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Review Article

Evaluation of M-Health Applications Use in Epilepsy: A Systematic Review

Niloofar MOHAMMADZADEH [1], Sahar KHENARINEZHAD [1], Ehsan GHAZANFARISAVADKOOHI [1], Mohammad Saleh SAFARI [2], *Shahrbanoo PAHLEVANYNEJAD [1,2]

1. *Department of Health Information Management, School of Allied Medical Sciences, Tehran University of Medical Sciences, Tehran, Iran*
2. *Department of Veterinary, Veterinary Faculty of Science and Research Branch of Islamic Azad University, Tehran, Iran*
3. *Department of Health Information Technology, School of Allied Medical Sciences, Semnan University of Medical Sciences, Semnan, Iran*

***Corresponding Author:** Email: shpahlevany@gmail.com

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Abstract

Background: Epilepsy is a neurological disorder characterized by seizures and recurrent attacks. Self-management leads to seizure control and maximizes the quality of life in epileptic patients. The purpose of this study was to evaluate the quality of applications available in the epileptic google play store based on the rating features of MARS (Mobile Applications Rating Scale).

Methods: The search was conducted systematically using the keywords "epilepsy", "seizure", "mobile health" at the Android google play store. Data were extracted and analyzed from Feb 2018 to Apr 2019.

Results: Accordingly, 45 apps were identified potentially relevant of which 20 met inclusion criteria. Twenty-five apps were excluded because they were unrelated to epilepsy self-management, or not Development for people with epilepsy, not in English language or were not free and available. The total mean MARS score was 3.21 out of 5, and more than half of apps (17, 85%) had a minimum acceptability score of 3.0. The mean of apps' items were 3.27 in Engagement, 3.96 in function, 3.30 in Aesthetics, 2.96 in Information and 2.73 in subjective quality items.

Conclusion: Few apps meet prespecified criteria for quality, content, and functionality for epilepsy self-management. Despite the rapid evolution of self-management apps, lack of validation studies is a significant concern that limits the clinical value of these apps. Moreover, having a guideline and benchmarking in the field of mobile application development, in epilepsy management, can help analyze the content of established applications.

Keywords: Mobile application; M-health; Epilepsy; Seizure; Evaluation; Mobile application rating scale

Introduction

Epilepsy is a neurological disorder characterized by seizures and recurrent attacks (1). It is the fourth most common neurological disorder in the world that affects about 3 million adults in the United States at present (2). About 40% of epileptic patients have reported recurrent seizures that repeated attacks can in addition to affecting their daily lives and increasing their psychological

stress, leading to economic and social burdens on the patient's family and reducing their quality of life (1, 3, 4).

Mobile health applications (M_health) allow healthcare providers to use mobile and wireless technologies. These programs are often designed to provide suggestions and recommendations on the health conditions of their users. Studies show that mobile health programs, in addition to promoting people's health through changing their behavior and providing health education, have a potential role in exchanging information between patients and health care providers (5, 6). Smartphone owners in the United States share their health information through Smartphones and 19% of them use a mobile phone to self-management their status (7).

Self-care is defined as one's ability to manage symptoms, treatment, and lifestyle changes, and these programs also aim to solve problems and make decisions about disease management (8). Supporting patients in self-care and allowing them to make decisions are two very important factors in self-care (9). M_health can facilitate patients' frequent contact with healthcare providers, share health information on time, and help better self-care. The Epilepsy Mobile Self Care Program is a set of steps and programs used by the person with epilepsy that leads to seizure control, enhancing quality of life and minimizing the impact of seizures (2, 10).

Consumer technology companies such as Apple and Google have put thousands of self-care apps in their Apple App Store and google play store, but only a few have been approved by the Food and Drug Administration (11). It is very important to evaluate mobile health plans, as there are currently no regulations for developing mobile health plans.

There are several tools to evaluate apps such as the health IT Usability Evaluation Model, Nielsen, Shneiderman, and Norman model, QUIZ or Chen usability model, and finally Mobile App Rating Scale (MARS).

One method of evaluating mobile health applications is the Mobile Applications Rating Scale (MARS), recently designed to evaluate systematically mobile health (M_health) applications (12). The MARS tool is a 23-item scale that measures the quality of health-related programs based on four qualitative dimensions (interaction, performance, aesthetics, and information) and one mental dimension (12, 13). The MARS tool, in addition to quantitatively evaluating apps, also evaluates them qualitatively.

A study on mobile epilepsy self-care programs used the MARS ranking scale to evaluate the quality of epilepsy self-care programs available at the Apple App Store (2). MARS ranking scale was used to evaluate the quality of applications to manage seizures in the operating systems of the iPhone, Android, BlackBerry, Windows, and Nokia (1). MARS has been used in previous studies to evaluate various mobile health programs such as sleep self-care control (14), health behavior change (15), diabetes (16), pregnancy (17), weight management (18) and pain management (19).

The purpose of this study was to evaluate the quality of applications available in the epileptic google play store based on the rating features of MARS.

Materials and Methods

The search was conducted systematically using the keywords "epilepsy", "seizure", "mobile health" in Mar 2018 at the Android google play store. Data were extracted and analyzed from Feb 2018 to Apr 2019. Inclusion criteria intended studies on epilepsy-focused programs developed for people with epilepsy, being English-language, free and available in above market.

At the beginning of the search, all program titles were evaluated using the keywords listed and the inclusion criteria by a researcher was done and 45 applications were identified (Table 1). The identified programs were then screened according to the exclusion criteria. Exclusion criteria were programs that were not in English (n=2), for physicians and health care providers (n=1), and programs that were used at conferences or meetings or publications (n=19), so were omitted.

Overall, 24 applications were downloaded and reviewed by two members of the research team (for prevention of bias) after the screening phase, non-working apps (n=2), entertainment apps (n=1), and apps to control Seizures in animals (n=1) were considered as exclusion criteria through discussion between team members (Fig. 1).

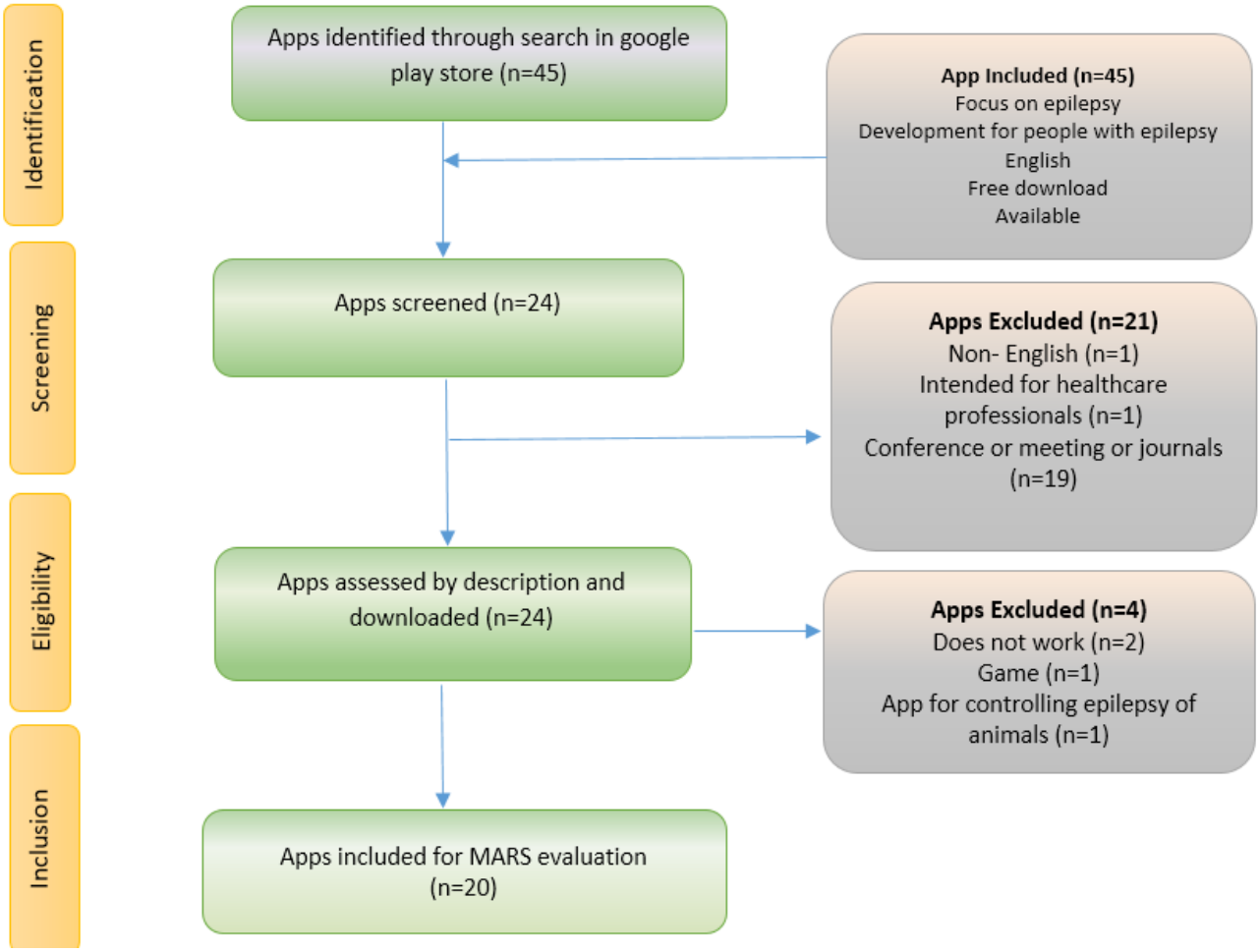

Fig. 1: Screening process flowchart

Finally, 20 epileptic self-care programs remained, with the following details extracted from the study programs: program name, cost, program users, their description and characteristics. The quality of the study's methodology consisted of using the Mobile Application Ranking Tool (MARS), used by a member of the research team to evaluate epilepsy self-management programs.

The MARS tool enables qualitative evaluation of mobile health applications that include interactive, performance, aesthetic, informational and mental dimensions. With the help of the MARS tool, it is characterized which of these programs have high quality, relevant information, are attractive, and beneficial to patients.

The MARS tool is a 23-item scale comprising a qualitative section of 19 items that is divided into 4 interaction scales engagement, performance, esthetics, information and finally, the mental part is divided into 4 items (Text box 1).

Text box 1. Definitions of Mobile App Rating Scale core subscales

1. Engagement: "Entertainment, Interest, Customization, Interactivity, Target group"

2. Functionality: "Functionality, Ease of use, Navigation, Gestural design"

3. Aesthetics: "Layout, Graphics, Visual appeal"

4. Information Quality: "Accuracy of app description, Goals, Quality of information, Quantity of information, Visual information, Credibility, Evidence base"

All information items on the MARS core axis are rated on a 5-point Likert scale (1=inadequate, 2=poor, 3=acceptable, 4=good, and 5=excellent). Scoring to each section as above, conducted by a member of the research team.

MARS's overall score comes from the four scales of interaction, performance, aesthetics, and information. MARS scores range from one to five, which higher scores indicating better program quality. MARS showed excellent internal consistency (alpha = 90) and good reliability (ICC = 79) (2, 12).

Results

The 20 epilepsy self-care programs were developed based on the search strategy that was reviewed in Table 1 for their features.

These programs target a wide range of users. There were 11 programs for patient use and 9 plans for shared use between patients and healthcare providers (physicians).

Most apps in the Google Play Store are suitable for all ages, only two apps designed for use (10, 17). All downloads were free, but Seizario: Seizure and Fall Detection, Epi Calendar - Seizure Diary were designed to be free to download but paid for in-app features. The 20 epilepsy self-management programs were evaluated (qualitative and quantitative) by a member of the research team on a 5-point Likert scale based on MARS rating characteristics (Table 2).

Engagement

The score in this section was scored on a 5-point Likert scale in 5 subscales (Fun, Interest, Customization, Interaction, and Targeting), with a mean of 3.27. Scores ranged from 2.0 to 4.4 out of 5. The WOE program received the highest score for engagement. The main goal of the Win Over Epilepsy program is to help epilepsy patients easily record their disease history so they can keep track of seizures, drug use, and doctor appointments.

Functionality

The score of the performance section was a 4-point Likert scale in the 4 sub-sections and the mean score for the performance section was 3.96. Scores ranged from 3.2 to 5. WOE, designed to provide basic information on the history of seizure and seizure registration, appointment scheduling, appointment with a physician, to share medical information with a physician, and prescribe medications, two language versions supported and clear for how to use it, it achieved the highest performance score.

Esthetics

The esthetics section was scored in 3 subgroups with a 5-point Likert scale and the average score for the aesthetics section was 3.30. Scores ranged from 2.3 to 5. Mirgi samjho, developed by Simply IT InfoTech as a source of epilepsy designed for diagnosis and treatment, achieved the highest aesthetic score with the highest graphics quality and visual appeal.

Table 1: Epilepsy app descriptions

No	***App name***	***Features***
1	Epilepsy journal	- Record seizure details - Visual representation of data - Generate reports - Keep track of medications with reminders - Quickly document all the important variables concerning epilepsy - Generate a simple and easy to read report to print out or email doctors
2	Seizure tracker	- Time and visually record seizures - Videotape seizures and upload them to YouTube for private sharing - Automatically add recorded seizure to Library - Store information in Seizure Library - keeping good records
3	My seizure diary	- Organizing and tracking daily medications, side effects and rescue therapies - Using reminder systems for medicines, appointments - Organize health history - Record and track multiple events more easily - Focus on self-monitoring and tracking - Manage medications and adherence - Communicate with your care providers - Share my family - Share with caregivers and health care team
4	Epi Diary	- Timely notification and reminders - Attach photos of your actual medications - Check medications immediately from the notification - Check seizures right from the lock screen - Keep Historically accurate medication record - Visual Medication Management (VMM) technology to improve safety in taking medications - Track sleep situation - One-touch data entry technology for enter seizure information
5	Epilepsy Ireland: epilepsy management app	- Help people to track and record medications and seizures - Plan epilepsy appointments - Provides an effective reminder system for medications and prescription renewals - Gather and present data about your medication details, seizures and symptoms
6	Epilepsy inclusion	- Savable and printable personal medical history like seizure record charts - Medication records and reminders for medical appointments - Facilitate communication with medical professionals
7	Total Epilepsy Recorder	- Provides a method for documenting a seizure (date, time, duration, symptom, video, and trigger) - Remind you to take your medications on time - Track behavioral and physical medication side effects
8	Seizure Sync Epilepsy Manager	- Save up to 80% on Medications EVEN if you have Insurance - Seizure Tracking - Medication Reminders - Journal Logging - Seizure Detection - Keep a medical record for family and doctors - Instant SMS and Email notifications in emergency - Ultimate epilepsy management - To help record the information that's essential to user and his/her care provider
9	Helpilepsy - epilepsy assistant & diary	- Track epilepsy - Understand epilepsy - Manage epilepsy

		- Visualize epilepsy & the treatment efficacy with neurologist - Help user track & share epilepsy information more easily and more effectively
10	Young Epilepsy	-Helps track and manage seizures and symptoms
11	Simple Seizure Diary	- Share web versions of the charts via e-mail - As well as adding comments you can label your seizures with colors
12	Seizario: Seizure and Fall Detection	- Alert message is sent to pre-specified emergency contacts - Accesses the location information during emergencies
13	Epi Calendar - Seizure Diary	- Add individual seizure causes - Control over your health data
14	Bio Mark Health Epilepsy	- Medication reminder system - Track to medication side effects - Track emotional changes, seizure triggers
15	Open Seizure Detector	- Alarm for Seizure - Epileptic seizure detector - Alert system that utilizes a Pebble smart-watch to detect shaking
16	Epi hunter	- Seizure start and seizure end
17	Ep App	- A tool that teenagers and young adults can use to complement their treatment - Help them better manage epilepsy. - Provide educational information about epilepsy
18	Win Over Epilepsy (WOE)	- Records seizures, complete history of the attack - Records doctor's details, to contact conveniently. - Enable scheduling of future visits and setting visit reminder. - Records medicines' prescriptions
19	Epilepsy Foundation App	- Provides reminders for taking medications, doing medical tests, and appointments with the doctor - Send an SMS to his/her emergency contact. - Store their epilepsy related medical history
20	Mirgi samjho	- Patient history - Diagnosis - Reminder - Pregnancy registry

Information

The score of the information section was scored on a 5-point Likert scale in the 7 sub-sections and finally, the mean score for the performance section was 2.96. Scores ranged from 2 to 4. Ep App and Mirgi samjho received the highest score of information. EpA pp is dedicated to providing epilepsy educational information along with self-management tools for adolescents with epilepsy, parents/supervisors and physicians involved in care. The program can help teens and youth to manage their illness and treat of it. This program aimed to improve the worldwide standard of care and quality of life for children and adolescents with epilepsy. The Mirgi samjho program guides epilepsy first aid for disease management and control. The information in the Ep App and Mirgi samjho program was exactly relevant to the purpose of the program.

Subjective quality

The mental quality part of the program is 4 items (usefulness of the program, the number of times the program is used, cost and satisfaction of the program). The mean score of the mental quality of the programs was 2.73. Scores ranged from 1.5 to 4. WOE and Mirgi samjho programs achieved the highest mental quality score.

Table 2: Epilepsy apps characteristics evaluation based on MARS

App name	*Engagement*	*Function*	*Aesthetics*	*Information*	*Subjective quality*	*Overall*
Epilepsy journal	3.8	4	3.3	3.2	2.5	3.5
Seizure tracker	2.4	4.2	3.6	3.2	3	3.3
Epilepsy foundation app	4	4.5	3.3	2.4	2.5	3.5
My seizure diary	3.8	4.2	3	3	3.5	3.5
Epi diary	3	3.7	3	2.7	1.5	3.1
Epilepsy ireland : epilepsy management app	3	4.2	3	2.7	2.7	3.2
Total epilepsy recorder	2.6	4	3.3	2.4	2.7	3
Seizure sync epilepsy manager	3.2	4	3	2.5	2.5	3.1
Helpilepsy - epilepsy assistant & diary	4	4	3.3	2.7	2.7	3.5
Young epilepsy	3.6	3.5	3.6	3.2	2.7	3.4
Simple seizure diary	3	4	3.3	3	3.2	3.3
Seizario: seizure and fall detection	3.2	3.7	3.3	3.2	2.7	3.3
Epi calendar - seizure diary	2.8	3.5	3	2.5	2.2	2.9
Bio mark health epilepsy	2.8	3.5	3	2.5	1.7	2.9
Open seizure detector	2.8	3.7	2.3	3.5	3	3
Epi hunter	2	3.5	2.6	2	2.2	2.5
Ep app	3.4	4.2	3	4	3.2	3.6
Win over epilepsy (woe)	4.4	5	4.6	3.7	4	4.4
Mirgi samjho	4.2	4.7	5	4	4	4.4
Epilepsy inclusion	3.4	3.2	3.6	2.8	2.2	3.2
Mean	3.27	3.96	3.30	2.96	2.73	3.21

Discussion

In the present study, most programs focused on educating patients about their disease status or how to manage epilepsy and follow up on these patients. Patients should be able to control their seizure in an emergency. Considering that seizure detection through mobile apps is one of the major components of self-care, there were 16 applications in the present study that could control and track patient seizure periods and if seizures occurred to inform relatives/parents of the patient. Drug self-management is one of the main features of many epilepsy patients, leading to improve patient control and seizure control. With the dramatic increase in antiepileptic drugs approved by the US Food and Drug Administration, approximately 30% to 35% of epileptic patients cannot control their seizures. Moreover, 30% to 60% of these epilepsy patients do not adhere to their medication guidelines.

Women with epilepsy are not as serious about their medications as taking the medication may cause nausea or vomiting, or some pregnant mothers with epilepsy are worried about fetal damage from medication use. Medication adherence is a major challenge for physicians and health care providers (20). Thus, mobile applications may be able to manage seizures and follow-up of patients' medication use (9). In the present study, 15 mobile applications can recall and track drug use at the right time for patients with epilepsy. Most of these programs allow users to manually enter the prescription drugs along with their dose and time. Using mobile health plans, physicians and providers can monitor patients' medication regularly. One of the programs that have the highest score in MARS, which can track, and control epilepsy patients is WOE and Mirgi samjho.

In a study that worked on smart applications for seizure management, we found 11 mobile apps that had features that allowed patients to manage their medications and there have been 18 programs for rapid diagnosis of seizures (1). In the present study, there are some web-based seizure tracking programs that allow the patient to take care of their health, in addition, to improve the management of their data.

One of these epileptic seizure tracking applications is the Seizure tracker. Features of this program include recording seizures, posting them on YouTube, preparing graphical reports, and shar-

ing information with health care providers. The limitation of this program is the lack of registration of daily patient seizures. My seizure diary is a mobile self-care program that has been evaluated to control seizures in patients with epilepsy in this study. In addition to managing and controlling seizures, the program also remembers patients taking medication. Three mobile applications used for self-care and seizure control in patients with epilepsy were investigated that achieved the characteristics of the present study (21). Fisher and his colleagues worked on seizure daily notation in two web-based applications, My Epilepsy Diary and Seizure Tracker.

In 2012, there were 13052 accounts in My Epilepsy Diary and 10235 in Seizure Tracker. These two programs allow patients to record different types of seizures and medications and receive their output in the form of graphical reports and table summaries (22). In 2011, the Web Ease program was created, a web-based education, supportive and awareness program to teach self-management to people with epilepsy to reduce transportation and health care costs. The program has three modules of medication management, stress management, and sleep management that by logging in to this website participants can record their medication, stress and sleep information and store information about each patient in a database. Finally, users can view their information in text and graphics format (23). Moreover, according to the Institute of Medicine's (IOM) report, the creation of decision support tools can lead to increased self-care decision making Focused on epilepsy. MINDSET is a clinical information management decision support tool in epilepsy patients designed for patients and healthcare providers to manage treatment, diagnose, prevent seizures and maximize the quality of life (10).

The highest rank of MARS in the present study was related to performance and esthetics. However, scores for the interaction, information provision and mental quality of the program were very low, which in the Escoffery study indicated that the lack of interaction and information provision was due to a lack of comprehensive training in mobile applications (2). Since epilepsy care intervention programs are less developed in children, adolescents, and their families, a limited number of programs for adolescents and adults have been found in the present study. In this study, most mobile applications are used by people of different ages. However, two Epilepsy and Ep App self-care programs have been found for adolescents and young adults. In the Escoffery study, an adult epilepsy self-care measurement tool called AESMMI was developed. The tool consists of 113 elements divided into 10 epileptic self-care contexts. These ten areas of self-care include treatment, signs and symptoms, seizures, lifestyles, health, safety, information, communication, social support and management (24).

Sharing personal care with health care providers is considered a part of self-care. In this study, nine mobile self-care programs share information with physician or other healthcare providers. One of the essential elements in mobile health is communication and collaboration between patients and healthcare providers. However, telecommunication through electronic devices results in reduced face-to-face communication between patients and providers and limits access to information obtained through examination. The overall MARS score in the present study was 3.21, which ranges from 2.5 to 4.4. Of the 3 WOE, Mirgi samjho, Ep App highest and 3 Epi hunter programs, Bio Mark Health Epilepsy, Epi Calendar - Seizure Diary scored the lowest in MARS (5).

The MARS tool was used to evaluate the quality of genetic applications, the overall MARS score was 3.78, with scores ranging from 2.4 to 4.7, which is roughly consistent with the present study (25). Moreover, the same tool was used to manage mobile health apps, the mean score was 3.1 and the scores ranged from 1.9 to 4.9 (18). The My Epi Pal mobile app was developed, an Android-based mobile app designed to control and manage seizures in epileptic patients. This program helps patients with epilepsy manage seizures, get medical history, medication reminders, make appointments with a health care provider, diagnose seizures through the patient's move-

ment and voice, and alert relatives during a seizure (26). However, this study was not found at the time of the present study because mobile applications were removed from the market store after some time.

According to the survey, only 3 programs had websites and resources for their information, and the other 17 provided no sources for their information. For this reason, there are a limited number of applications in the current study that incorporate comprehensive information with supportive tools.

Mobile application developers should consider ways to not only allow users to download the application but also to use it, as well as expanded applications to provide the necessary knowledge and skills to their patients' educational needs (2). Limitations including lack of a cohort study, a randomized trial, brevity of app exposure, low parent-log return rates, and restricted evaluation of psychosocial and mental health impact need to do future work (27).

Conclusion

New mobile health technologies such as smartphones can have a potential role in epilepsy self-care and monitoring. Some epilepsy self-care programs are currently available in market stores, but cannot provide good information and have a great impact on the user. On the other hand, some of these programs are not based on scientific evidence and the confidentiality of the collected information is not guaranteed. Applications should also be able to meet the needs of users such as user-friendliness, simplicity and attractiveness in addition to improving above needs. Qualitative evaluation of applications in the field is essential.

Moreover, having a guideline and benchmarking in the field of mobile application development, in epilepsy management, can help analyze the content of established applications. Best features of the apps that were better and got more points were records seizures, complete history of the attack, records doctor's details to contact conveniently, enable scheduling of future visits and setting visit reminder, records medicines' prescriptions. Moreover, to better respond to these patients' needs and expectations, programs must be designed and developed in collaboration with a wide range of patients. The use of mobile app quality assessment tools like MARS can be very useful in this regard.

Quality indicators also should be considered such as credibility, reliability, completeness, accuracy, and control of data sharing. Knowledge and skills for creation social media tools and mobile apps match the curriculum of health care professionals.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflicts of interest

The Authors declares that there is no conflict of interest.

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