Original Article

Mobile Health: A Comparative Study of Medical and Health Applications in Iran

Lida Fadaizadeh[1], Mohammad Sanaat[1], Ebrahim Yousefi[1], Niloofar Alizadeh[2]

[1]Telemedicine Research Center, National Research Institute of Tuberculosis and Lung Diseases, Shahid Beheshti University of Medical Sciences, [2]Department of Biostatistics, National Research Institute of Tuberculosis and Lung Diseases, Shahid Beheshti University of Medical Sciences, Tehran, Iran

Abstract

Background: The use of mobile phones in the field of medicine is rapidly increasing in developed and developing countries. This study aimed to evaluate the performance of the top mobile applications based on superiority from the user's point of view and medical content. **Methods:** Information of each app was recorded in a Google Forms, especially designed for this purpose. The Bazaar App Store, which has two main categories for health: medicine and health and fitness, was used as a source for Persian-language Android applications. The apps of these two domains were installed, and our experts reviewed and rated them in terms of content and technical performance. **Results:** From a total of 3500 applications available in the App Store, 112 apps were selected. Of these, 76.8% were in the field of medicine and 23.2% in the field of health and fitness. The developers of the app consisted of four main groups: (1) nonhealth-care organization, (2) individual app developers, (3) health-care organization, and (4) university or academic research group. The top five major areas of services were: (1) general medical services, (2) addressing medical centers and online appointments, (3) drug information, (4) physical activity and (5) patient follow-up. **Conclusion:** The review of users' scores and comparing it with the scores of specialists showed that although people tend to use telemedicine services, since there is still no formally approved framework for design and scientific content of these applications, most apps operate in the field of general information and services.

Keywords: Application, electronic health, mobile health, telemedicine

BACKGROUND

Mobile phones have become an integral part of people's daily lives, and this technology has emerged as a relatively new and innovative way of teaching health and providing health services.[1] According to the World Bank in 2015, about 99% of the world population have smartphones and in Iran in 2015, about 93% of the population is owned by mobile phones.[2,3]

Mobile phone has high adaptability to technological growth[4] and, on the other hand, is a useful tool for providing educational and health-care services.[5] Besides, the speed of teaching and learning by this device is high.[6]

The concept of mobile health (m-Health), which is based on communication devices, especially mobile, has emerged due to accessibility and availability of this technology for the general population.[7] M-health offers new models of care outside the medical centers[8] and therefore reduces medical costs.[9] Patients can use mobile applications and health sensors to gain health information, prevent various diseases, track their physical activity,[10] as well as to monitor physiological markers related to their health.[11]

There are several apps in the field of telemedicine in Iran, but no official guideline exists for their development and no supervision by academic and research centers has been done in terms of verifying the scientific content or practicality of the apps. This study was conducted to review Persian-language apps in the field of medicine and health and fitness for the purpose of evaluating their content and their practical and technical specifications.

Address for correspondence: Dr. Lida Fadaizadeh, Telemedicine Research Center, National Research Institute of Tuberculosis and Lung Diseases, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
E-mail: tmrc.nritld@gmail.com
ORCID: https//orcid.org/0000-0002-0736-2130

Access this article online

Quick Response Code:

Website:
www.bmbtrj.org

DOI:
10.4103/bbrj.bbrj_31_22

MATERIALS AND METHODS

This study was approved by the ethical committee of National Research Institute of Tuberculosis and Lung Disease (NRITLD) with registration number IR.SBMU.NRITLD.REC.1396.336

A checklist was created to evaluate applications in Google Forms. The checklist included the app name, designer, application installation cost, number of downloads, target community, user score, scientific score, technical score, and scope of application. Bazaar App Store, as the largest source of Persian-language mobile applications, was used according to the classification available on the site, which included: (1) medicine and (2) health and fitness. The reason for using the Bazaar App Store is that it is the largest center for providing domestic Android Apps in the country.

Applications were downloaded and installed based on inclusion criteria: (1) available in the Bazaar App Store, (2) being in the category of medicine or health and fitness, (3) having a Persian-language developer, (4) the app should be active (5) have up-to-date content, and (6) the content of the app should be in coordination with the information provided on the site. Exclusion criteria included (1) the purpose of the app is not compatible with the content within the app, (2) number of installations <10, and (3) technical problem in installing or using the app. The apps were rated in terms of applicability, quality, and accuracy of scientific content by a scientific expert. Development and programming quality, user-friendliness, and design of the apps were evaluated by a technical expert. The ratings by our experts ranged from the weakest score 1 to 5, the best score.

The apps were divided into four main categories based on the developers, which include (1) nonhealth-care organization, (2) individual app developers, (3) health-care organization, and (4) university or academic research group.

First, a comparison was made between the user and expert ratings based on the group of developers. We obtained the mean score of the user for each developer and compared it with their mean technical and scientific scores.

In the next step, the apps were divided according to the type of payment into three categories free, paid app, and in-app purchase. Expert scoring was compared to user rating in each category.

Eventually, all applications enrolled in the study were classified according to their field of activity and content to show the main interest of the users.

All statistical analyses were performed using SPSS software ver. 25.0 (SPSS Inc., Chicago, Ill., USA) at a significance level of 0.05. The frequency of data was calculated, and MannWhitney statistical tests were used to compare the median score between two groups, KruskalWallis was used to compare the median score between three groups and more. Pearson and Spearman's tests were used to examine the linear relationship between two quantitative variables.

RESULTS

Of the total apps in the Bazaar App Store that were available for download, 112 apps were suitable for study and review, and the rest were excluded based on inclusion and exclusion criteria [Figure 1].

Statistical analysis of developers showed that 65.2% of them were related to the nonhealth-care organization. 14.3% were individual app developers who designed the apps and 14.3% were developers of health-care organizations. Only 6.3% of the apps were designed by universities and academic research centers. In total, 76.8% of the apps were in the field of medicine and 23.2% in the field of health and fitness [Figure 2].

The mean score given by the users was 4.22 out of 5.00. The same score given by the scientific reviewer was 3.52 and by the technical reviewer 3.35. A statistically significant difference was detected between the scores of users and experts as a whole ($P < 0.0001$) [Table 1].

Examining the rating of applications considering the developers showed that:
1. The mean score of users compared to the score of experts given to apps designed by health-care organizations was not significantly different from each other [$P = 0.096$, Table 2]
2. The mean technical and scientific scores of apps designed by universities and affiliated research centers did not show a statistically significant difference [$P = 0.644$, Table 2]
3. The mean score of users compared to the score of experts given to apps designed by individual app developers showed a statistically significant difference ($P < 0.0001$) (user rating was higher than expert rating) [Table 3]
4. The mean score of users compared to the score of experts given to apps designed by the nonhealth-care organization showed a statistically significant difference ($P < 0.0001$) (user rating was higher than expert rating) [Table 2]
5. The studied apps were examined in the category of developers in terms of the median difference in user scoring and the total technical and scientific scoring, which did not show a significant difference [Table 2]

Table 1: Average score of users and scientific and technical rating

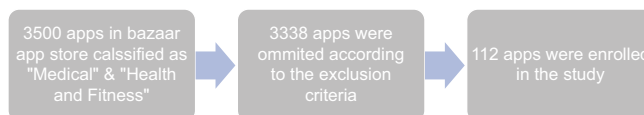| Rating	Average	P
Users rate	4.22±0.48	<0.0001
Scientific rate	3.52±1.01	
Technical rate	3.35±1.22	

Figure 1: Applications enrolling in the study

6. Using the Pearson correlation coefficient, the relationship between the variable "user score" and "scientific score" was investigated, and accordingly, there was a significant direct linear correlation between the two variables ($R = 0.569$ and $P < 0.0001$). Investigating the relationship between the two variables "user score" and "technical score" with Pearson correlation coefficient resulted in $R = 0.272$ and $P = 0.004$ and between the two variables "technical score" and "scientific score" resulted in $R = 0.400$ and $P = 0.0001$ [Table 3].

The correlation coefficient diagram of user rating and scientific scoring showed that users gave more points to apps with more acceptable scientific content. This indicates that users pay special attention to the content of applications [Graph 1].

Out of 112 apps, 77 were free, 30 were free with in-app purchase, and 5 needed to be bought [Graph 2].

In the comparison between users' scores in three groups of free, free-in-app purchase, and apps that need to be paid for download using the KruskalWallis ranking statistical test, a significant difference was observed between the median scores of the three groups [$P < 0.0001$, Table 4].

In another comparison that was done using the MannWhitney statistical test on the score of apps, a two-to-two comparison between the groups of apps was done based on the payment method. The results reported a significant difference between the "free-in-app purchase" group compared to both the "free"

and "pay-for-download" groups of the app [$P < 0.0001$, Table 5].

A classification was made based on the field of activity of the 112 Persian-language apps in the Bazaar App Store. Results showed that the top six areas of activity of apps included general programs, online appointment scheduling and information of medical centers, nutrition and diets, drug information, physical activities, and home care [Graph 3].

In the next step, we observed the apps that were specially designed for a specific disease. Statistical analysis showed that they mainly worked in the field of women's health, psychology, diabetes, and internal diseases, which were constantly updated, and their user interface was improving. After careful review of the apps, the findings showed that in the field of women, items were related to menstrual calendar adjustment, recording physical condition, preparation for pregnancy, prenatal care, gestational diabetes, health education and prevention of sexually transmitted diseases, and recording the user's clinical symptoms. In the field of psychology, there was a wider application of telemedicine because having a tool for communication between physician and patient was enough to contact the patient, and verbal communication including telephone, voice and text message, and video contact with a psychologist was easily applicable.

For diabetic patients, applications provide general information such as diets, exercises that can be effective in controlling blood sugar[12], measuring body mass index, recording clinical symptoms including blood sugar, insulin dosage, and finally, the appointment of a specialist and the address of medical centers for diabetic patients was designed.
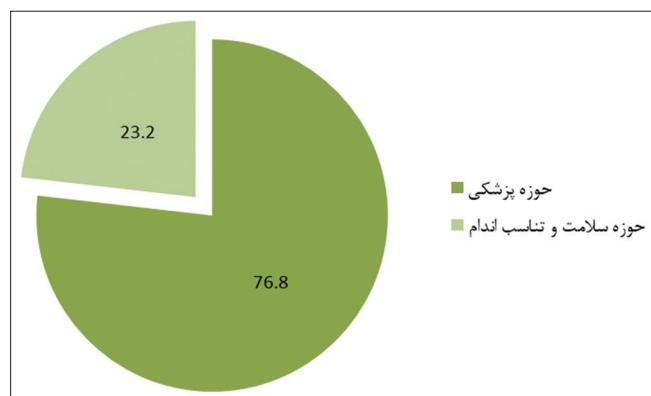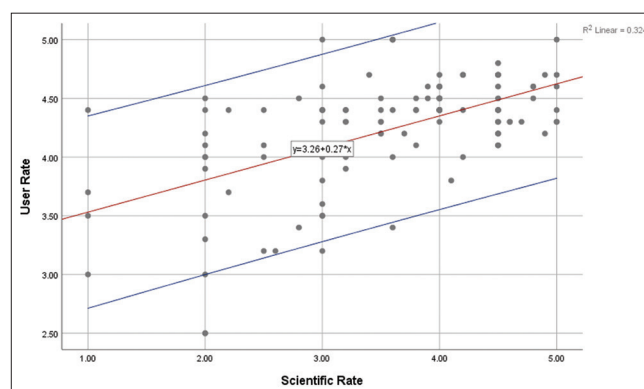

Figure 2: Percentage of applications in the study according to classification

Graph 1: Correlation coefficient between user rate and scientific rate

Table 2: Average score of user and scientific and technical rating according to the developer

Developer	Average			*P*
	User rate	**Scientific rate**	**Technical rate**	
Health-care organization	3.96±0.61	3.37±0.90	3.26±1.27	0.096
University or academic research group	4.50±0.18	4.34±0.61	3.96±0.90	0.644
Individual app developer	4.28±0.50	3.04±0.94	3.03±1.26	<0.0001
Nonhealth-care organization	4.24±0.45	3.58±1.03	3.39±1.22	<0.0001
P	0.057	0.017	0.421	

Applications related to gastrointestinal diseases provided only general information such as drugs related to gastrointestinal problems.

The results of applications developed for students as target group showed that a total of six apps existed, and the satisfaction of students from these apps is listed in Table 6.

DISCUSSION

The purpose of telemedicine is to provide medical services to applicants. The results of this study showed that the main activities of telemedicine in Iran are summarized in providing general information, scheduling appointments, diets and nutritional advices, drug information, physical activities, and home care advices. Due to the lack of standardization of this branch of health services, most apps are nonspecifically designed and have weaknesses. Of course, the security of these apps still needs to be

discussed. Here, we examine the characteristics of these telemedicine apps.

The definition of telemedicine can be expressed as the use of technology in medicine.[13] One of the main uses of this new method is nowadays referred to as "M-Health" which is using mobile phones and applications to perform health and medical services. Design of these applications can vary according to the purpose of their use, from conveying general knowledge to performing virtual visits in special situations such as coronavirus pandemic.

The results of this study showed that in Iran, most apps are generally designed with less specificity. The main purpose of these apps is to simply facilitate access to basic medical information about a disease. However, we have seen that in

Table 3: Table of correlation coefficient between user and scientific and technical rating

	User rate	Scientific rate	Technical rate
Medical			
User rate			
Correlation coefficient		0.461	0.226
P		0.0001	0.36
Scientific rate			
Correlation coefficient	0.461		0.328
P	0.0001		0.002
Technical rate			
Correlation coefficient	0.226	0.328	
P	0.36	0.002	
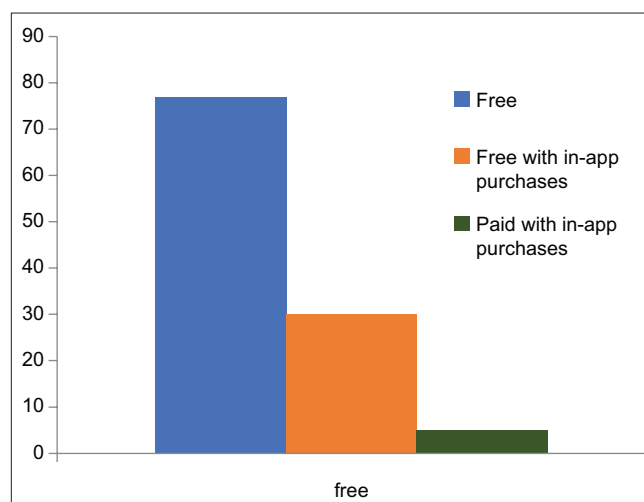
Graph 2: Application classification based on the payment

Table 4: Comparison of user rating according to the payment method

| User rate	Mean±SD	Median	IQR	*P*
Costumer cost				
Free	4.38±0.24	4.50	0.30	<0.0001
Free with in-app purchases	4.49±0.21	4.40	0.30	
Paid app without in-app purchases	4.36±0.23	4.20	0.50	

SD: Standard deviation, IQR: Interquartile range

Table 5: Two by two comparing of user rates according to the payment method

User rate	Mean±SD	Median	IQR	*P*
Costumer cost				
Free	4.38±0.24	4.50	0.30	<0.0001
Free with in-app purchases	4.49±0.21	4.40	0.30	
Costumer cost				
Free with in-app purchases	4.49±0.21	4.40	0.30	<0.0001
Paid app without in-app purchases	4.36±0.23	4.20	0.50	
Costumer cost				
Free	4.38±0.24	4.50	0.30	0.104
Paid app without in-app purchases	4.36±0.23	4.20	0.50	

SD: Standard deviation, IQR: Interquartile range

Table 6: Medical student's comments for the specific medical-related apps

App name	Number of comments	Number of unsatisfied comments	Percent
App Kitab	22	2	9.09
Tebcase	177	31	17.51
Termelo	36	1	2.78
Appokerats	66	2	3.03
Amoozesh Modavem Jame'eh Pezeshki	295	154	52.20
Dictionary Pezeshki Takhasosi	22	1	4.55
Total	618	191	30.91
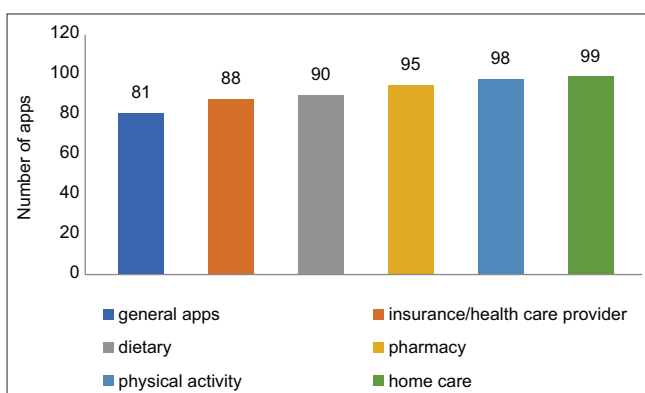
Graph 3: Top 6 Persian health-related apps

this area, the lack of technical support and updating and not conveying useful evidence-based medical information to users has caused people to become discouraged from using them; therefore, they return to receiving information from the doctor in traditional face-to-face methods.

One of the main goals of telemedicine is to examine the patient remotely.[14] However, this possibility has not yet been available due to the existing restrictions, such as the protection of patient privacy and limited access to the tools needed for examination. In addition, due to the lack of permits for virtual visits by the Ministry of Health and Medical Education, the use of "telemedicine" in the Iranian health system still has a long way to go to find its practical position, and therefore, telemedicine is currently limited to general information and services.

According to the present study, most telemedicine apps in Iran are provided by nonspecialist developers. Similarly, a study by American Telemedicine Association (ATA) found that most of the applications available in app stores around the world were also developed by nonproprietary developers. Based on these results, ATA decided to develop a framework for designing telemedicine-related applications to unify the apps available to users. This framework was obtained through repetition, experience, trial, and error, and eventually, a guideline was developed by the ATA which helps to improve the quality of applications.[14]

In Iran, some activities in the field of telemedicine have been carried out for communication between physician and patient.[15,16] However, the number of these activities is very small compared to the total existing apps. Many apps provide medical services, but not all of them are supported by certified medical centers to help gain the trust of patients. This is one of the most important factors for the success of telemedicine apps.

Our study also showed that the apps that were more practical and user-friendly and were up-to-dated regularly were more often downloaded. As a result, providing a comprehensive and appropriate guideline by the Ministry of Health for designing telemedicine apps can help improve the design and content of the available telemedicine apps in Iran.

Application cost is an important barrier to the use of most applications by patients. Usually, at the beginning, the providers offer their apps to the users for free, then according to the feedback received from users and assessing their opinions, the scientific content of the app will be updated and improved. Finally, some or all services provided by the application may be available through payment. According to our results, the majority of users tend to use free services and the use of apps that require payment to download is low. This is considered an issue in developing countries and deters the patients from using the application on a regular basis since patients are charged for availability of some essential options which is usually not affordable by everyone.[17]

Considering the scores given by users, there is indeed a statistically significant difference between the scores given to free apps and the other two groups of "free, in-app purchase," and "payment for downloading," but practically, the difference between the scores was not meaningful.

According to the topic of the program, more programs were used that had more specialized content for the patient. In other words, if an application is specially designed for a disease that the patient has, the patient will feel freer to interact with it and will gain more information from it, and eventually will be more satisfied with using it.

Users rate the app based on their needs, so "users' score" can be considered as a valid scale to check the performance and content of an app. In our study, examining the correlation coefficient between users' scores and the scientific score showed that users gave higher scores to apps with more acceptable scientific content. Moreover, we saw a lower correlation coefficient between users' score and technical score, which shows that the patients pay less attention to technical

quality of the applications, and the content of an application is more important.

One of the main concerns of patients using telemedicine systems is the confidentiality and security of the platforms. Since the function of these systems is based on transmitting sensitive personal information of the users, patients may not feel free to give full information about their situation. Therefore, all interactions through these systems must initially be approved by the user of telemedicine apps. For this purpose, informed consent of the telemedicine service, especially prepared and adjusted by lawyers so that no rights are violated, must be signed by the users before any information transfer. Furthermore, confidentiality and the fact that patient information is not misused is one of the important issues that should be mentioned by developers.[18] All legal aspects should be informed to the patient from the beginning of app installation and communication should begin with the complete consent of the patient. However, none of the apps reviewed in this study took the necessary measures to cover these issues, and this may be an important obstacle in the success of these applications.

Having no standard framework for the preparation of apps and also no legal and judicial support for physicians and patients are also considered weaknesses of this system. Hence,special attention should be taken into consideration for preparing guidelines and standards for taking care of legal issues of patient management.[14,18]

In Iran, due to political and economic issues, we face restrictions on the use of the necessary infrastructure.[19] Restrictions on the use of various app stores, including the Apple app store, have virtually eliminated a large portion of mobile users running iOS. Therefore, most developers have tended to design Android apps and present them in domestic app stores. Fortunately, with the advent of the Progressive Web App, this problem has largely been resolved and access of IOS mobile phone users to these platforms has been made possible.[20]

Conclusion

In general, several factors should be considered to have a useful and effective telemedicine application. Having a proper design team, medical professionals who are familiar with information technology, and the support of research and treatment centers can be involved in the effectiveness of the app. Therefore , giving proper education about telemedicine to patients , and keeping in mind about the laws for patients privacy, and their rights, can encourage the physicians to use a medicine in larger extend as general public health programe. The sum of these conditions can make the position of telemedicine in Iran valuable.

Financial support and sponsorship

Conflicts of interest
The authors declare that none of the authors have any competing interest.

References

1. Patrick K, Griswold WG, Raab F, Intille SS. Health and the mobile phone. Am J Prev Med 2008;35:177-81.
2. Bank TW. Mobile Cellular Subscriptions (Per 100 People); 2016. Available from: http://data.worldbank.org/indicator/IT.CEL.SETS.P2.
3. ITU. ICT Facts and Figure; 2016. Available from: http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx.
4. Rainie L. Internet, broadband, and cell phone statistics. Washington, DC: Pew Internet & American Life Project; 2010.
5. Oksman V, Rautiainen P. "Perhaps it is a body part": how the mobile phone became an organic part of the everyday lives of Finnish children and teenagers. InMachines that become us 2017. P. 293-308. Routledge.
6. Ventä L, Isomursu M, Ahtinen A, Ramiah S, editors. "My Phone is a Part of My Soul" – How People Bond with Their Mobile Phones. Mobile Ubiquitous Computing, Systems, Services and Technologies, 2008 UBICOMM'08 The Second International Conference On. IEEE; 2008.
7. Cipresso P, Serino S, Villani D, Repetto C, Sellitti L, Albani G, *et al*. Is your phone so smart to affect your state? An exploratory study based on psychophysiological measures. Neurocomputing 2012;84:23-30.
8. Kotz D, Avancha S, Baxi A, editors. A privacy Framework for Mobile Health and Home-Care Systems. Proceedings of the First ACM Workshop on Security and Privacy in Medical and Home-Care Systems. ACM; 2009.
9. Fries JF, Koop CE, Beadle CE, Cooper PP, England MJ, Greaves RF, *et al.* Reducing health care costs by reducing the need and demand for medical services. The Health Project Consortium. N Engl J Med 1993;329:321-5.
10. Consolvo S, Klasnja P, McDonald DW, Avrahami D, Froehlich J, LeGrand L, *et al.*, editors. Flowers or a Robot Army? Encouraging Awareness & Activity with Personal, mobile Displays. Proceedings of the 10th international Conference on Ubiquitous Computing. ACM; 2008.
11. Mohan P, Marin D, Sultan S, Deen A, editors. MediNet: Personalizing the Self-Care Process for Patients with Diabetes and Cardiovascular Disease Using Mobile Telephony. Engineering in Medicine and Biology Society, 2008 EMBS 2008 30th Annual International Conference of the IEEE. IEEE; 2008.
12. Odnoletkova I, Goderis G, Nobels F, Fieuws S, Aertgeerts B, Annemans L, *et al.* Optimizing diabetes control in people with Type 2 diabetes through nurse-led telecoaching. Diabet Med 2016;33:777-85.
13. Perednia DA, Allen A. Telemedicine technology and clinical applications. JAMA 1995;273:483-8.
14. Krupinski EA, Bernard J. Standards and guidelines in telemedicine and telehealth. Healthcare (Basel) 2014;2:74-93.
15. Fadaizadeh L, Najafizadeh K, Shajareh E, Shafaghi S, Hosseini M, Heydari G. Home spirometry: Assessment of patient compliance and satisfaction and its impact on early diagnosis of pulmonary symptoms in post-lung transplantation patients. J Telemed Telecare 2016;22:127-31.
16. Fadaizadeh L, Shajareh E, Mahdizadeh M, Sanaat M. Evaluation of Diagnostic Agreement between Teledermatology and Clinical Examination of Skin Diseases. journal of medical council of islamic republic of Iran 2019;37:231-4.
17. Vo V, Auroy L, Sarradon-Eck A. Patients' perceptions of mHealth apps: Meta-ethnographic review of qualitative studies. JMIR Mhealth Uhealth 2019;7:e13817.
18. Saei MH, Saghafi M. Telemedicine study in terms of legal. Medical Law J 2014;8:143-66.
19. Takian A, Raoofi A, Kazempour-Ardebili S. COVID-19 battle during the toughest sanctions against Iran. Lancet 2020;395:1035-6.
20. Fernandes G, Portela F, Santos MF, editors. PWA and Pervasive Information System – A New Era. World Conference on Information Systems and Technologies. Springer; 2020.