (blue: low, red: medium, green: high, orange: very high). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

International School of Dentistry were purposefully selected to measure their satisfaction with "Dandanyar" application. Those clients who were aware and capable of using the application on their smartphones constituted the study population. They were asked to install and use the application for their main problem prior to the examination and triage. The patients were also asked to make use of the application in case of other oral and dental problems for a period of one month (at least once

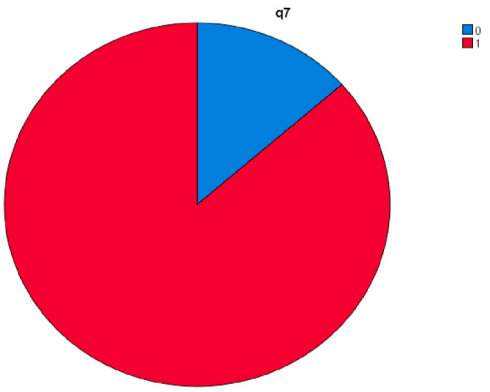

Fig. 11. The coverage of oral and problems by the system from the patient point of view (blue: no, red: yes). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

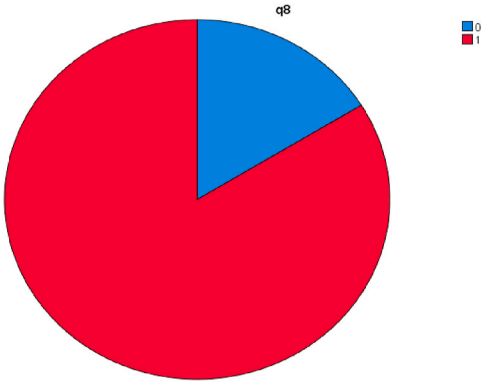

Fig. 12. The tendency of users to follow system instructions (blue: no, red: yes). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

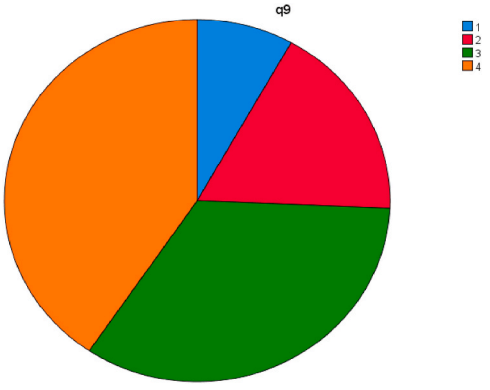

Fig. 13. The overall user satisfaction with the application (blue: low, red: medium, green: high, orange: very high). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

in the month) and then given an online satisfaction questionnaire to complete. The app effectiveness was evaluated by scores obtained from the checklist of specialists and user satisfaction was measured for the related areas.

The PASS (Power Analysis and Sample Size) software was used for estimating sample size. The confidence interval for one proportion with $\alpha = 0.05$, $p = 0.8$, and confidence level of 0.2 resulted in a minimum of 70 samples to measure user satisfaction. The confidence interval for one

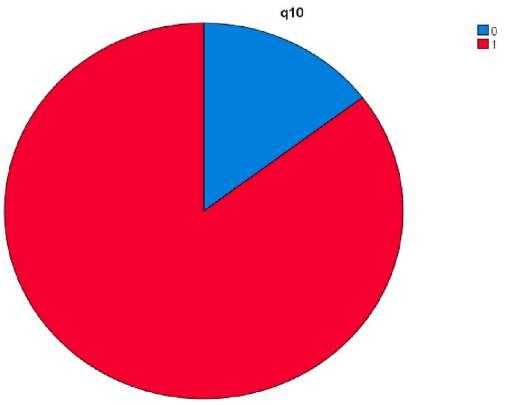

Fig. 14. Recommendation for installation and use of the application (blue: no, red: yes). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

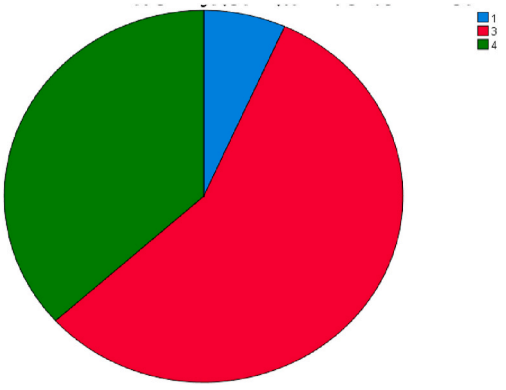

Fig. 15. The closeness of application and specialist in diagnosis from the specialist viewpoint (blue: disagree, red: agree, green: strongly agree). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

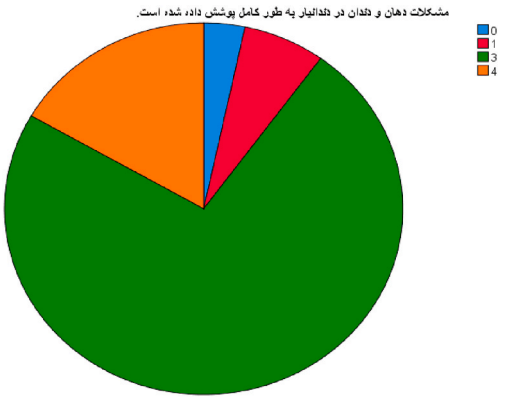

Fig. 16. The coverage of oral and dental problems by the application from the specialist viewpoint (blue: strongly disagree, red: disagree, green: agree, orange: strongly agree). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

mean with $\alpha = 0.05$, SD = 0.25, and confidence level of 0.1 yielded a minimum sample size of 27 dentists to evaluate app effectiveness.

3. Results and discussion

The self-care system for screening oral and dental problems and

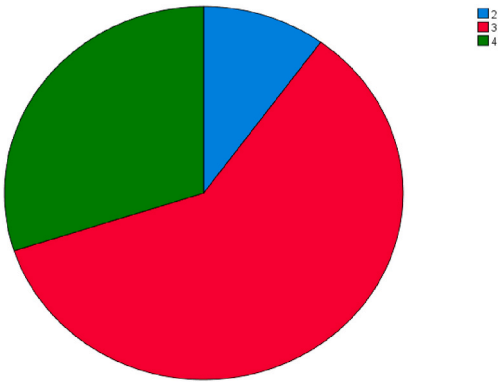

Fig. 17. The effectiveness of application as an aid in diagnosing oral and dental problems from the specialist viewpoint (blue: abstain, red: agree, green: strongly agree). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

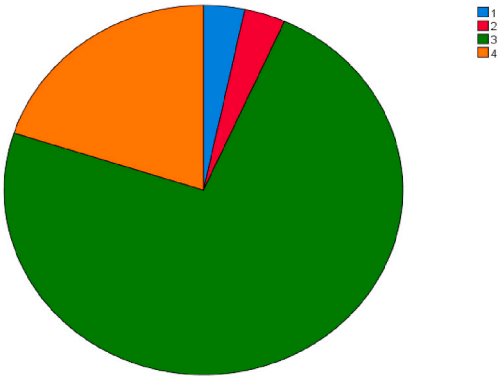

Fig. 18. The scientifically proper design of application for screening oral and dental problems from the specialist viewpoint (blue: disagree, red: abstain, green: agree, orange: strongly agree). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

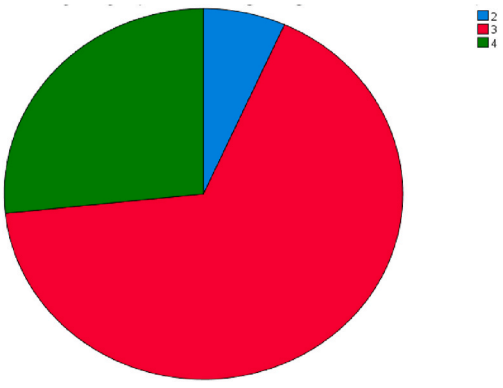

Fig. 19. The assistant role of application in proper and timely referrals to dental centers during the Covid-19 pandemic from the specialist viewpoint (blue: abstain, red: agree, green: completely agree). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

emergencies was used by the population users in the form of Dandanyar mobile application and the results were recorded by the server. The recorded results were then analyzed on major aspects of the study.

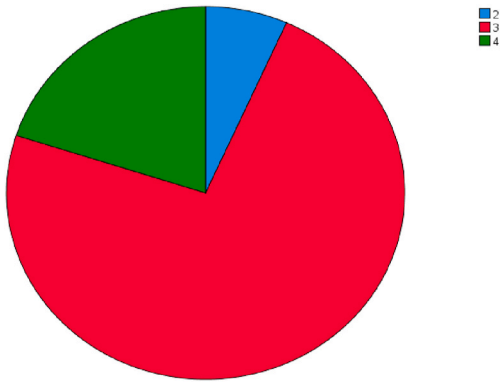

Fig. 20. The app classification of oral and dental problems in right paths from the specialist viewpoint (blue: abstain, red: agree, green: completely agree). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

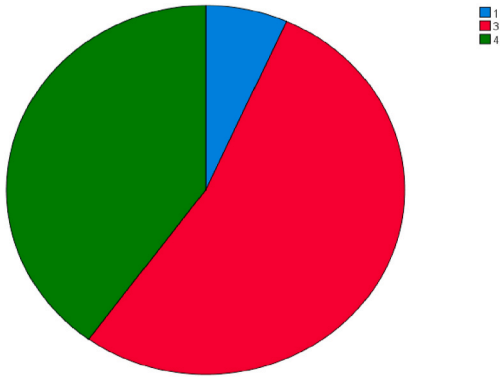

Fig. 21. The adequate visual appeal and appropriate graphics from the specialist viewpoint (blue: abstain, red: agree, green: strongly agree). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

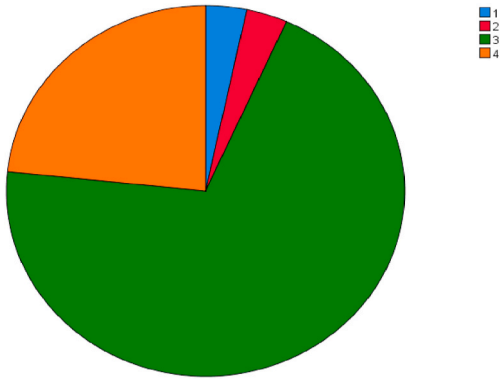

Fig. 22. The user-friendliness of the system from the specialist viewpoint (blue: disagree, red: abstain, green: agree, orange: strongly agree). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

a) User satisfaction with Dandanyar application from the patient point of view

74 Out of 75 questionnaires filled by the patients who had the system on their smartphones were analyzed. The responses to questions are as follows.

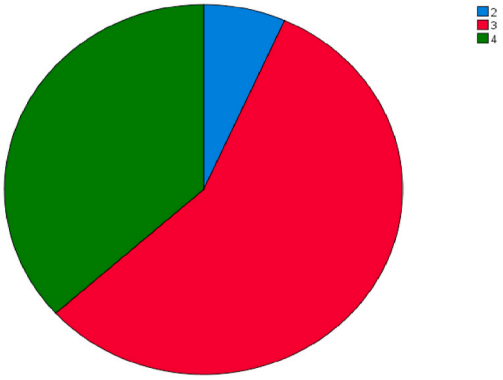

Fig. 23. The recommendation for installing and using the application to clients (blue: abstain, red: agree, green: strongly agree). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

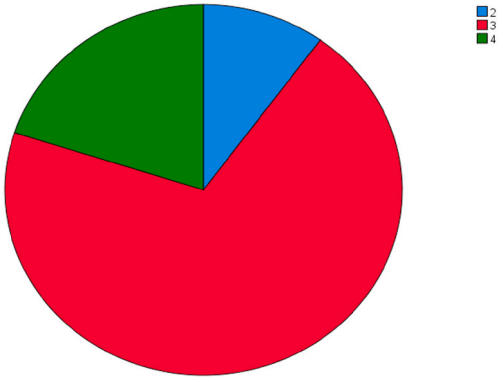

Fig. 24. The recommendation for installing and using the application to my colleagues (blue: abstain, red: agree, green: strongly agree). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

1) Did you use this system for your oral problems? (Yes/No)

A total of 17 clients (23 %) did not use Dandanyar system, whereas 57 (77 %) clients used it for their oral and dental problems.

These findings are promising for initial screening of emergency and non-emergency problems in similar conditions to Covid-19 pandemic and possible avoidance of unnecessary referrals. In a study, Verzantvoort et al. designed an application for self-triage of patients before going to primary care clinics and found that 65 % of users followed the application advice.[3] In spite of similar findings, the percentage of users who followed the application advice in their study was lower than that of our study.

2) How clear and easy to understand were the questions and explanations of Dandanyar system to you (very low/low/medium/high/very high)?

Dandanyar system questions and explanations were considered very low understandable by 6 (8.1 %), low understandable by 7 (9.5 %), moderate to understand by 32 (43.2 %), and high understandable by 29 (39.2 %) patients.

Given that only about 40 % of users perceived questions as completely clear to understand, some clarity revision must be made to questions so as to be more understandable to the public population for the updated versions.

3) Did you find this system useful to offer advice on emergency dental care referrals? (Yes/No)

Dandanyar system was of no use for 18 (24.3 %) but useful for 56 (75.7 %) people in guiding them to refer for emergency dental care.

Considering the application usefulness approved by more than two-thirds of users, such systems need to be developed and implemented for virtual screening and diagnosis of oral and dental problems to promote "remote dentistry". Further, studies have recently highlighted the role of telemedicine in treating oral problems.[15]

4) Did you find this system useful to make decision on emergency referrals to dental centers during coronavirus pandemic? (Yes/No)

Dandanyar system was found to be of no use for 18 (24.3 %) but useful for 56 (75.7 %) people in taking advice on emergency referral to dental centers during coronavirus pandemic.

Given the users' opinion about Dandanyar system during Covid-19 pandemic, it is expected that Iranian people welcome this system in quarantine conditions.

5) Did you encounter any problems in the process of using the application? (Yes/No)

While 48 (64.9 %) people had no trouble using the application, 26 (35.1 %) clients did.

As approximately 35 % of patients had trouble working with the application, they must be provided with guidance files for the updated versions.

6) How well did you find this system visually appealing (very low/low/medium/high/very high)?

The visual appeal of Dandanyar system was low in the view of 5 (6.8 %), moderate in the view of 9 12.2 %), high in the view of 31 (41.9 %), and very high in the view of 29 (39.2 %) patients.

More than 80 % of users found the application visually appealing. One of the determining factors in the optimal use of the application is visual appeal. This factor alongside other indicators can be influential in the future popularity of the application with users.

7) Was your oral or dental problem included in the questions posed by this system? (Yes/No)

While the oral or dental problem of 10 (13.5 %) clients was not covered by the system questions, it was included in application questions for 64 (86.5 %) clients.

Since more than 86 % of patients claimed that their oral problem was covered by the application, the corresponding item played a key role in evaluating app performance and user satisfaction. This result is desirable for the statistical population of the present study.

8) Did you tend to follow the instructions of this system? (Yes/No)

While 12 (16.2 %) people stated that they did not tend to follow system instructions, 62 (83.8 %) people followed them.

9) How was your overall satisfaction with this system (very low/low/medium/high/very high)?

The level of satisfaction with Dandanyar system was low for 6 (8.1 %), moderate for 13 (17.6 %), high for 25 (41.9 %), and very high for 30 (40.5 %) patients.

10) Did you recommend installation and use of this system to others? (Yes/No)

A total of 11 (14.7 %) clients did not recommend others for the application installation and use, whereas 64 (85.3 %) clients did.

The study results on the last three questions indicated the approval of this instrument in the statistical population. This issue could be further investigated in a larger statistical population for more generalizability and accuracy of results on such diagnostic aids. In line with the present study result, Verzantvoort et al. concluded that such kind of self-triage application was a cost-effective method for patient management and triage.[3] The application could be a valuable tool to reduce pressure on the health care system and guide patients on referrals to primary care clinics.

b) The efficiency of Dandanyar application from the specialist viewpoint

All 30 dental specialists completed the 10-item questionnaire of app performance assessment as follows.

1) Dandanyar diagnosis of oral problems is close to the specialist's clinical diagnosis (strongly agree/agree/abstain/disagree/strongly disagree).

There were 2 (6.7 %) disagreed, 17 (56.7 %) agreed, and 11 (36.7 %) strongly agreed opinions on the application and specialist closeness in diagnosis.

It seems that there is a higher correlation between the diagnosis of dentists and that of self-triage applications with a scientific basis and valid algorithms than those of online symptom-checker software and Google search.[16] This issue was confirmed by more than 90 % of specialists in the present study.

2) Dandanyar covers all the oral and dental problems in dentistry (strongly agree/agree/abstain/disagree/strongly disagree).

There were 1 (3.3 %) strongly disagreed, 2 (6.7 %) disagreed, 22 (73.3 %) agreed, and 5 (16.7 %) strongly agreed specialists who confirmed the application coverage of oral and dental problems.

3) Dandanyar is an effective tool for diagnosis of oral and dental problems (strongly agree/agree/abstain/disagree/strongly disagree).

There were 18 (60 %) specialists who agreed and 9 (30 %) specialists who strongly agreed on the application effectiveness in diagnosing oral and dental problems. In this regard, 3 (10 %) specialists voted for abstained.

4) Dandanyar is scientifically designed to diagnose and screen oral and dental problems (strongly agree/agree/abstain/disagree/strongly disagree).

There were 1 (3.3 %) disagreed, 22 (73.3 %) agreed, and 6 (20 %) strongly agreed specialists on the scientifically proper design of application for screening oral and dental problems. There was only 1 (3.3 %) specialist with abstain on this issue.

5) Dandanyar acts as an aid for timely and proper referrals to dental centers during the Covid-19 pandemic (strongly agree/agree/abstain/disagree/strongly disagree).

While 2 (6.7 %) specialists had abstain, 20 (66.7 %) people agreed and 8 (26.7 %) people strongly agreed that the application aids patients with a timely and proper referral for dental care during the Covid-19 pandemic.

6) Dandanyar classifies oral and dental problems in right paths (strongly agree/agree/abstain/disagree/strongly disagree).

It was found that 2 (73.3 %) dentists agreed, 6 (20 %) strongly agreed, and 2 (6.7 %) abstained on the system classification of oral and dental problems in right paths.

7) Dandanyar has adequate visual appeal and appropriate graphics (strongly agree/agree/abstain/disagree/strongly disagree).

It was found that 16 (53.3 %) dentists agreed, 12 (40 %) strongly agreed, and 2 (6.7 %) abstained on the application visual appeal and graphics.

8) Dandanyar is user-friendly (strongly agree/agree/abstain/disagree/strongly disagree).

A total of 21 (70 %) people agreed, 7 (23.3 %) strongly agreed, and 1 (3.3 %) abstained on the application user-friendliness, whereas there was only 1 (3.3 %) specialist who disagreed.

9) I recommend installation and use of this application to my clients (strongly agree/agree/abstain/disagree/strongly disagree).

It was found that 17 (56.7 %) dentists agreed, 11 (36.7 %) strongly agreed, and 2 (6.7 %) abstained on making a recommendation to their clients for installing and using application.

10) I recommend installation and use this application to my colleagues (strongly agree/agree/abstain/disagree/strongly disagree).

Among specialists, 21 (70 %) people agreed, 6 (20 %) strongly agreed, and 3 (10 %) abstained on making a recommendation to their colleagues for installing and using the application.

The specialists also expressed their opinion about the application in a descriptive manner, summarized as follows:

It is better to be more concise.

It is better to notice that most of overlap and confusion occur surrounding the ear, nose, and throat dentistry diseases, such as pericuronitis which causes pain on swallowing where the patient does not sense their swelling of gum tissue.

It is better to consider maxillary sinus pains.

It is better to clarify pain near the wisdom teeth and its swelling of gum tissue.

It is better to address jaw joint problems in transparent classification.

It is better to divide abscesses into oral and extraoral.

Since more than 90 % of specialists have a positive opinion towards the overall questionnaire to measure application effectiveness, the application is expected to meet with the approval of dentists and their clients in the future. The result of the present study is consistent with that obtained by NogueiraRG et al. who studied FAST-ED (Field Assessment Stroke Triage for Emergency Destination) application platform.[17] Their application was a free smartphone software to assist medical emergency specialists in field survey and triage of patients with an acute ischemic attack.

Their study results showed that the FAST-ED application had a high potential to improve the triage of patients with an acute ischemic attack. Contrary to the results of the present study, Chuchu N et al. concluded that artificial intelligence-based analysis technology utilized on smartphone applications was not accurate enough to diagnose dermatitis and melanoma.[18] In case of skin malignant lesions or missed melanoma, these applications made inaccurate diagnoses.

In the near future, this system of screening and triage for oral and dental emergencies can be utilized to minimize the number of referrals to dental centers and also guide patients to the relevant specialty. This system is thus helpful in keeping social distance, minimizing unnecessary referrals, protecting both client and specialist health, saving time

for both clients and specialists on dental examination (usually free). This makes the first level of referral system partially mechanized within the area of oral health care.

Limitations:

The limitations regard to this study are.

1. Patients need access to internet
2. Difficulty in progress therapy
3. Lack of human relationship

4. Conclusion

In spite of the growing trend of eHealth in different areas, dentistry has not sufficiently grown in the use of ICT (*e.g.,* telehealth/telemedicine). In the Covid-19 pandemic, the necessity for systems that can reduce people's presence in high-risk environments such as dental offices become more evident. In this article, Dandanyar system was designed, implemented, and evaluated in the form of an Android mobile and web application for screening of oral and dental problems. The proposed system is specifically practical and helpful in Covid-19 pandemic condition. According to the standard guidelines, this system allows the user to follow the diagnostic procedure for one of the six oral and dental problems (pain, swelling, wound, bleeding, trauma, and change in the sense or the shape of neck). This procedure entails responding to some standard questions in the form of certain self-reported answers based on which the application makes final diagnosis and offers necessary advice for self-care.

Other capabilities and features were considered wisely in Dandanyar system (web and mobile application); for example, it is possible to edit the content of all of the six paths, besides recording responses of the users to all the questions in the database of the application (on the server side) for further survey and statistical analysis on the results. This developed system was used by a population of 104 users (74 clients and 30 specialists). The user responses and the expert opinions were then analyzed to evaluate system effectiveness in making diagnosis and self-care recomendations for its users. The evaluation results of Dandanyar system for screening oral and dental problems showed that more than 90 % of specialists had a positive attitude towards application effectiveness. On the other hand, clients expressed their satisfaction with various aspects of the application in more than 80 % of cases. So, we highly recommend universities and (governmental) public health systems using this application for screening and triage of dental patients to reduce unnecessary commuting to dental clinics.

Ethical clearance

The method of this study was approved by Tehran University of Medical Sciences, Ethical Committee by ethical code: (IR.TUMS.DENTISTRY.REC.1399.071).

Patients consent

An Informed Consent was designed to give the participant all relevant information about the research and their role within. The consent was in Persian language.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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