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Investigating the role of mobile health in epilepsy management: A systematic review

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Abstract:

Epilepsy is the most common chronic neurologic disease which is characterized by recurrent attacks of headache after seizure. Researches show that self-management is an important factor in improving the quality of life and quality of care of people affected by epilepsy. Mobile phone technologies play a potential role in patient care assistance and treatment of epilepsy. This systematic review was conducted with an aim to study the role of mobile health in the management of epilepsy. This study was conducted by searching databases such as PubMed, Scopus, Web of Science, and Google scholar search engines using the following keywords: "m-health," "mobile health," "Telemedicine," "Mobile Application," "Smartphone," "epilepsy," and "epilepsy management." Articles published from January 1, 1990 to September 1, 2021 were searched. Inclusion criteria included all articles published in English with a focus on the role of mHealth in the management of epilepsy. Review articles and studies that were not about patients were omitted. In this study, of a total of 4225 retrieved articles, 10 studies met the full-text inclusion criteria. Three types of researches (30%) were done in the USA, five studies (50%) were conducted as randomized controlled trials, and eight articles (80%) had the highest quality. Among the considered articles, three articles (30%) were engaged in training users in epilepsy management. Five articles (50%) reported improvement in seizure control in patients with epilepsy and two articles (20%) did not report any significant improvement. Mobile technologies have a promising role in providing health assessment, education, and other services for patients, and they also help in controlling seizures attack and improvement of epilepsy management. These technologies enjoy great attractiveness, and utilizing them will lead to patient satisfaction.

Keywords:

Epilepsy, epilepsy management, mobile health, seizure, self-management, smartphone, smartphone application, telemedicine

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Introduction

Neurologic disorders are the main cause of disability in the world.^[1] Epilepsy is the fourth most common neurologic disorder after migraine, stroke, and Alzheimer's. The World Health Organization (WHO) reports that approximately 50-60 million individuals worldwide have epilepsy, and only 70% experience a positive response to conventional seizure-controlling medications.^[2,3] Previous researches have shown that the incidence of epilepsy is

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twice as common in children and youths as in adults.^[4] It is the most common chronic neurologic disease which is characterized by recurrent attacks of headache after an episode of seizure. Epilepsy is not only a physical illness, but also has mental, social, and economic consequences on patients' lives.^[5-7] Moreover, it is a long-term and costly disease with negative impacts on individuals' quality of life.^[4,8] Most of the patients with epilepsy (PWE) also suffer from a wide spectrum of other problems such as mood disorders, memory disorders, and side effects of the Anti-epileptic drugs.^[7,9]

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In the last decades of the last century, many changes have been made in the management of diseases. Therapeutic and medical approaches in dealing with patients and diseases have been widely replaced by preventive and collaborative approaches in which the role of patients is vital to manage their care services.^[10]

Researches have shown that self-management is an important factor in improving the quality of life and quality of care for the treatment of people affected by chronic diseases such as epilepsy. Self-management indicates the ability of patients to deal with their chronic condition and eventually maximize their quality of life.^[11] Escoffery *et al.*^[2] stated in their research that self-management is the core of epilepsy treatment. Self-management in epilepsy can be defined as, “all stages and processes used to increase the control of seizure, quality of life as well as decreasing the impacts of seizure disorder.” Also, self-management in epilepsy helps patients to increase their ability and self-efficacy.^[5,12]

Studies show that PWE want to know more about this disease, and some educational self-management courses have been trialed internationally.^[8] Supporting patients' confidence in self-care and managing the side effects of the treatment may have major impacts on patients' performance and their quality of life.^[13]

Self-care or taking care by individuals or family members is one of the important elements in the management of chronic as care is often shifted to the home environment. Mobile device-enhanced health care, or mHealth, which is defined as “medical and public health practice supported by mobile device” by the World Health Organization (WHO), is being touted as a means to support self-care.^[14,15]

Previous studies have emphasized the effectiveness of self-care training programs in patients with back pain, knee pain, arthritis, neck pain, angina pectoris, and epilepsy.^[16]

Telemedicine involves the exchange of health and medical information with various tools of communication to improve health. Telemedicine is a strategy to reduce costs and increase equitable access to quality health services. Some of its benefits include increasing access to health-care services, making education affordable, increasing access to education, raising the level of social support, improving treatment results, and increasing the quality of services.^[17]

Technologies for better diagnosis and purposeful treatment of such diseases are evolving rapidly. Developers of health applications are mainly interested in developing apps related to self-management in

patients with chronic diseases. Nowadays, advanced electronic tools have become a part of patient care in many specialties. Mobile phone technology, with a growing number of subscribers, practically like digital personal assistants with advanced capabilities, is rapidly evolving. Specially, these technologies play a potential role in patient care assistance and the treatment of epilepsy.^[2,18]

According to a polling conducted in a research, 90% of PWE are desirous of using mobile phones for control of seizures. Mobile health applications, music, curative video games, and combining them with prescribed medicines provide new opportunities for merging pharmacological and nonpharmacological interventions for PWE to retrieve from epilepsy and also for those who live with other chronic disorders such as depression and pain.^[1,3] Also, research shows that using mobile health self-management applications gives positive results in improving individuals' health.^[19]

In this study, we tried to check the impact of mHealth tools on epilepsy management, so that the researchers can design new means to control the disease in a better way.

The goal of this systematic review was to study the role of mobile health in the management of epilepsy.

Materials and Methods

This research was conducted as a systematic review in 2021 by conducting a search in databases such as PubMed, Scopus, Web of Science, and Google scholar search engines using the following keywords: “m-health,” “mobile health,” “Telemedicine,” “Mobile Application,” “Smartphone,” “epilepsy,” and “epilepsy management.” Articles published from January of 1990 to September of 2021 were searched. The search strategy is shown in Appendix 1.

Also, references to the articles were checked to ensure that the search results were complete. After removing duplicate titles using Endnote software version 7x, all of the articles' titles and abstracts were studied independently by two reviewers. The selected articles that met the inclusion criteria were analyzed and read as full text. Inclusion criteria included all articles published in the English language with a focus on the role of mHealth in the management of epilepsy. Review articles and studies that were not about patients were omitted.

Studies have shown that there are no tools to assess the quality of mHealth studies. Therefore, a quality assessment tool, including 10 items [Table 1], was developed based on

two reviewed studies.^[20,21] Each of the quality assessment items was measured with a score of 0 or 1.

Results

In this research, 4225 articles were extracted. After an initial checking of the title and abstract, 43 qualified articles were obtained for full-text evaluation. After full-text evaluation, 33 articles were discarded and 10 articles were selected for finer analysis. Figure 1 shows the flowchart of article selection according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) chart.^[22]

Characteristics of the selected studies are reported in Table 2. As demonstrated in this table, these 10 studies were disseminated between the years 2012 and 2020.

Table 1: The tool used for measuring the quality of studies

Quality evaluation criteria	Score
The study objectives have been clearly stated	1
The type of mobile health tool has been clearly stated	1
The features of the mobile health tool have been clearly stated	1
Data collection method has been clearly described	1
The study population has been clearly specified	1
Intervention has been clearly explained	1
The mobile health tool has been reviewed in terms of usability	1
Study design has been clearly explained	1
Study setting has been clearly marked	1
Study limitation has been fully reported	1
Maximum points	10

Three number of studies were done in the USA and in each of the countries of China and Malaysia, two types of researches were done. One research was conducted each in Australia, South Korea, and Taiwan. Among these studies, five types of researches (50%) were conducted as randomized controlled trials (RCT), one was (10%) a before–after study, one was (10%) a cohort study, and one (10%) was conducted as a cross-sectional study. The type of two remaining researches (20%) was unknown.

Among the considered articles, three articles (30%) were engaged in training users in epilepsy management field. Seven articles (70%) reported the results of seizure control in PWE. All three articles which considered users’ training reported an increase in individuals’ knowledge. Out of the works that examined seizure control, five articles (71.4%) reported an improvement in seizure control, while two works (28.6%) did not report any noteworthy progress.

The quality scores were categorized based on 10 selected items, which are presented in Table 3. Out of 10 articles, eight (80%) had the highest quality (they had a score of 8 or above).

Discussion

Studies indicated that there are a few systematic review articles in epilepsy management. Hence, investigating the role of mobile health in epilepsy management was considered in this research. In summary, among

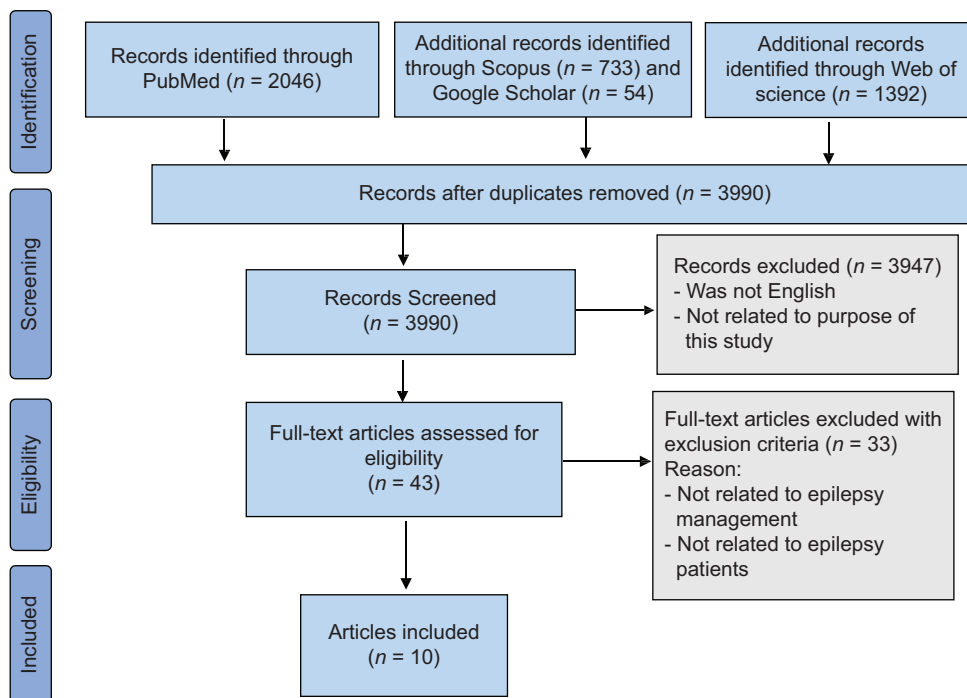


Figure 1: Article selection chart based on PRISMA flowchart

Table 2: Characteristics of the selected studies

Ref.	Author name	Country of study	Year of study	Study type	Sample size	Result	Conclusions
[3]	Afra <i>et al.</i>	The USA	2018	-	40 patients	Patients preferred automated features for different aspects of seizure and disease management	Transforming nonpharmacological interventions into mobile software and incorporating it into medicines is an attractive strategy for improving treatment results in many neurologic disorders
[23]	Glynn <i>et al.</i>	The USA	2016	Before-after	20 patients	Parents and children reported similar levels of satisfaction with cognitive training Parents reported high levels of satisfaction with the quality of the application's content	Children found it enjoyable, and 75% reported that they use the application for fun
[24]	Le Marne <i>et al.</i>	Australia	2018	Prospective cohort	51 patients	Design, content, usability, and functionality of the application were desirable This study states that EpApp increases knowledge and is engaging	There is no significant improvement in the number of seizures or psychosocial parameters
[25]	Liu <i>et al.</i>	China	2016	Cross sectional	502 patients	The findings of this study indicate that there is a positive trend toward using the application among PWE	Utilizing smartphone apps could be a promising strategy for seizure self-management
[26]	Lua and Neni	Malaysia	2012	Prospective, randomized, interventional	51 patients	-The findings of the study highlighted the positive feasibility, acceptability, and positivity of MEES in PWE	Mobile phone technology has a promising role in providing health assessment, education, and other services to the patients
[27]	Lua and Neni	Malaysia	2013	Randomized controlled, open-label trial	144 patients	Education about seizure management and psychosocial development may also be helpful in reducing health-care providers' anxiety, which should result in fewer restrictions in everyday life. Therefore, it results in improved HRQoL for PWE	Disease education for PWE and their families plays an important role in adapting to life with epilepsy, developing self-confidence, and competence in self-management, which requires being aware of one's own needs and being able to access resources to meet these needs
[28]	Si <i>et al.</i>	China	2020	Randomized controlled trial	380 patients	This study indicated that patients' satisfaction with this application is high	Using a smartphone application specially for epilepsy is efficient and could improve self-management by patients and may improve control of seizure
[29]	Yoo <i>et al.</i>	South Korea	2019	-	8 patients	It helped patients to record the seizures accurately	This is useful for analyzing seizure process, detecting the trigger factors of seizure, and ensuring efficient management of epilepsy
[30]	Johnson <i>et al.</i>	The USA	2020	Randomized controlled trial	129 patients	Goal setting may have had a positive effect on the treatment group as it sustains their epilepsy self-management behaviors The average goals met per subject (4.6) and the percentage of goals attained (78%) are positive indicators of engagement and behavior change	The Program of Active Consumer Engagement in Self-Management in Epilepsy (PACES) program has now been effectively delivered by telephone and in person After 6 months of treatment, the group that received treatment showed sustained improvement in self-management, self-efficacy, and overall composite when compared to the control group.
[31]	Chen <i>et al.</i>	Taiwan	2012	A longitudinal, randomized controlled trial	155 patients	GEE analysis showed scores decreased significantly at T3 from baseline for the control group (CG) for epilepsy knowledge and QoL ($P<0.001$) Improvements in scores for sleep quality, anxiety, depression, self-efficacy, coping, and social support did not differ between groups.	Although the overall goal was improvement in QoL for PWE, the self-management intervention (SMI) program did not significantly improve HRQoL. The lack of improvement in HRQoL following the SMI may indicate that additional time is required to change behaviors that impact this variable for PWE

GEE=Generalized estimating equations, HRQoL=Health-related quality of life, MEES=Mobile epilepsy educational system, PWE=Patients with epilepsy, QoL=Quality of life

Table 3: Quality score of the 10 adopted articles

Quality evaluation criteria	3	[36]	[19]	[33]	[35]	[25]	[18]	[24]	[30]	[31]
1) The study objectives have been clearly stated	1	1	1	1	0	1	0	1	1	1
2) The type of mobile health tool has been clearly stated	1	1	1	1	1	1	1	1	1	1
3) The features of the mobile health tool have been clearly stated	1	1	1	1	1	1	1	1	1	1
4) Data collection method has been clearly described	1	1	1	1	1	1	1	1	1	1
5) The study population has been clearly specified	1	1	1	1	1	1	1	1	1	1
6) Intervention has been clearly explained	1	1	1	1	1	1	1	1	1	1
7) The mobile health tool has been reviewed in terms of usability	0	0	1	0	1	0	0	1	0	0
8) Study design has been clearly explained	1	1	1	1	1	1	1	1	1	1
9) Study setting has been clearly marked	1	1	1	1	0	0	0	1	0	1
10) Study limitation has been fully reported	0	0	1	1	1	0	1	0	1	1
Total scores	8	8	10	9	8	7	7	9	8	9

10 qualified articles, three items (30%) considered training and increasing the level of users’ knowledge in the field of epilepsy management. Five articles (50%) reported improvement in control of seizure and two of them (20%) did not show any significant advances in control of seizure.

Si *et al.*^[28] stated in their research that using smartphone applications improved epilepsy self-management among the PWE from West China. On the other hand, transforming nonpharmacological interventions into mobile software and its incorporation into pain killers, antidepressants, and anticonvulsant medicine is an attractive strategy for improving treatment results in many neurologic disorders. In addition, mobile software is a nonpharmacological method for PWE that can be combined easily with other treatment approaches.^[3] It seems that incorporating pharmacological interventions into mobile phone technologies can improve the treatment results for PWE.

Le Marne *et al.*^[24] reported that the application which they used in their study (EpApp) increased patients’ knowledge on self-management of epilepsy and also enjoyed great attractiveness. In contrast, it did not show any significant advances in decreasing the number of occurring seizures and existing psychosocial parameters. It seems that training via mobile phone applications alone may be insufficient for changing psychological variables, and necessity for more research in this field is felt.

Moreover, the results of a research conducted by Giesler *et al.*^[32] did not support the hypothesis that the website studied may increase self-efficacy in coping with cancer or self-regulation and management of emotional distress among patients. The reasons include website characteristics, its use by participants, or psychological causes.

Also, despite the regular use of technology considered in the research conducted by Stamenova *et al.*,^[33] patients

with chronic obstructive pulmonary disease (COPD) assigned to remote monitoring there was no significant difference in patient outcomes such as self-management skills, knowledge, symptoms, or healthcare utilization when comparing self-monitoring to standard care or to each other. This may be due to low use of health care at the initial stage, the lack of structured educational components in the intervention groups, and the lack of integration of action plan with the technology.

Cnossen *et al.*^[34] demonstrated that patients’ satisfaction improved in online self-management education. It should be noted that, satisfaction was associated with the educational level and health literacy skills and only those patients who had internet access could use this program. It seems that the level of patients’ satisfaction in self-management programs is associated with the educational level and having necessary facilities for using these programs.^[35] Another research conducted in 2020 shows that digital health alone is not sufficient in countries which have health system with few resources.^[14]

The study conducted by Yoo *et al.*^[29] demonstrated high level of patient satisfaction in the application used in their study. Also, this app helped them to record their seizure attacks exactly. These recordings were useful for analyzing the process of seizure, detecting the trigger factors of seizure, and ensuring efficient management of epilepsy. Moreover, by merging the recorded items with electronic health records, patients’ medical information can be used as guidance for physician’s decision-making for setting the next treatment plan, which can be of much help in the overall management of epilepsy. Also, Patterson^[36] studied an application for epilepsy management for individuals with suspected epilepsy and showed that it is a reliable and valuable tool in epilepsy diagnosis and management, which helps specialist doctors.^[36]

Another research also demonstrated that this app was effective in decreasing the number of seizures, and that

patients prefer telemedicine to conventional services for epilepsy management.^[25] It seems that, utilizing the items recorded in self-management apps and combining them with individual's electronic health records can help specialist doctors in decision-making for continuing patients' treatment or even diagnosing different types of seizures.

Liu *et al.*^[25] explained that there is a positive trend in using epilepsy applications among patients and based on this positive trend and current development of mHealth in China, using smartphone applications can be a promising strategy for seizure self-management. It seems that mobile phone apps are being widely accepted by patients. So, mobile phone technology has a promising role in providing health assessment, education, and other services for patients.^[24,26,37] Also, in another study performed by Ekstedt *et al.*,^[38] a self-management application provided access to a digital tool for patients with cancer, their family members, and health-care specialists. It served as a means of communication between patients and healthcare providers. In addition, it promotes patient self-care and empowerment during the period of care and treatment. It seems that utilizing mobile phone applications can provide an appropriate relationship among patients, their families, and health-care providers to help improve epilepsy self-management and to continue patients' treatment plans.

The limitation of the present study was that it only examined English-language studies. The reason for this was the abundance of articles in English compared to other languages.

One of the strengths of this study is that it does not limit its focus to a single aspect of mobile health usage, but rather considers all domains. Also, according to investigations, there are a few researches about the impact of mobile health on epilepsy management and in this comprehensive review, it was tried to collect and investigate these researches.

Generally, it appears that educating patients can be effective in the control of seizure attacks. Also, mobile technologies can be used to enhance knowledge, improve epilepsy management, and increase patients' quality of life. Moreover, by combining mobile software and other treatment methods, self-management of PWE can be improved. Also, recording the details of seizure attacks can be useful for analyzing the process of seizure and epilepsy management and helps guiding physicians in decision-making. Based on the above-mentioned points, it is suggested to help improve the quality of life of PWE by producing a comprehensive application for epilepsy patients that can record seizure attacks and educate patients.

Conclusions

Mobile technologies have a promising role in providing health assessment, education, and other services for patients, and they also help in control of seizure attacks and improvement of epilepsy management. These technologies enjoy great attractiveness, and utilizing them will lead to patient satisfaction. Combining mobile software with other treatment methods and transforming nonpharmacological interventions into these software tools are engaging strategies for improving treatment results.

Considering the few number of articles in the field of mobile phone utilization in epilepsy management and also the wide and increasing usage of mobile phone and variety of applications in epilepsy management, it is necessary to do more researches in this field and reporting the obtained results clearly.

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Conflicts of interest

There are no conflicts of interest.

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Appendix

Appendix 1: Search strategy for each database

Data bases	Search strategies
PubMed	(((((Mobile Application)[Title/Abstract] OR (Smartphone))[Title/Abstract] OR (Telemedicine))[Title/Abstract] OR (App))[Title/Abstract] OR (m-health))[Title/Abstract] OR (mobile health))[Title/Abstract] AND (epilepsy))[Title/Abstract] OR (epilepsy management[Title/Abstract])
Google scholar	"Mobile Application" intext OR "Smartphone" intext OR "Telemedicine" intext OR "m-health" intext OR "mobile health" intext AND "epilepsy" intext OR "epilepsy management" intext
Scopus	((("mobile health" OR "m-health" OR "smartphone" OR "mobile application" OR "telemedicine") AND ("epilepsy" OR "epilepsy management"))
Web of science	M-health (Title) OR Telemedicine (Title) AND epilepsy (Title) OR epilepsy management (Title)