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AIDS Rev. 2022;24:24-31

Mobile applications in HIV self-management: A systematic review of scientific literature

*Esmaeil Mehraeen[1], SeyedAhmad SeyedAlinaghi[2], Zahra Pashaei[2], Pegah Mirzapour[2], Alireza Barzegary[3], Farzin Vahedi[4], Kowsar Qaderi[5], Marcarious M. Tantuoyir[4,6], Zahra Nazeri[7], Amirali Karimi[4], Mohammad Mehrtak[8], and Mohammad Heydari[1]**

[1]Department of Health Information Technology, Khalkhal University of Medical Sciences, Khalkhal, Iran; [2]Iranian Research Center for HIV/AIDS, Iranian Institute for Reduction of High-Risk Behaviors, Tehran University of Medical Sciences, Tehran, Iran; [3]School of Medicine, Islamic Azad University, Tehran, Iran; [4]School of Medicine, Tehran University of Medical Sciences, Tehran, Iran; [5]Department of Midwifery, School of Nursing and Midwifery, Kermanshah University of Medical Sciences, Kermanshah, Iran; [6]Biomedical Engineering Unit, University of Ghana Medical Center (UGMC), Accra, Ghana; [7]Department of Health Information Management, Tehran University of Medical Sciences, Tehran, Iran; [8]Healthcare Services Management, School of Medicine and Allied Medical Sciences, Ardabil University of Medical Sciences, Ardabil, Iran

Abstract

Self-management through mHealth by mobile apps creates new opportunities for people living with HIV (PLHIV) for integrated and accurate management. Our study focused on current evidence on HIV self-management mobile applications to identify and assess their objective, infrastructure, and target populations. A systematic review was conducted on studies that use apps to improve self-management among HIV-positive patients, using PubMed, Scopus, Embase, Science direct, UpToDate, and Web of Science databases. The search was limited to English-written articles and published in the past 10 years. A search of Google Play for Android and App Store for iOS devices was performed to find the apps identified in the included articles. Concerning the aim of this study, the target populations of 17 identified HIV-apps were found to be mainly directed at PLHIV (n = 15). Furthermore, the objectives of 17 identified HIV-apps were found to self-care, self-monitoring, and self-management (n = 7), improve medication adherence (n = 5), prevention and treatment (n = 5), adherence to antiretroviral therapy (ART) (n = 4), Cognitive Behavioral Stress Management (n = 1), and support safer conception among HIV couples (n = 1). The operating system of most HIV-apps was Android (n = 15), one app for iOS and seven apps was both of them, and most apps were free (n = 19). The findings indicate that mHealth strategies for PLHIV have had a substantial positive effect on ART, drug adherence, prevention, and treatment, as well as social and behavioral problems affecting PLHIV. Even though the mHealth market needs to be regulated, it specifies that mHealth is relevant and should be used in the self-management, self-monitoring, and self-care of PLHIV.

Keywords

HIV/AIDS. Self-management. Mobile applications. Smartphone. Medical informatics applications.

Correspondence to:
*Mohammad Heydari
E-mail: heydari.mohammad12@yahoo.com

Received in original form: 24-03-2021
Accepted in final form: 14-09-2021
DOI: 10.24875/AIDSRev.21000025

Introduction

Since the advent of antiretroviral therapy (ART), HIV has become a chronic disease and requires lifelong active self-management to maintain physical and mental health and improve quality of life by coping with the disease and its potential challenges[1-3]. According to findings, people living with HIV (PLHIV) experience challenges in physical health, psychological function, and social relationships[4-8]. Lack of self-management causes physical and mental problems for PLHIV due to irregular use or discontinuation of ART, incomprehension of illness and wellness, disobedience of prevention principles, inability to manage disclosure and stigma, fluctuation in mental state, and improper cognitive skills[9-11]. Consequently, it could lead to changes in CD4 count and viral load, acceleration of the disease progression, depression, stress-related problems, and an increased likelihood of transmitting the disease to others[12,13].

Given that most people have a phone and use it regularly, using mobile health technology (mHealth) is a smart way to engage patients in their healthcare. Furthermore, mHealth has the potential to be an appropriate medium for providing up-to-date and suitable health information[14]. According to evidences, self-management oriented interventions improved knowledge of PLHIV about their condition, and also have positive impact on physical and psychological health[15]. In particular, mHealth, using less time and resources in comparison with face-to-face activities, can be used as a powerful tool to change health behavior for prevention and self-management, and it is always available to the person and can make changes based on the individual's needs and can perform advanced computation[16,17]. It is estimated that there are more than 47.000 mHealth applications that can confirm their helpfulness and usability[18]. As mHealth technology expands according to the demand, designing practical and effective apps becomes more important[19].

At present, the fastest growing area in the provision of health-care services is related to mobile and wireless technologies[20]. In 2020, about 78% of the world's population had smartphones, which shows 1.6 times increase in smartphone users compared to 2016[21]. mHealth has the potential to stabilize the delivery of care and treatment interventions in large populations at low cost[22]. Using mobile, it can be possible to activate receiving educational messages and necessary reminders, receive 24-h service, and connect with health-care providers[23].

Self-management through mobile phone by mHealth, as innovative and technology-enhanced methods, creates new opportunities for PLHIV for integrated and more accurate management[24]. Self-management tools may include personal monitoring of health status, connecting with social networks with peer groups, improving communication with health-care providers, and providing conditions for easy and purposeful access to the required information about their health status[25,26]. In general, improving self-management can help prevent the progression of HIV, reduce hospitalization and referrals to care centers, get better clinical and care results, and reduce the incidence of comorbid infections[27,28]. Furthermore, mHealth self-management would be more suitable for PLHIV who faced barriers such as a stigma to sustain in care and treatment services[29-31].

About 15 apps are available for self-management of health for PLHIV, which include various sections such as reminders, lab reports, logs of medication, drug information, communication, nutrition, fitness, resources, setting, and search; none of the apps had all mentioned functions[32,33]. Findings of some related studies have shown the impact of mHealth self-management in PLHIV on coping with stress[34], adherence to ART[35], retention in care[36], and engagement in HIV care for the drug-using population[37] and men who have sex with men (MSM)[38].

We aimed to assess the researches published with concentration on HIV self-management mobile applications to identify and describe current evidence-based mHealth interventions. We had three specific research goal: (1) type of developed intervention to support self-management among PLHIV, (2) effectiveness of interventions, and (3) feasibility and applicability of interventions. Furthermore, the specific programmatic requirements, cost of apps, and target populations were assessed.

Methodology

Design

This review is conducted in two main stages. In the first stage of this study, the research question and inclusion/exclusion criteria were recognized. This methodology enables the exploration and identification of studies that provide scientific evidence on the use of mobile-based apps for HIV self-management. This study is useful to determine the recent status of knowl-

edge, suggest a scientific route for action, and propose potential limitations that could be considered in future studies[39]. The second phase of this study designed a search to obtain the apps used in the included articles, analysis, and classification of the identified apps, and a summary of the findings.

This review design subjects to explain the use of HIV self-management apps, with the possibility of identifying which apps are supported by related scientific evidence for use in health-care organizations. The first phase involves a systematic review of the currently available evidence on the study aim to provide a better understanding of specific aspects of related knowledge. A systematic search was then done and the identified articles were evaluated according to the inclusion and exclusion criteria. The included studies were subsequently categorized, and a synthesis of the review analysis was established. The second stage searched for the apps featured in the obtained articles found previously using the Google Play Store for Android devices and App Store for iOS devices.

Research question

The present study seeks to answer two main questions:

1- Which available HIV self-management apps for patients and health-care professionals have been used in recent studies?
2- What are the features of these apps?

Criteria for the selection of studies

The selection of the studies was performed by three researchers independently. We included English-written original articles published from December 2010 to May 8, 2020. Studies were selected for both patients and health-care professionals associated with HIV.

The exclusion criteria were as follows:

– Different types of studies, such as reviews, abstracts, reports, and letters to the editor.
– No access to the full-text document.
– Duplicated results in databases.
– Use of other virtual devices without using an app, such as videogames or web pages.

Search strategy

The systematic search was carried out in May 2020 using PubMed (Medline), Scopus, Embase, Science direct, UpToDate, and Web of Science databases. The search was limited to English-written articles and published in the past 10 years. We searched the keywords of HIV, AIDS, self-management, self-care, mobile applications, smart-phone, mobile-phone, and medical informatics applications on the following search strategy:

A. (HIV) OR (AIDS) OR (HIV/AIDS) [Title/Abstract]
B. (Mobile applications) OR (Smart-phone) OR (Mobile-phone) OR (Medical informatics applications) OR (m-Health) [Title/Abstract]
C. (Self-management) OR (Self-care) OR (Self-monitoring) [Title/Abstract]
D. [A] AND [B]
E. [A] AND [C]
F. [A] AND [B] AND [C]

A search of the Google Play Store for Android apps and App Store for iOS devices was performed to find the apps identified in the included articles. The Android apps were downloaded to an HTC U Ultra mobile phone and the iOS apps were downloaded to an iPhone 6s.

Literature selection

We screened the titles and abstracts of retrieved papers to identify studies meeting the inclusion criteria. The appropriate full-text articles were included and their results were discussed to make the final selection. After reading the full text of all eligible papers, the researchers made the final decision for each study.

Variables for analysis of the selected articles

To analyze the identified articles included in the review, the following variables were used: first author, the title of article, publication date, country, and app's name.

We used an Excel® tool to analyze the downloaded apps and data extraction. The data were analyzed and categorized using the following variables: reference number of articles that used an app, the name of the app, objective of the app (self-monitoring, self-management, self-care, education, follow-up, diagnosis, and treatment), type of target population (patient, patient's family, healthcare providers), operating system (iOS or Android), download cost, and other available details.

Data analysis

A quantitative and qualitative synthesis of the identified studies was carried out according to the search

strategy and the identified characteristics; these were later analyzed according to frequencies (n) to facilitate the interpretation of data.

The resulting analysis for these apps consists of a description using frequencies (n) of the characteristics analyzed in the mobile devices.

As this is an integrative review, it was not necessary to request approval from the Ethics Committee to carry out this study. The authors declare that there are no conflicts of interest.

Results

Results of the process

Through the search strategy, 548 articles were identified in Medline (PubMed) (n = 82), Scopus (n = 103), Embase (n = 79), Science direct (n = 69), UpToDate (n = 89), and Web of Science (n = 126). After an initial review of retrieved articles, 112 duplicates were removed, and the title and abstract of the remaining 436 articles were reviewed. After reading the title and abstract, 321 articles were excluded because they did not provide access to the abstract or full text (n = 13) or because they did not feature HIV/AIDS patients (n = 308). After reading the full research texts, n = 92 articles were excluded as they were found to be reviews (n = 23) or opinion articles (n = 15), or did not involve the use of an app (n = 54). Finally, 23 articles met inclusion criteria and were included in the final review (Fig. 1).

Characteristics of the included articles

Of the 23 resources included in the review, most studies were conducted in the United States (n = 17). The reviewed period of publication was between 2015 and 2020, with most studies published during 2020 (n = 7)[34,40-45] and 2018 (n = 5)[36,46-49]. Furthermore, the reviewed articles were published in the following journals: International Journal of Medical Informatics (n = 4), JMIR mHealth and uHealth (n = 3), Journal of the International AIDS Society (n = 2), Journal of Biomedical Informatics (n = 2), AIDS and behavior (n = 2), Trials (n = 1), Journal of Pain and Symptom Management (n = 1), BMJ open (n = 1), mHealth (n = 1), AIDS patient care and STDs (n = 1), Electronic physician (n = 1), Clinical trials (n = 1), Digital culture and education (n = 1), Current HIV/AIDS Reports (n = 1), and Studies in health technology and informatics (n = 1) (Suppl. Table 1).

We have extracted data from the added studies and mentioned them in suppl. table 2. Added studies and extracted data were of objective (to discuss the objective of the app and its main propose of being made which shows whether it is related to our study or not and it can be studied better), target population (to understand whether this app can be useful for our findings and can be related to our topic and it also can show our main goal of study), operating system (to show how big is the population that this app can cover and how useful it can be), cost (to show how reachable and affordable that app can be), and other details (to mention the honorable findings which worth mentioning but were not suitable for our table).

Objectives and profiles of HIV/AIDS-related apps

Based on the findings of the present study, the objectives of 17 identified HIV apps were found to self-care, self-monitoring, and self-management (n = 7)[45-47,50-53], improve medication adherence (n = 5)[41,44,45,51,54], prevention, treatment, and care (n = 5)[33,38,43,55,56], Adherence to ART (n = 4)[40,44,49,54], Cognitive Behavioral Stress Management (n = 1)[34], and Support safer conception among HIV serodiscordant couples (n = 1)[57].

Of the 23 articles found through the search, (n = 6)[33,52,53,55,56,58] did not identify the name of the app that was used to carry out their study. Regarding the aim of study, the target populations of 17 identified HIV-apps were found to be mainly directed at PLHIV, except three studies that targeted healthcare workers[43], adolescent MSM and transgender people[42], and black MSM[38]. The operating system of most of HIV-apps was Android (n = 15)[33,38,40-43,45,49,50,52,53,55-58], the operating system of the seven studies' apps was both Android and iOS[36,44,46-48,51,54], and (n = 1)[34] was only available for iOS. Furthermore, most apps were available for free[33,34,36,40-48,51-58] (n = 20).

Discussion

We identified 23 research papers published from 2015 to 2020, reporting on mHealth self-management interventions to support individuals receiving HIV treatment and care. The findings of this systematic review show that there has been substantial progress in recent years in the development and evaluation of health interventions for PLHIV.

In this study, we showed that mHealth interventions can have a significant impact on outcomes including adherence to ART, medication adherence, prevention,

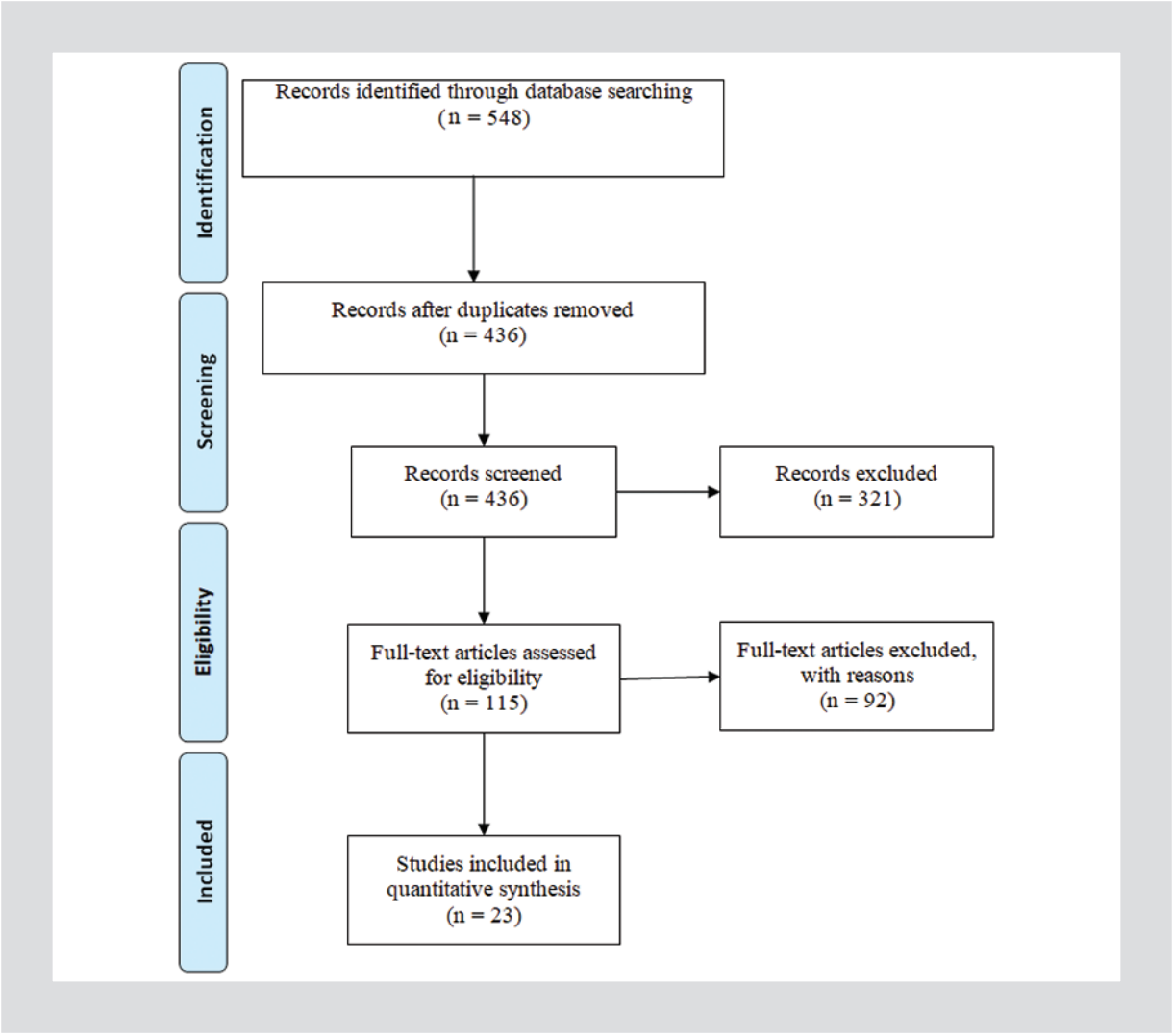

Figure 1. *Flowchart of the identification process.*

treatment and care[7,10,24,29,31], Adherence to Cognitive Behavioral Stress Management, and Support safer conception among HIV serodiscordant couples. It is worth noting that none of the identified studies have evaluated the cost-effectiveness of mHealth interventions, which may be necessary to convince health-care providers of the value of the widespread implementation of mHealth interventions as an appropriate adjunct to clinical care. Almost all apps are available only in English. At present, all apps available in the app stores have a limited number of them that are specifically tailored for PLHIV to manage their health. The mHealth apps are also rapidly changing. A systematic review showed that using mobile apps and SMS messages as mHealth interventions for self-guided care by PLHIV improved their physical health and significantly reduced their anxiety, stress, and depression[59]. In a qualitative study, PLHIV suggested some tools to meet their healthcare needs, including: reminders/alerts, lab results tracking, and notes on health status. That study highlighted that mHealth technology can be used as a social actor by providing chat boxes/forums, testimonials of lived experiences, and personal outreach. Examples of media that can function as a persuasive technology include games/virtual rewards, coding of health tasks, and imagination on how to connect with PLHIV[56]. In a 2015 review and comparison of apps for HIV/STD-positive persons, Schnall et al.[53] identified 15 apps for PLHIV IV. None of the apps identified in their review are currently available. Similarly, in our review, some of our originally identified apps were no longer available when we want to download the app a few weeks before submission of the manuscript.

The Food and Drug Administration (FDA) should establish regulations for mobile apps that are medical devices and whose functionality could pose a risk to a patient's safety if the mobile apps were to function as unintended[60]. Regulation of apps is important taking into account factors such as supervision, cost of development, dissemination, and the use of these apps. With the current guidelines, the apps that we identified in our review do not fall within the category of mobile medical apps. Young PLHIV have more opportunities to engage with knowledge, health management resources, and social media through mobile technology, which can help them adhere to care and medication recommendations. Since younger adult populations have been reported as having higher levels of stress, mobile-based self-management systems are an effective and socially relevant method for intervention delivery[61].

The security and confidentiality of patients' information are of particular importance in the use of these electronic health tools, especially for PLHIV. Few studies have discussed security and confidentiality in e-health tools. Although mobile health provides access to individual PHR to patients, security and privacy concerns are of particular importance in the field of healthcare organizations. The new technologies, such as Blockchain, are a solution for healthcare records to address the security and privacy concerns which are currently not present in existing e-Health systems[62]. Furthermore, due to the high production of data and information recorded in mobile health apps, data analysis of these big data can be useful in the management of the data. The importance of data analysis in healthcare organizations and the provision of health-care deliveries has been proven[63,64].

Based on the findings of the present study, self-care, self-monitoring, and self-management, improve medication adherence, prevention, treatment and care, Adherence to ART, Cognitive Behavioral Stress Management, and Support safer conception among HIV sero-discordant couples are the objectives of HIV-care applications. Since the introduction of ART, HIV has become a chronic condition requiring self-management, including adherence to ART and attendance at routine HIV treatment appointments. PLHIV, on the other hand, mostly do not stick to their care regimens; just 30% of them are ART adherent to the point of viral suppression[65]. In addition to the physical health benefits, special apps for PLWHIV may also have positive effects on their emotional well-being and quality of life. Therefore, it is suggested that more qualitative and quantitative studies be conducted in this regard in the future. Due to the sensitivity of ethical considerations in providing technology for PLHIV, conducting more studies investigating privacy of smartphones apps is important and challenges.

Limitations

There exist limitations in reviewing current programs. First, search functions in the mobile app stores are limited, and a search term returns hundreds or thousands of unrelated apps. This review was limited to the research literature; however, commercial programs may be available that are acceptable and useful to patients but are not included in this review. Negative findings are not included in this study, which may not render this review comprehensive due to the exclusions made. Furthermore, generic interventions in mHealth self-management were not included unless specifically evaluated in people with HIV. There may be programs that are useful for PLHIV but have not yet been evaluated in this group.

Conclusion

This study stipulates that mHealth is important and should be implored in self-management, self-monitoring, and self-care of PLHIV. Using this route of medical intervention serves as an alternative to address issues related to in-person hospital visits for PLHIV. With the rapid advancement in health technology, there is a need for the proper regulation of these applications that are classified as mHealth to monitor and prevent unintended functions of these applications. The cost-effectiveness of these mobile applications should be properly evaluated by both service providers and end-users. This will boost enough confidence of healthcare providers and their clients in using mHealth related interventions especially in addressing chronic diseases like HIV. Findings in this study show that mHealth interventions for PLHIV have positively affected adherence to ART, medication adherence, prevention, treatment and care, and social and behavioral issues affecting PLHIV significantly.

Ethics approval

The present study was extracted from the project with code 97-01-55-38289 and the ethics code: IR.TUMS.VCR.REC.1397.139 in the field of health information management entitled "Design, Implement and Assessment a Mobile and Web-based Intelligent Self-Management System for HIV Positive Persons" supported by the Tehran University of Medical Sciences.

Supplementary Data

Supplementary data are available at AIDS Reviews online (10.24875/AIDSRev.21000025). These data are provided by the corresponding author and published online for the benefit of the reader. The contents of supplementary data are the sole responsibility of the authors.

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