



User Acceptance Factors for mHealth

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Abstract. There used to exist a vision of telemedicine in which healthcare became universally connected. mHealth is a manifestation of that vision. However, studies that demonstrate theoretical user acceptance factors of mHealth are limited. We are still just neophytes in this area of research with the full potential of mHealth being an unknown. Through the use of literature review and qualitative we examined the effectiveness of mHealth use in a clinical setting, the factors inhibiting the proliferation of mHealth technologies, and the future expectations of mHealth. In this qualitative study twenty random patients between the ages of 25–94 were surveyed on their usage and expectations of mHealth related apps. Of the twenty patients that were sampled, only five had reported of past experience with mHealth related applications. Of those five with past experience in use of mHealth apps, only two reported to have continued with mHealth use on a daily basis. Reasons cited for discontinuation of use included difficult to understand interface, failure to provide precise diagnosis, and time required for data entry. Concerns that patients had for mHealth included security risks, ease of use, and accuracy of disease prediction. Key features that patients expect for the future of mHealth included medical record consolidation, easier appointment scheduling and prescription refills, integration with wearable health monitoring devices, and facilitation of direct patient-to-patient and physician-to-patient communications. Future studies of mHealth will require a greater sample size to verify the validity of these concerns and find solutions to meet the future expectations of mHealth.

Keywords: mHealth · Acceptance · Application

1 Introduction

The term eHealth has been used interchangeably by individuals of various academic intuitions, health facilities, professional bodies, and funding organizations [1]. Even as the term became recognized internationally, a unanimous agreed upon definition has yet to be determined [1]. In a systematic review of eHealth bibliographic databases, it was determined that the term carried 2 universal themes of health and technology. In particular, it has become widely accepted that eHealth is the utilization of “ICTs (information and communication technologies), including Internet technologies to manage health, arrange, deliver and account for care, and manage the health care system” [2]. In another

systematic review of eHealth impact on the quality and safe of health care, it was noted that there is a large gap between the hypothesized benefits of eHealth and the empirically demonstrated benefits [3]. Despite its promotion by many policymakers and tech enthusiasts, eHealth required further studying to fully comprehend its implementation risks as well as cost-effectiveness.

mHealth system is a category of eHealth that typically involves the implementation of a mobile device [4]. This specific category of eHealth has been maturing and evolving at a rapid rate for the past decade with the advances in mobile cellular technology and artificial intelligence. The full potential of mHealth has yet to be understood, but some practical applications of mHealth today include its implantation in the field of fitness and lifestyle application and its use as a tool to promote health monitoring in less developed regions of the globe, predominantly in Africa and South America [4]. Its adoption by health care professionals is becoming widespread on multiple levels of clinical practice such as information and time management, health record maintenance access, communications and consulting, and patient management and monitoring [5]. In a previous Research/Physician Channel Adoption Study, it was found that doctors' ownership and use of mobile devices is pervasive, with 87% using a smartphone or tablet device in their workplace, compared to the 99% using a computer [6]. The use of mobile applications in healthcare also extends to patients. It was estimated that 500 million patients will have utilized mobile applications in management of their health [7]. According to a survey done in 2012, the global penetration of cellular services and data use had reached 87% with no sign of decrease [8]. In the momentum of this mHealth burgeoning, it becomes ever more important to address our deficiencies in the lack of understanding of this area of research.

In 2015, number of mHealth related apps was estimated to be over 100,000 in the iOS App Store alone with 98.19% of those available to people living within the United States [9]. However, in a national cross-sectional survey conducted in 2015, it was found that only 58.23% of those sampled downloaded a health-related mobile app [10]. Even worse, 45.7% of those individuals eventually stopped using the application after one year. Interestingly, most of those surveyed felt that the apps had improved their health [10]. Previous research found several reasons why users discontinued their mhealth applications [11]. However, studies that demonstrate theoretical user acceptance factors of mHealth applications are limited. This is the first study with experimental design to evaluate the users' perspectives on mHealth applications.

2 Literature Review

Despite its recognition as a significant issue, the obesity epidemic continues to plague the United States. It was estimated that approximately 34% of the adult US population are obese [12]. Poor diet management was cited as one of the leading causes of obesity. Consequences of obesity include hypertension, hyperlipidemia, and type 2 diabetes [13]. The lack of available continuous health monitoring programs with physicians can be a contributing factor to this issue. A 2013 study focused on the use of mobile applications

in diet and fluid intake self-monitoring of adults receiving hemodialysis [14]. In a six-week intervention program, 24 participants monitored their own diet and fluid intake through the use of the Dietary Intake Monitoring Application (DIMA). Results of the study suggested that intervention via the integration mHealth application is feasible. Similarly, mobile applications were studied as tools for personal lifestyle check-up and improvement suggestions [15]. A 23-question survey was presented based on items in the Korean National Health and Nutrition Examination Survey (KNHANES). Data from 25,124 participants were analyzed and it was concluded that the difference between participants' usual lifestyles and lifestyles after using the program was statistically significant. People also reported of greater motivation to continually make improvements to their own lifestyle after using the program. During office visits with physicians, a very limited amount of time is spent on weight-loss counseling and lifestyle choices [16]. Commercially available mobile applications were analyzed and were found to have the potential to improve factors such as motivation and stress management. Despite evidence for the practical application of mHealth, the issues of integration and acceptance remain.

VTT Technical Research Centre of Finland studied the user acceptance of mobile services based on a series of case studies [17]. A Technology Acceptance Model for Mobile Services was formed based on the case studies. According to the model, user acceptance is built on three factors: perceived value of the service, perceived ease of use, and trust. Midwives in rural Ghana were studied in the integration of mHealth in their daily care [11]. mHealth was found as a significant mechanism for improving the efficiency and effectiveness of their care, but participants felt that the interface would be too time intensive and cumbersome to use progressively. Currently, many mHealth intervention programs are designed on the basis of pre-existing healthcare system constructs that do not necessarily consider the consumers. These programs may not be as effective as those that involve the end users in the design process [18].

The accessibility of mHealth apps, in terms of their ease of use, was cited by multiple studies as being a key contributor, if not the top contributor, of an individual's determination in the consistent use of these applications [10]. People's perception of ease of use is defined to be the degree to which a certain system can be utilized free from additional effort [19]. Key system requirements can be identified when users are involved in the design process [18]. User-centered design (UCD) mHealth app was studied in a group of adolescents with type 1 diabetes [20]. The participants and their family caregivers were interviewed regarding their past experiences and UCD was then utilized to develop the mobile app. By the end of the study, it was concluded that the use of UCD and incentives increased frequency of blood glucose monitoring in adolescents and participants were more likely to take actions to improve their glycemic control. UCD can also be utilized as a tool for personal lifestyle check-up and improvement [15].

Perceived risk can be described consumers' sensitivity to possible losses while using the technology [20]. For mHealth users, the perceived risk is generally associated with the security of their private health information [21]. The Health Insurance Portability and Accountability Act (HIPAA) of 1996 is the standard security protocol to which all electronic health information is being regulated [22]. Typically, mHealth systems must

conform to the standards of confidentiality, integrity, audit control, user authentication, and access control [22].

Security risks are becoming areas of concern for some individuals using mHealth applications. According to one survey, approximately 73% of physicians text other physicians regarding work related issues [23]. A concern amongst patients is that of the HIPAA privacy protection [24]. Potential threats to the breach of security include theft or loss of the mobile device, improper disposal of the device, and interception of transmission by unauthorized personnel [23]. This privacy concern extends to the use of mHealth applications. In 2013, University of Michigan studied the potential use of mobile applications in the care and management of diabetic patients [25]. Although mobile health apps have great potential for improving chronic disease care, they lacked integration and acceptance due to concerns regarding the threats to safety and privacy [25]. There are over 35,000 mHealth applications on the iOS and Android operating systems [26]. Of the 600 most commonly used apps, only 183 (30.5%) had privacy policies. Two thirds (66.1%) of privacy policies did not specifically address the app itself. The privacy policies that are available do not make information privacy practices transparent to users, require college-level literacy, and are often not focused on the app itself. A study of 256 participants across twenty-four groups measured consumers' attitudes and perceptions towards mHealth [27]. Findings had indicated that consumers were primarily concerned regarding the tradeoffs between the privacy/security of using and the potential benefits. In order to address the security concerns, it was recommended that health care providers and technology developers consider tailoring mHealth accordingly to various types of information in the health care setting, as well as according to the comfort, skills, and concerns individuals may have with mHealth technology [27].

mHealth can be also be viewed as a more secure platform of communication through data encryption [28]. mHealth had been successfully implemented as an intervention in children dealing with anxiety [28]. Patients engaged in cognitive behavioral therapy (CBT) directly with their therapists via mHealth apps. Goal setting with rewards increased patients' active participation with their therapists, leading to more successful outcomes.

In the study above, the SmartCAT app was able to successfully bypass traditional text message or email exchanges, which poses potential threats to security and confidentiality of sensitive health data [28]. Figure 1 demonstrates this protocol.

Given the prior evidence of positive effects, it is imperative that these mHealth apps be understood more closely in regard to an improved adoption rate. Ultimately, adoption will be based on the users' perceived value of mHealth. Research in the area of perceived value has been beset by "inadequate conceptualization and the lack of a validated scale" [29]. Six point-of-care applications were examined for their usability in a clinical setting on four different devices [30]. The applications studied included DynaMed, DynaMed-Plus, Epocrates, Essential Evidence Plus, Medscape, and UpToDate. Overall, there was no significant difference between the various point-of-care tools with regard to information coverage. Selection of point-of-care tools was found to be highly dependent on the individual preference based on ease of use, perceived benefits, and perceived risks. Interviews with post hospital care patients are beneficial for insight into qualities of a mHealth application that are deemed "valuable" [31]. These values include, but not

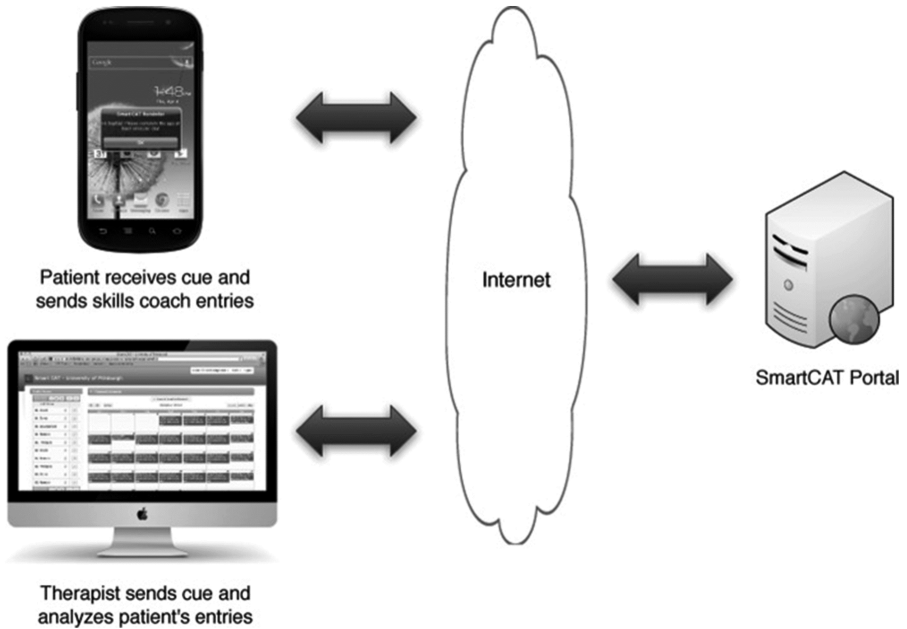


Fig. 1. Functional diagram of the SmartCAT (Smartphone-enhanced Child Anxiety Treatment) platform [28].

limited to, meeting basic accessibility, usability and security needs; encouraging patient-centeredness; facilitating better, more secure communications; and supporting personalized management by providers. Principal factors for mHealth acceptance in accordance with the literature are displayed in Table 1.

Table 1. Factors for mHealth acceptance in accordance with the literature review

| Principal factors considered when using mHealth applications | References |
|--|--|
| Perceived ease of use | Kaasinen [17], McCurdie et al. [18], Cafazzo et al. [20], Curioso and Mechael [40], Estrin and Sim [41], Lewis and Wyatt [45], Jonas et al. [43], Curioso and Mechael [40] |
| Trust | Kaasinen [17], Pramana et al. [28], Zubaydi et al. [22], Bajwa [38], Arora et al. [21] |
| Perceived value of service | Kaasinen [17], Aranda-Jan et al. [37], Wildenbos et al. [49], Johnson et al. [30], Akter et al. [29] |

3 Research Method

A qualitative study, face-to-face interview, was undertaken to collect users' information of mHealth application usage. Items of inquiry included the subject's hours of use on a

mobile device, purpose of usage, uses of mobile device, previous experience with mHealth related applications, and expectations of mHealth apps in the future. The study was conducted with the consent of random patients who presented to the Physicians Regional Walk-in Clinic in Naples, FL. Physicians Regional Clinic was ultimately chosen because of the convenience of access as to the researchers. Twenty random patients, in total of 8 males and 12 females, were interviewed.

Ages of the participants ranged from 25–94 with 45% of these individuals over the age of 65. Of those sampled, individuals within the ages of 25–30 used their mobile devices for everything including communication, entertainment, and media consumption. On average, the patients in this group used their phone between 4–6 h. Individuals between the ages of 51–64 are generally those are still in the labor force and they typically see primary use of their mobile devices in communication and work-related activities with an average of 3–4 h of phone use daily. Those who were 67 years and older generally admitted that they were “casual phone users”. Consistently, the participants in this group stated that they used their devices for communication and news update, but no more than 2 h of use daily.

4 Discussions

Responses from the twenty participants in this research were analyzed and the factors are shown in Table 2 in order of importance as noted by the interviewees.

Table 2. Factors for mHealth acceptance in accordance with patient interviews

| Principal factors considered when using mHealth applications | References |
|---|--|
| Interface/Ease of use | Kaasinen [17], McCurdie et al. [18], Cafazzo et al. [20], Curioso and Mechael [40], Estrin and Sim [41], Lewis and Wyatt [45], Jonas et al. [43], Curioso and Mechael [40] |
| Scheduling for appointments/ Prescription refills | |
| Patient-to-physician communication/ Physician-to-physician communication | Pramana et al. [28] |
| Accuracy of diagnosis/Disease prediction | Alepis and Lambrinidis [33] |
| Integration with wearable health monitoring devices | Dobkin and Dorsch [34], Poon et al. [36], Mercer et al. [46] |

It was found that sixteen had cited ease of use or ease of learning a new interface as an expectation for them to accept mHealth applications into their daily routine. Perceived of use was discussed as a major contributing factor in the literature review. It is important to note that some of the participants of the study that had past experience with mHealth as a diagnostic tool found that the diction of these apps can be confusing or difficult to understand. In particular, one patient noted, “Sometimes it’s frustrating having to look

up a certain term and be taken out of the app to do so.” Information presentation is equally as important as the quality of information in enticing users to continually dedicate time for mHealth apps. Engaging users in the design process can significantly improve patient adherence to use of these mobile applications [18].

Integrating appointment scheduling and prescription refills into mHealth apps are functionalities that have not been fully explored in past studies. Patients noted the difficulty of scheduling for appointments especially during the months when Florida sees an increase in its population due to the influx of patients from the north. One patient surveyed states that she tried calling the scheduling center but was given an appointment in 3 months for an acute bronchitis that needed to be resolved as soon as possible. Patients who are not able to be scheduled with their usual primary care physician were given the option of seeing another physician or going to a walk-in-clinic. Neither option was optimal as these physicians lacked the information and understanding of the patient’s past medical history. For instance, the patient above with bronchitis may have had a history of asthma or used an ACE inhibitor, which would have indicated cough as a potential side effect. Electronic health records have improved methods of recording patient records, but with a majority of patients reporting of less than 20 min spent with their physicians [32], there may not be adequate time for another physician to review the patient’s complete medical records and address the pertinent issues. With mHealth applications, patients hope that future scheduling can be done on the urgency of medical issue. Patients expect that the mHealth system will be able to determine whether the issue is acute or chronic and whether the issue needed to be addressed immediately. Appointments can then be offered based on the nature of their issues. For simple issues such as prescription refills, patients hope that the system would be able to fill them if they have been taken on a long-term basis. For prescriptions that are tightly regulated, patients hope to establish a direct line of communication to their providers through mHealth, who will then determine if the patients should be seen immediately. This leads to the following factor taken into consideration: mHealth as a means of facilitating patient-to-physician communication.

As indicated in the study of CBT for children with anxiety disorders, mHealth was able to be successfully implanted as a communication device between the provider and the patient [28]. This achievement is extraordinary in that it was able to successfully merge the functions of an advanced online patient health portal with that of a mHealth app. In the interviews with patients, a majority (65%) had indicated integration with existing health portals as an expectation of future mHealth apps. Online health portals are essentially conduits to contacting their health providers. In the typical health portal, one can gain access to their lab results, vaccination records, and records of past visits. It can also sometimes be used as a means of contacting physicians through a secure messaging system. Four of the twenty patients interviewed had indicated that they were seasonal patients, which meant spending Winter months in Florida and the rest in their home state. They state that even though they would request medical records to be sent from their home state to providers in Florida, records would still sometimes be absent from their charts in Florida. Patients hope to extract medical records securely from their health portal to their mHealth app, then uploading that information to the other health portal that needs to be supplemented. In this manner, mHealth will have become a web

of information, connecting patients' care teams nationally. One particular patient from Massachusetts noted the difficulty of having her different physicians in different states to agree on certain medical treatments. She hopes mHealth to also be utilized as a means of facilitating direct physician-to-physician communication. More research for this feature is required to ensure that it can be compliant with HIPAA regulations.

Although seven of the twenty patients had expected mHealth as an accurate diagnostic tool in the future, there were five in the study that remained skeptical. One patient who had used mHealth to diagnose her husband noted that the app was unable to ask questions strictly pertaining to the experienced symptoms. The provided possible diagnoses were in various fields of medicine, which caused her to have more questions than answers. Some of the patients interviewed remained skeptical of the mHealth's future capability in this regard as it would lack the patients' medical records and would be unable to perform a physical exam. However, a past study has applied the concept of Analytical Hierarchical Process algorithm to infer the presence of an illness in the subjects, or lack thereof [33]. The system was able to extrapolate data from the corresponding subjects' electronic health records and incorporate this data into the system's decision making and diagnosis. A more advanced system is currently being studied to also incorporate patient's image related health tests, which include X-Rays, ultrasounds, and MRI's. Future integration of wearable health technologies may also potentiate the credibility of mHealth as a diagnostic tool.

"The great promise of mHealth is to enable evidence-based practices to wirelessly reach into the homes and communities of people who cannot readily or affordably access health care [34]." Three patients surveyed in this study noted active use of smartwatches in the tracking of their fitness routine. However, they state that they have not used the devices beyond simple tracking of steps taken and heart rate. Previous trials had indicated effectiveness of ankle triaxle accelerometers, gyroscopes, and pressure-sensitive textiles combined with wireless communication to provide monitoring of patients with impaired ambulation [34]. The live data received by patients' health providers allowed the clinicians to provide feedback for better self-management of home-based rehabilitation programs. High cost was cited as one of the chief reasons for the lack of widespread use of these devices. However, these sensor technologies are becoming increasingly integrated into our daily lives. As mentioned above, smartphones now are becoming natively equipped with sensor technology to measure the body's oxygen saturation and pulse. Even smartwatches are becoming integrated in the monitoring of home-based dementia patients [35]. Developments such as wearable cuff-based blood pressure monitor device can allow the clinical staff to continually observe variability in patients' vital signs remotely [36]. It's important to recognize that the future of mHealth may not be limited to certain mobile based applications, but the inclusion of multiple sensors and monitoring devices working in tandem with the app.

5 Conclusions

Applications involving mHealth have been maturing since 1995. However, it remains that there is no unanimous definition of mHealth. It can be understood that mHealth is

an enabler of participatory health that includes not only mobile devices, but also possible add-on health monitoring applications. But with the rapid advancements of wireless communication technologies in the last decade, our understanding of mHealth has not yet reached the level to fully comprehend the full potential of mHealth and factors for greater user acceptance.

Through the extensive literature review, three dominant factors were found to have significant influence in users' decision to integrate mHealth applications. These include perceived ease of use, trust, and perceived value of service. Patients who were interviewed in this study listed five principal reasons that they believe were integral for the acceptance of mHealth. These factors included ease of interface, appointment scheduling, physician communication, accuracy of disease prediction, and integration with existing wearable health monitoring device. New findings from the patient interviews can expand upon the value of service as noted in the literature review. These additional features include the app's native ability to communicate with healthcare providers, refill prescriptions and schedule appointments, and accurately predicate acute diseases. Strangely, security was not a primary concern amongst the patients that were interviewed. A greater sample size will be required to validate these findings.

This study addressed some new patient concerns regarding mHealth generally not found in past studies. As there are still gaps within our understanding of mHealth and its full potential, fellow researchers can utilize the information from these interviews to further expand upon the existing foundation of mHealth. Besides conducting additional surveys, researchers can examine the plausibility of these future mHealth expectations and find ways to fulfill these expectations. mHealth is still in the nascent stage of development and proliferation. However, it has the potential to improve the care of healthcare providers. It may be possible for providers to continuously monitor vitals of critical care patients or communicate directly with other physicians to work out a plan of care straight from the mHealth application.

Limitations of this study include the small sample size, limit of a single clinic as area of research, and the majority of the city population being greater than 65 years of age and are generally less integrated with the advances of modern smartphone technologies. Future studies should streamline the survey to random participants from around the country. Focus should be placed on perfecting the interface module of the mHealth application. Prior research has shown the effectiveness of mHealth apps in improving the health of individuals who continued consistent use of the app [15]. Unfortunately, many individuals cease use of these applications within the first year [10]. Patients sampled in this study point to laborious interface as the main reason for discontinuation of use. This was also cited as one of the main reasons for discontinuation of use by a previous study [11]. The development and implementation of a successful mHealth application interface will be critical to the future of our healthcare.

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