



Mobile Health Applications in the COVID-19 Pandemic: A Scoping Review of the Reviews

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Abstract

Background: Mobile health (m-Health) is a combination of electronic communications and medical information technology that has helped patients and health care workers during the COVID-19 outbreak. This study aimed to aggregate and highlight findings from existing review studies about applications of m-health to prevent COVID-19.

Methods: This scoping review was conducted based on the Arksey and O'Malley framework after searching the PubMed, Web of Science, and Scopus databases from March 2020 to February 2022. Keywords for the search included the English words "Mobile health"; "mobile apps"; "corona disease"; "COVID-19"; and "review." Screening of articles was done in 4 stages.

Results: Out of 37,569 papers found in the search, after the screening and review process, 22 articles were finally selected. From the analysis of the studies, 2 main categories emerged with the titles of "primary preventive applications" and "secondary preventive applications."

Conclusion: M-health is used in both primary and secondary prevention. The m-health tools can be effective in controlling the spread of COVID-19 and improving the treatment process of this disease by providing various pieces of training related to COVID-19 as well as installing various programs to monitor the condition of patients. Also, m-Health can provide services through the exchange of treatment data between health care providers or between patients and health care providers, as well as provide appropriate training for the remote care needs of patients with COVID-19.

Keywords: Mobile Health, Mobile Application, Prevention, COVID-19, Review

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Introduction

As the epidemic spread around the world, technologies have helped patients and health care workers (1). Electronic Health (e-Health) is a combination of electronic communications and medical information technology. This term includes a wide range of services or systems in the fields of medicine, health care, and information technology, such as electronic health records, electronic prescriptions, telemedicine or telephone medicine, m-health,

et cetera (2). Use of this software is significant to help manage and prevent chronic and infectious diseases in developed countries (3). During the COVID-19 pandemic, mobile health (m-Health) apps were widely used to raise public awareness on how to protect themselves and encourage adherence to various precautionary protocols (3).

One of the reasons for using web applications is its many advantages over its disadvantages; for example,

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↑What is "already known" in this topic:

Mobile health is a combination of electronic communications and medical information technology that came to the aid of patients and health care workers during the coronavirus disease 2019 (COVID-19) outbreak.

→What this article adds:

Mobile health is used in both primary and secondary prevention. The m-health tools can be effective in controlling the spread of COVID-19 and improving the treatment process of this disease by providing various trainings related to COVID-19 as well as installing various programs to monitor the condition of patients.

providing increased program development capabilities in a variety of ways (4). Facilitators of m-Health implementation include knowledge, attitudes, and perceptions of stakeholders about the use of m-Health to diagnose diseases in low- and middle-income countries (5). Considering the importance of the spread of COVID-19 as a contagious infectious disease and the importance of self-care in preventing this disease, providing self-care services can be an important achievement for people in the community. Given the important role of various m-health systems (applications, Bluetooth, etc.) in the prevention, control, and treatment of COVID-19 and the widespread use of these tools during quarantine, it seems necessary to conduct a study in this field. Virtual health includes clinical care and professional participation through telemedicine and telecommuting to link physicians, patients, and other health care professionals to provide clinical services, assist patient self-management, and coordination of care (6).

Several review studies have been conducted in relation to m-health (7-10). Each of these studies has contributed to our understanding of this issue, but the combination of knowledge in several studies is needed to advance knowledge and application of such tools. Therefore, the present study was conducted to aggregate and highlight the findings of existing review studies on this issue. This study aimed to aggregate and highlight findings existing in review studies about applications of m-health in the COVID-19 pandemic.

Methods

The present study is a scoping review of existing review studies. Scoping review is used to describe the available literature on a topic. The steps of scoping review based on the Arksey and O'Malley framework are as follows: (1) Identifying the question; (2) Identifying studies; (3) Selecting studies related to the review question from the search results; (4) charting the data; (5) gathering, summarizing, and reporting the findings; and (6) optional consultation with the relevant stakeholders (11).

According to the main research question: "What are the applications of m-health in the COVID-19 pandemic?" the search was conducted in the PubMed, Web of Science, and Scopus databases. The inclusion criteria included all studies that have been published in full text, in English, and in the period from March 2020 to February 2022. Exclusion criteria included articles in the form of letters to the editor, short reports, posters or lectures, instrumentation articles, book summaries, and duplication of articles. Keywords for the search included the English words "Mobile health"; "mobile apps"; "corona disease"; "COVID-19"; and "review", which were used individually and in combination using the Boolean operators AND and OR. The history and details of the search in the PubMed database are shown in Table 1.

Screening of articles was done in 4 stages (initial search, review of duplicate articles, review of access to the full text of articles, and study of extracted articles). The

Table 1. History of Search Details in the PubMed database

Search	Query	Results
#1	Search: (((Mobile health[Title/Abstract]) AND (corona disease[Title/Abstract])) OR (COVID-19[Title/Abstract])) AND (review[Title/Abstract]) Filters: Free full text, Associated data, Review, Systematic Review, from 2020/3/1 - 2022/2/1	3,491

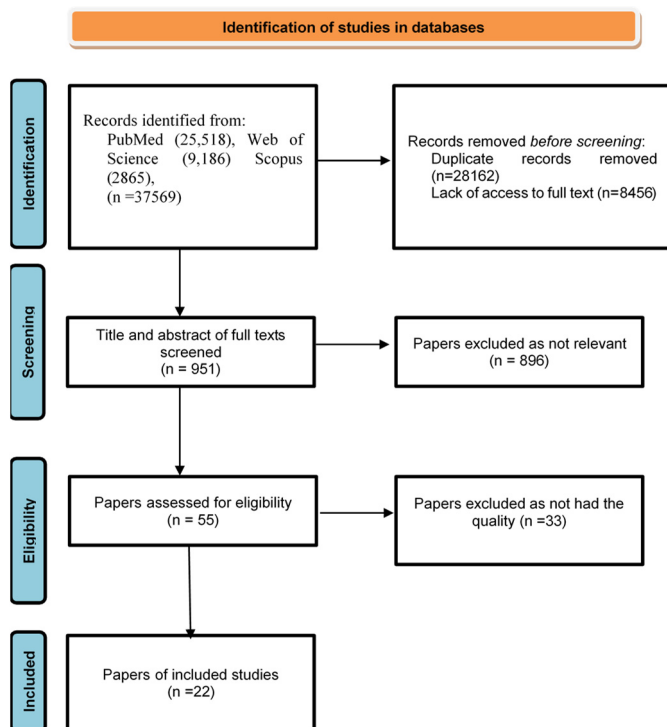


Figure 1. PRISMA Flow chart showing the process of review

review process is shown in Figure 1.

Data were extracted and recorded using a table that in-

cluded the names of the authors, the time of the study, the objective, the type of study, and key points of the findings

Table 2. Characteristics of included studies

Author(s)	Year	Study Objective	Type of Study	Key Points of M-health Applications
Ye (4)	2020	Review the Role of Health Technology and Informatics in a Global Public Health Emergency in COVID-19 Pandemic	Review	<ul style="list-style-type: none"> • Strong support in pandemic prevention • Pandemic control.
Kondylakis et al (23)	2020	To shed light into studies found in the scientific literature that have used and evaluated mobile apps for the prevention, management, treatment, or follow-up of COVID-19.	Systematic review	<ul style="list-style-type: none"> • Training • Information sharing • Risk assessment • Self-management of symptoms • Contact tracing • Home monitoring • Decision making • Rapidly offering effective • Managing the COVID-19 pandemic • Reducing the burden on hospitals • Providing access to credible information • Tracking the symptoms and mental health of individuals • Discovering new predictors
Singh et al (27)	2020	To scope the evidence base on apps that were developed in response to COVID-19.	Review	<ul style="list-style-type: none"> • Contact tracing • Symptom monitoring.
Aslani et al (22)	2020	To identify mHealth applications in epidemic/pandemic outbreaks and provide some suggestions for tackling COVID-19.	Review	<ul style="list-style-type: none"> • Public health aspects • Data management • Educational programs • Diagnosis and treatment • An appropriate method for encountering epidemic/pandemic outbreaks due to its extensive applications. • To use in the patient-physician relationship as tele-visits • Using in fever coach • Providing real-time information for healthcare providers • Population monitoring • Detecting the disease based on obtained data from different locations
Davalbhakta et al (18)	2020	Provide an overview of mobile applications being currently utilized for COVID-19 related activities their Quality Using the Mobile Application Rating Scale (MARS)	Review	<ul style="list-style-type: none"> • Contact tracing • Control the spread of misinformation associated with the COVID-pandemic • Raise awareness • Allow contact tracing • Help improve provision of the preventive and clinical care of patients
Williams et al (20)	2020	Review of M-health Technology in Combating COVID-19 Pandemic	Review	<ul style="list-style-type: none"> • A vital tool in creation of awareness and dissemination of information • As a means of curtailing the spread of the COVID-19 from person to person • Tracking of infected persons • Reduction of person-to-person contact • Virtual screening • Remote monitoring of patients.
Cho et al (25)	2020	Contact Tracing Mobile Apps for COVID-19: Privacy Considerations and Related Trade-offs	Review	<ul style="list-style-type: none"> • An essential tool for public health officials and local communities to fight the spread of novel diseases, such as for the COVID-19 pandemic • To assist health officials in tracking down exposures after an infected individual is identified

Table 2. Continued

Author(s)	Year	Study Objective	Type of Study	Key Points of M-health Applications
Huang et al (31)	2020	Review of how digital contact tracing slowed Covid-19 in East Asia.	Review	<ul style="list-style-type: none"> • Contact-tracing
Chung et al (32)	2020	To ensure appropriate and timely treatment of structural heart disease patients; to minimize the risk of COVID-19 exposure to patients and health care workers; and to limit resource utilization under conditions of constraint.	Review	<ul style="list-style-type: none"> • Reducing the risk of COVID-19 exposure to patients and healthcare workers • To ensure appropriate, sensitive and timely treatment of patients with coronary heart disease
Kodali et al (33)	2020	To explore the experiences and expectations of Arogya Setu app users by conducting a combined content analysis of their reviews.	Review	<ul style="list-style-type: none"> • Contribute to the containment • Management of COVID-19
Osei and Mas-hamba-Thompson (29)	2021	To review recent literature that highlights the use of mHealth applications, facilitators, and barriers and challenges of implementing mHealth for disease screening and treatment support in LMICs.	Narrative Review	<ul style="list-style-type: none"> • mHealth for screening infectious diseases • Screening non-infectious diseases • Disease surveillance • Medication and treatment compliance • Appointment reminders • Communication between healthcare providers and Patients • Maternal and child health • Knowledge, attitudes, and perceptions of stakeholders • Disease diagnosis
Asadzadeh et al (21)	2021	To study the application of m-health solutions for the management of the COVID-19 outbreak	Review	<ul style="list-style-type: none"> • Early detection • Fast screening • Patient monitoring • Information sharing • Education • Prevention • Diagnosis • Treatment • Protection
Eslami Has-sanAbady et al (30)	2021	To examine and summarize evidence related to medical informatics applications in COVID-19 crisis, as evidence-based approaches	Review	<ul style="list-style-type: none"> • Care and treatment through exchanging treatment data among health care providers or between patients and healthcare providers not complying with data protection regulations • Providing documents appropriate for tele-intensive care needs of remote COVID-19 patients
Almalki et al (15)	2021	To identify, analyze, and categorize health apps related to COVID-19 that are currently available for consumers in app stores	Descriptive Review	<ul style="list-style-type: none"> • Essential role in public health crisis management • A participatory approach to curtail the spread of COVID-19

about m-health applications. To extract the data, 2 experienced researchers simultaneously reviewed and analyzed the articles. Finally, after removing duplicate items that were not related to the research objectives, 22 articles were selected (Table 2). To analyze the data, the textual data of the findings and conclusion section of each study were carefully read and coded, then this information was compared with each other in terms of similarities and differences, and finally the main categories emerged.

Results

Out of 37,569 papers found in the search, after the screening and reviewing process, 22 articles were finally selected. After analyzing the data, finally, 2 main categories—primary preventive applications and secondary preventive applications—emerged (Figure 2). These categories are addressed below:

Primary preventive applications and secondary preventive applications—emerged (Figure 2). These categories are addressed below:

Primary Preventive Applications

M-health technology is widely used as a tool to reduce COVID-19 transmission from person to person and reduce person-to-person contact and virtual screening (12).

E-Health solutions have the potential to provide useful services to help in the COVID-19 pandemic in terms of prevention and education (8). M-health has been used for various aims, such as information sharing and education about the COVID-19 outbreak (13).

The main applications of m-Health for epidem-

Table 2. Continued

Author(s)	Year	Study Objective	Type of Study	Key Points of M-health Applications
Eslami et al (16)	2021	To identify and classify subdomains of eHealth solutions that have been utilized, developed, or suggested for the COVID-19 pandemic.	Scoping review	<ul style="list-style-type: none"> • Prevention • Diagnosis • Treatment • Screening • Surveillance • Resource allocation • Education • Management • Control
Alanzi (24)	2021	To review the functionalities and effectiveness of the free M-health applications available in the Google Play and App stores used in Saudi Arabia, Italy, Singapore, the United Kingdom, USA, and India during the COVID-19 outbreak.	Review	<ul style="list-style-type: none"> • Contact tracing • Awareness building • Appointment booking • Online consultation
Niakan Kalhori et al (17)	2021	To review and analyze the digital technology that is being applied to control the COVID-19 pandemic in the 10 countries with the highest prevalence of the disease	Review	<ul style="list-style-type: none"> • Management of pandemics and health-related crises
Zamri and Syed Mohideen (26)	2021	To provide an overview of the practicality of mHealth apps in healthcare administration	Review	<ul style="list-style-type: none"> • Information apps • Diagnostic apps • Control apps • Adapter apps
Wirth et al (51)	2020	To inform the current discussions and to support the development of solutions providing an optimal balance between privacy protection and pandemic control.	Review	<ul style="list-style-type: none"> • Individual surveillance • Public health (most common: digital contact tracing)
Islam et al (52)	2020	To explore the existing mobile applications developed for the COVID-19 pandemic.	Review	<ul style="list-style-type: none"> • Remote assistance • Monitor Current status of patients • Prevent COVID-19 • Control COVID-19 • Communication support • Treatment services • Raise awareness • Improve mental health
Yan Ng et al (53)	2021	To identify original research articles focused on blockchain applications in health care	Systematic review	<ul style="list-style-type: none"> • Pandemic control and surveillance • Health and vaccine passport or certificate • Contact tracing • Electronic medical records • Artificial intelligence, big data, or federated learning • Supply chain • Clinical trials
Shahbazi et al (54)	2021	To provide adequate knowledge of the obstacles, challenges and opportunities for the development of these systems for developers and health care providers.	Review	<ul style="list-style-type: none"> • Improving physical activity • Reducing care costs

ic/pandemic outbreaks include public health aspects and educational programs (14). Mobile apps have been implemented for training and information sharing about the COVID-19 pandemic (15). Many applications have been developed for various functions such as awareness-raising and online counseling (16).

Another application of m-health programs is to inform citizens if people are infected with the virus and to encourage them to inform health authorities and ask for their

support (17). Information apps give general health information to the public, such as WebMD, Health Central, and Wrong Diagnosis.com (18). Smartphone applications have great potential to control the spread of misinformation related to the COVID-19 pandemic, increase awareness, and ultimately help improve prevention. There are many programs to share up-to-date COVID-19 information. These provide unmet health care needs, including the dissemination of health information, symptom screening, and

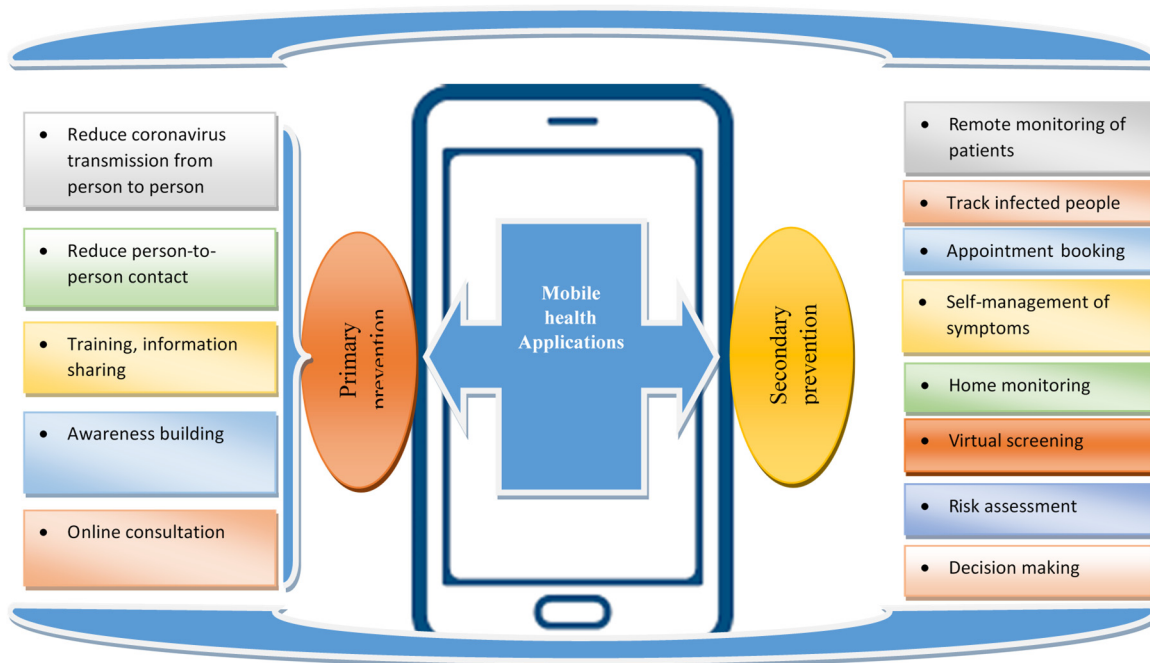


Figure 2. Schematic model of M-health applications

the provision of tools for educating health care providers (10). M-Health is an appropriate method to deal with COVID-19 outbreaks because of its wide range of applications (14). The epidemic has also rapidly increased the uptake of remote health systems in many countries. When combined with wearable devices, it is possible to screen for COVID-19 symptoms at home and remotely monitor other integrated features such as mobile physicians or remote health systems (19). For example, 1-Check COVID-19 has an accurate and detailed description on the app store, which clearly shows the objectives, that is, providing real-time situational awareness of COVID-19 and public health risk assessment survey. The app clearly requested details about the users' symptoms, travel, medical conditions, and exposure with clarity, and provided credible health information links (eg, Centre of Disease Control) to help the user learn more about COVID-19 features. It may advise its users to quarantine for some time, based on guidelines. This information is easy to comprehend and written in simple and easy language. In addition, several sections covered a wide range of topics, and many of these sections contained additional links to other reliable websites. The Information was presented under a clear heading that is categorized into sections (eg, General Advice, Testing, and Physical Distancing) (10). Digital learning packages were used to inform people about illness, geographic information, and self-care programs. These projects were deployed in various European countries and the United States, Australia, and China (9). Governments or national authorities can consider the use of these programs as a tool in public health crisis management. By involving people in personal health tracking and self-assessment, we can hope for the role of these programs in preventing the spread of COVID-19 with a collaborative approach (7).

Secondary Preventive Applications

The advent of m-Health interventions has a significant transformative effect on health care delivery, particularly in treatment support, diagnostic purposes, health monitoring, data accuracy, and many others (20).

The use of emerging health technologies and digital practices in health care, such as artificial intelligence, telemedicine, m-health, big data, and 5G, has become a powerful "weapon" to fight epidemics (21). E-Health provides useful services to help in the COVID-19 pandemics in terms of diagnosis, treatment, screening, surveillance, resource allocation, management, and control (22). Mobile apps are considered to be a valuable tool for citizens, health professionals, and decision-makers in facing critical challenges imposed by the pandemic, such as reducing the burden on hospitals, providing access to credible information, tracking the symptoms and mental health of individuals, and discovering new predictors (15). Also, m-health has been used for various aims, such as fast screening, early detection (13), contact tracing of infected people, appointment booking (16), remote monitoring of patients (12), clinical patient care (10), patient monitoring, and treatment in response to the COVID-19 outbreak (13).

Also, mobile apps have been implemented for risk assessment, self-management of symptoms, contact tracing, home monitoring, and decision-making, rapidly offering effective and usable tools for managing the COVID-19 pandemic (15). The main applications of m-Health for epidemic/pandemic outbreaks include data management, diagnosis, and treatment. During the pandemic outbreak of COVID-19, m-Health was one of the best choices to use in the patient-physician relationship, like televisits, using fever coach, providing real time information for health care providers, population monitoring, and detecting the disease based on obtained data from different locations

(14).

Another application of m-health programs includes a voluntary citizen-tracking program based on Bluetooth proximity technology, which was approved by European member states on May 13, 2020, with the support of the European Commission and the impossibility of tracking people's whereabouts. Citizens voluntarily install the program, national authorities disable programs at the end of the epidemic, and users are free to remove them whenever they wish (17).

There were several types of contact tracing programs. China was the first country to develop a special contact tracing program using sophisticated tracking and monitoring methods (23). The benefits of implementing m-health tools include reducing the risk of COVID-19 exposure to patients and health care workers to ensure appropriate, sensitive, and timely treatment of patients with coronary heart disease (24). The m-health program in India (Aarogya Setu), designed to track contact with an infected person and provide health tips to get rid of COVID-19, can help with contact tracing and disease management during the COVID-19 epidemic (25).

In general, e-Health can deliver services by facilitating the transmission of medical records between health care professionals or between patients and health care professionals, as well as by offering the proper training to meet the needs of patients with COVID-19 who require remote care (22).

Discussion

M-Health refers to the use of technologies enabled by mobile devices for public health purposes (26). The use of m-Health applications can influence communication and relationships between patients and providers positively, facilitating relationship-centered health care (27). The results of the mobile apps' assessment could potentially help mobile app developers improve or modify their existing mobile app designs to achieve optimal outcomes (28). This study aimed to aggregate and highlight findings from existing review studies about applications of m-health to prevent COVID-19. Data analysis results showed that m-health could be used in the primary and secondary prevention of COVID-19. Prevention includes a wide range of activities aimed at reducing risks or threats to health. The goal of primary prevention is to prevent disease or injury before it occurs. This is done by preventing exposure to hazards that cause disease or injury, changing unhealthy or unsafe behaviors that can lead to disease or injury, and increasing resistance to disease or injury if exposed (29). Accordingly, m-health applications such as reducing COVID-19 transmission from person to person, reducing person-to-person contact, training, information sharing, awareness building, and online consultation fall into the category of primary prevention.

Given the worldwide prevalence of COVID-19, and as there is still no effective treatment or vaccine, the strict implementation of traditional public health measures, such as isolation and quarantine, remains the most effective tool for controlling the outbreak (30). Using m-health is an effective communication channel for disseminating

new information about COVID-19 and saves time (31). Public health measures, such as isolation and quarantine, are the cornerstones of preventing the spread of infectious diseases. It is especially important when a specific drug or vaccine is not available (32). The use of m-health apps is a main route to instigate the process of health empowerment and shape health attitudes. However, an accurate evaluation of the effectiveness of m-health apps requires distinguishing between lifestyle and health management behaviors and adopting a cost-benefit approach (33).

The second theme in the present study was "secondary preventive applications." Secondary prevention aims to identify a disease within a patient before the onset of symptoms and reduce the impact on the life of the patient (34). This is done by detecting and treating disease or injury as soon as possible to halt or slow its progress, encouraging personal strategies to prevent reinjury or recurrence, and implementing programs to return people to their original health and function to prevent long-term problems (29). By this definition, m-health applications, such as remote monitoring of patients, tracking infected people, appointment booking, self-management of symptoms, home monitoring, virtual screening, risk assessment, and decision making, fall into the category of secondary prevention.

Applications of m-health include telemedicine as well as support for health information systems to monitor and manage the spread of the disease (35). Advances in biosensor technologies have made it possible to monitor continuously physiological parameters using wearable biosensors with various factors, which can continuously measure skin temperature, respiration rate, blood pressure, pulse rate, blood oxygen saturation, and daily activities. These physiological parameters are transmitted in real time to a smartphone application called Biovital Sentinel. This data is then processed using an analysis engine to detect subtle physiological changes. The results are displayed on the web for physician review (30).

According to the international community, m-health can respond quickly and provide up-to-date clinical guidelines to health professionals (36). Using mobile devices through proprietary operating systems as a means of communication may increase access to reliable information for physicians (31). M-health is a comprehensive strategy that uses mobile applications, sensors, social networks, and location tracking technologies to obtain medical data and provide health services and plays a key role in combating the COVID-19 pandemic (37).

In times of COVID-19 and physical distancing measures, this may evolve into a digital blended-care approach by combining telemedicine with internet-based e-Health or smartphone-based m-Health interventions (38).

These measures can increase the patient's compliance with the monitoring system and also greatly shorten the distance between abnormality detection and the next intervention. In recent decades, wearable technology has been increasingly used for medical diagnosis, especially in the diagnosis of arrhythmias (30). In fact, by continuously collecting and analyzing multidimensional physiological parameters, a deeper understanding of the various disease

processes can be achieved, which potentially allows us to improve clinical management. However, such potential in disease management in the real world has not been fully explored (39). M-health is important in the management of the COVID-19 epidemic. It also allows older people who have difficulty using e-health to receive adequate care, as they are at greater risk than younger people (40). With the most advanced telecommunication technologies that enable fast and multidirectional data transfer, it is now possible to monitor remotely the physiological parameters of a large number of people in real time. The data can then be transmitted to physicians for timely intervention (36). Integration of new technologies and practices includes artificial intelligence (AI), 5G mobile networks, m-health applications, telemedicine services, and health information exchange services (41). Logging into health care systems can be helpful for a number of things, including reporting and monitoring information on human transmission, gathering and analyzing data, tracking and issuing alarms, and more. All of these functions are useful for strong support in pandemic prevention and control (21). At the same time, the use of contemporary mobile communication technology facilitates the automatic collection and transfer of physiological data. These measures can increase patient compliance with the monitoring system as well as greatly shorten the time between the detection of an abnormality and subsequent intervention (39). Effective prevention, monitoring, and interventions are important to reduce the prevalence of COVID-19. Using a variety of biosensors and diagnostic applications, the symptoms of the disease can be detected earlier and thus help to prevent the spread of the disease (33). It can also help nurses to recall risk warning signs and alarms in various programs (42).

However, smartphone communication technologies are constantly improving the availability and ability to provide e-health services, even for countries with limited resources (43). Scientists, researchers, and health care professionals around the world are working to find a solution to COVID-19. However, without enough funding, not much can be done. Governments should provide additional funding for ministries of health, science, and technology to conduct research specifically to combat COVID-19. The government should also provide financial assistance to individuals and encourage the implementation of innovative ideas and financial support to maximize the potential of mobile technology in the fight against COVID-19 (12).

Considering the wide capabilities of m-health solutions, investigation and use of all potential applications of m-health should be considered to combat current epidemics and reduce their negative effects (31). Given the available information technologies worldwide in the 21st century, especially in developed countries, it seems that more digital health products with a higher level of intelligence will be used to manage epidemics and health-related crises (9). M-health provides the community with access to information and will be notified if there are patients nearby. These programs will be able to provide more access and benefits for users to help the community prevent the fur-

ther spread of the epidemic (44). M-health contributes to remote evaluation (triage) and continuity of medical care (45). It is also suggested that by expanding the internet networks and upgrading the technological infrastructure, people should be able to access such facilities more easily. In addition, there is a need to formulate rules and provide guidelines to address ethical and legal barriers to accessing patient information. Although responses to contact tracing programs have been welcomed by most countries, it is still too early to determine whether they are effective in limiting the spread of COVID-19 (46).

Limitation

The main drawback of this study was the lack of availability of papers in various languages and unpublished studies. Thus, over 8500 articles were excluded from the process.

Conclusion

M-Health is used in both primary and secondary prevention. According to the results of this study, m-health tools that include applications and remote systems can control the spread of COVID-19 by providing various training related to COVID-19 and installing various programs to monitor the condition of patients. E-Health can provide services through the exchange of treatment data between health care providers or between patients and health care providers, as well as by providing appropriate training for the remote care needs of patients with COVID-19. It is hoped that the challenges in this area will be addressed by expanding knowledge in this area and proper planning.

Ethical Considerations

This study is based on a review of the studies and does not involve human participants. Hence, an ethical consideration did not apply to the present study. However, the researchers abided to research ethics like avoidance of plagiarism, fabrication, and data manipulation. The results of the analysis were quite honest. The result is presented as it appeared during the original analysis without manipulations and the researchers avoided data fabrication.

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Conflict of Interests

The authors declare that they have no competing interests.

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