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COMMENTARY

Perspectives on the Future Development of Mobile Applications for Dermatology Clinical Research

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ABSTRACT

The COVID-19 pandemic significantly impacted clinical research in dermatology and practices around the country transitioned to teledermatology amid physical distancing requirements. Despite their growing use in teledermatology and clinical care, dermatology applications have not been studied extensively in the research space. The use of mobile applications has the potential to improve the experience of study subjects and physicians and increase the pool of individuals willing to participate in research beyond the pandemic. We discuss the various pros and cons of mobile apps, as well as the necessary components they require to successfully conduct research.

Keywords: AI; Applications; Apps; Artificial intelligence; Clinical research; Mobile; Phone; Remote research; Teledermatology; Telemedicine

Key Summary Points

Remote research provides several benefits for study participants and researchers, such as reducing travel and time burdens.

Mobile applications for dermatology research require numerous features for optimal use, some of which include educating patients about studies, screening patients, obtaining informed consent, acquiring data, and facilitating high-quality photograph acquisition.

The emergence of machine learning and artificial intelligence may improve the objectivity of photograph evaluation.

Challenges of using applications in research include the cost of purchasing mobile devices, lack of access to high-quality internet, and difficulty navigating technologies.

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LESSONS LEARNED FROM THE IMPACT OF COVID-19 ON DERMATOLOGY CLINICAL RESEARCH

Clinical research suffered a dramatic decline in participation during the COVID-19 pandemic [1]. Desai et al. reported that 57 dermatology-related clinical trials during March, April, and May of 2020 were suspended, withdrawn, or terminated, affecting an estimated 7141 patients [2]. In addition to the many research patients affected during the pandemic, progress across many studies was impeded, potentially leading to delays in drug development. Amid physical distancing requirements, the lack of readily available technologies to conduct studies remotely contributed to significant interruptions.

THE EXPANSION OF TELEDERMATOLOGY AND MOBILE APPLICATIONS IN DERMATOLOGY

In the clinical care space, many dermatologists transitioned to teledermatology to maintain operations due to physical distancing requirements [3]. Teledermatology can occur synchronously, through the use of live video platforms, termed live-interactive teledermatology; or it can occur asynchronously, through the use of phone or web-based applications (apps), known as store-and-forward teledermatology [4]. Despite a recent resurgence during the COVID-19 pandemic, the use of teledermatology spans decades; its use showed promise in extending care to patients in rural communities and addressing the overall workforce shortage in dermatology [5]. Access to teledermatology for patients has been accelerated by the surge of mobile phone applications. Smartphone ownership has increased from 35% in 2011 to 81% in 2019 [6], and the overall convenience of smartphones makes them one of the most amenable devices to facilitate teledermatology. Recent reviews have evaluated the use of mobile-based applications for clinical use [7, 8],

and studies have also assessed the wide variety of applications available on app stores for consumers [9]. However, despite the rise in smartphone ownership and clinical applications, there is a paucity of mobile applications addressing clinical research in dermatology.

THE BENEFITS OF CONDUCTING REMOTE CLINICAL RESEARCH THROUGH TECHNOLOGY

Remote research provides several potential benefits for study participants and researchers. It ensures that trials will be protected from interruption due to future pandemics. Importantly, it may increase accessibility to patients who face barriers to participating in research trials. In 2018, a study conducted by Borno et al., which reviewed the travel requirements for 1600 research patients, found that the median unidirectional distance traveled to a study site was 25.8 miles, increasing to as much as 39.4 miles for certain trials [10]. Of note, patients living in low-income areas were cited as one of the groups having the highest travel burden [10]. Compounding this issue, patients of low socioeconomic status may often have busy work schedules and find it difficult to take time off to come to clinics for required monthly, and sometimes weekly, research visits. Lack of private transportation, childcare, and inflexible work schedules have resulted in higher no-show rates for minority and Medicaid patients [11, 12]. These barriers are further evident in clinical research, where a low number of nonwhite patients have been cited in psoriasis trials [13]. With fewer travel requirements, more patients may have the flexibility to enroll in a larger number of studies, improving the generalizability of clinical research.

IMPORTANT COMPONENTS OF DERMATOLOGY RESEARCH APPS FOR REMOTE STUDIES

Mobile applications for dermatology research are likely to be impactful for the conduct of

clinical trials; however, these applications can potentially be used for other studies, including cross-sectional and cohort studies. Mobile apps for clinical research require several features for optimal use. These apps should be able to educate the patient about the study, screen patients for eligibility, and obtain informed consent. Additionally, the app should be able to gather a variety of information, including surveys, personal health data, and demographics. Further, they should allow for accessible communication with the study team for risk assessments.

The application should facilitate high-quality photograph acquisition for disease severity assessments. Patients should receive guidance and assistance from the application to take photographs with proper positioning and lighting. Finally, these photographs should be uploaded and organized on a web-based platform where the study team can evaluate them.

The emergence of machine learning and artificial intelligence (AI) to evaluate clinical images, such as those taken from a smartphone, may improve the objectivity of these photographs in the future [14]. Algorithms are being developed to objectively rate clinical characteristics, such as skin erythema, which is a significant component of scoring in psoriasis and atopic dermatitis severity. As machine learning becomes further integrated into evaluating images, this technology can be incorporated into monitoring patient disease status objectively [15].

THE CHALLENGES OF USING MOBILE APPS FOR REMOTE CLINICAL RESEARCH

While reduced travel and overall convenience serve as potential benefits to remote research, other factors may present barriers to research access. The substantial cost of purchasing a mobile device that has a high-quality camera can be prohibitive. Lack of access to high-quality internet may present a challenge for some individuals. Reports show that only 56% of U.S. adults who earn less than \$30,000 have access to home broadband internet [16]. Reduced personal interactions with providers may lead

to decreased study motivation. Difficulties navigating technologies and potential delays in communication may also frustrate patients. In a previous evaluation of clinical care apps, participants from a racially and ethnically diverse population completed only 43% of tasks across 11 apps, citing lack of confidence with technology and difficulty understanding design features as issues [17]. Therefore, research apps should be inclusive of cultural, digital literacy, and language needs in their development.

To obtain high-quality photographs, patients will have to be instructed on how to properly acquire photographs in standardized positions for severity scoring. These photographs will have to be taken under good lighting and, sometimes, in a handsfree manner. Other logistical challenges include activities conducted outside the home. These involve obtaining bloodwork and arranging for receipt of medications; however, these activities can be achieved during more flexible hours. Appropriate data infrastructure and management are also necessary for patient privacy. Finally, automated algorithms to evaluate images for clinical characteristics may be prone to error if not evaluated in different racial and ethnic groups representing a spectrum of skin tones. Therefore, it is important that these algorithms are trained to characterize various skins of color.

The advantages and limitations of using mobile apps for clinical research with regard to accessibility, recruitment, screening, skin evaluation, adverse events, compliance, and data are summarized in Table 1.

DEVELOPMENT OF DERMATOLOGY RESEARCH MOBILE APPS BEYOND THE PANDEMIC

We anticipate the development and use of phone applications in research to expand beyond the pandemic. Remotely driven research modalities are being actively developed within the medical industry to augment and enhance traditional research methods. Two corporations, Medable Inc. (Palo Alto, CA, USA) and Science 37 (Los Angeles, CA, USA), have received substantial investments during the

Table 1 Advantages and limitations of mobile applications in dermatology research

Research study components	Advantages	Limitations
Accessibility	Reduced travel and time barriers Patients can participate in more studies	High-quality internet access required Phone with camera of sufficient quality required
Recruitment	Possibility of displaying studies tailored to patient characteristics	Certain populations of individuals may not feel comfortable with mobile app-based information
Screening	Efficient screening process without need for in-person appointment	Evaluation of skin must occur through photographs or video
Skin evaluation	Integration of AI and standardized image capture; possibility of more objective image evaluation in patients with skin of color	Variable photograph quality Taking proper standardized photographs of self may be challenging
Adverse events	Patients can report adverse events with ease Study team can triage adverse events	Potential for missed adverse events that could be elicited on in-person interview
Compliance	Efficiently track patient progress on study assessments (i.e., questionnaires)	Reduced face-to-face contact with study team may reduce compliance
Data	Reduced paperwork and data input burden on research staff Extract and analyze data promptly	Cost of data storage Maintenance of data security/encryption

AI Artificial intelligence

COVID-19 pandemic to design and roll out phone and web applications intended for conducting clinical research, with the goal of using these applications in the future [18, 19].

The use of mobile applications in the clinical research space presents great promise to improve the experience for study subjects and physicians and to increase the diversity of individuals willing to participate. However, potential limitations also exist, and research applications should be designed with these limitations in mind. Further studies are needed to evaluate the various strengths and shortfalls of these applications once they are developed.

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Compliance with Ethical Guidelines. This article is based on previously conducted studies and does not contain any new studies with human participants or animals performed by any of the authors.

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