

Original Research

Engaging Teens with Asthma in Designing a Patient-Centered Mobile App to Aid Disease Self-Management

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Abstract

Background: Despite the growing market of e-health disease self-management tools, few studies have reported the presence of teen patients in all phases of product design. While rates of American teens using mobile Internet grow, an opportunity to deliver disease self-management targeted for teen patients exists. Building on findings from previous investigations with teens with asthma, we explored teens' insights on the development of a patient-centered asthma management application (app). **Materials and Methods:** Two existing asthma apps were used by 16 teen asthmatics for 7–10 days. At the end of the trial period, in-depth interviews were conducted with each participant to gather insights about the user experience. **Results:** Participants requested more asthma-related content that educates them about their condition. Suggested improvements to currently available apps included a longer list of selectable symptoms to track, medication tracking, and more compelling interface features. **Conclusions:** Participants showed interest in using apps for managing their asthma, yet recommended improvements on current design. Whereas national figures point to a more ubiquitous mobile device environment, implementation efforts must respond to participants' recommendations while minding lingering digital divides. Currently available apps lack appealing components that teens seek or desire. Subsequent development should include teens' participation in component design insights.

Key words: behavioral health, mobile health, pediatrics, education

Introduction

For decades after the first handheld mobile phone was made commercially available, 91% of adults and 78% of teens in the United States own mobile phones.^{1,2} About half of teen-owned mobile phones are smartphones.^{1,2} Smartphones offer access to the Internet, rapid Internet speed, ample memory, and complex capacities as a consequence of the burgeoning emergence of applications (apps). At the same time, nearly all American teens use the Internet, with 74% accessing the Internet via mobile devices.² With an estimated 40,000–60,000 available apps for mobile devices,^{1,3} mobile Internet users can access personal health-, healthcare-, and chronic disease management-supportive tools. One study of apps available to European Android™ (Google, Mountain View, CA) device users revealed that 45% of reviewed personal health apps augment education and offer such things as insight to women's health, pharmacy services, and preparation of health diaries.⁴

Indeed, disease self-management tools cover a variety of conditions, including diabetes,⁵ pain management,⁶ asthma,⁷ and others. Explorations in the successful design of self-management tools point to user-centered design practices.^{8,9} For instance, the Electronic Self Report Assessment-Cancer platform, a computer-based cancer symptom tracker for ambulatory services among cancer treatment center patients, used focus groups, mock prototypes, and individual interviews to guide the entire development process with intended end-user insights.¹⁰ Quantitative surveys were used to gather information on ease of use during pilot testing of an electronic diary for teens with sickle cell disease.¹¹ Burns et al.¹² used think-aloud activities to monitor usability of Asthma-wise, an asthma education Web site targeted for adults 55 years of age and older. Other studies have documented iterative version development and immediate updating through usability testing.¹³

An understanding of how targeted groups use self-management tools is necessary to develop useful, appealing, and effective systems. The numerous apps developed to support management of asthma, a chronic condition affecting millions of Americans,¹⁴ have focused on symptoms, triggers, and medications.¹⁵ One example is the use of a Bluetooth®

(Bluetooth SIG, Kirkland, WA) device, Asthmapolis, that reduced the number of asthma attacks by allowing patients and their physicians to monitor frequency of asthma events, medication, and inhaler use.^{3,16} In a prospective, randomized trial, Taiwanese asthma patients using a mobile phone-based asthma intervention attained better respiratory and quality of life measures compared with controls.¹⁷ Another trial strengthened asthma control among children younger than 10 years of age through online modules, telephone-based nurse support, and parent involvement.¹⁸ In terms of asthma self-management, fewer design efforts have focused on teen groups or involve teens in the development process.

In Florida, one out of five children has asthma.¹⁹ In Hillsborough County, Florida (inclusive of Tampa), about 23% of youth between 10 and 20 years old have asthma.²⁰ Whereas numerous apps enable people living with asthma to manage and take control of their condition,^{7,15,17} few are designed with teen asthmatics at the center of development or as the likely end-user. Previous studies reveal that pediatric asthma patients, their parents, and their pulmonologists desire mobile, user-friendly solutions, such as an app, that tracks their asthma experience, alerts them when their conditions worsen, and strengthens communication among families and their healthcare providers.^{21–23}

The main objective of this study was to engage teen asthma patients in the developmental stages of product design for an asthma self-management app for persons in their age group. We assessed teens' overall impressions of currently available asthma apps. Participants specifically identified useful and nonuseful features and encountered barriers to using the tested asthma self-management apps. Preferred asthma-related content also was explored.

Materials and Methods

STUDY DESIGN

A prospective strategy whereby teen asthma patients were interviewed after using one of two currently available asthma self-management apps for at least a week addressed the main study objective. First, we assessed which apps were available for asthma patients to track and monitor their health and, of those apps, the ones that were tailored for teen patients. This approach identified two apps: AsthmaMD, a free app, and AsthmaPulse, a low-cost app that was free to participants of this study.⁷ To minimize bias related to how study participants accessed the apps, we used the iPhone® (apple, Cupertino, CA) operating system (iOS) platform across all study participants. Teens who already had an iOS device such as an iPhone or an iPod® Touch® (Apple) ($n = 7$) were given a product code to download one of the two apps,

and those without an iOS device were loaned an iPod Touch ($n = 9$) with an app previously downloaded. For their participation, all teens received peak flow meters and a Walmart gift card in the amount of \$50.

This study was reviewed and approved by the institutional review board of the University of South Florida.

STUDY POPULATION

Participants were recruited through volunteer sampling from a pediatric pulmonary clinic in an academic setting in the Tampa Bay region. Clinic staff members presented the study to eligible subjects and provided them with the information to contact the researchers. The study team recruited eligible participants by telephone. Recruitment for each app continued until either 10 teens tested each app or no new insights were gained.

Inclusion criteria for youth invited to participate in the study were (1) being a teen between the ages of 13 and 18 years old, (2) being a patient in the university-affiliated pediatric pulmonary clinic system, (3) being an English speaker, and (4) having daily asthma maintenance medications for persistent asthma. Ultimately, 16 youth between 13 and 18 years of age participated in the study.

PARTICIPANT EXPERIENCE

Participants were assigned to test one of two existing asthma management apps for a period of 7–10 days. They were trained to use the peak flow meter and the mobile device. At the end of the testing period, a research team member administered a semistructured interview to each participant.

In addition, both apps have the capability to share tracked information with a healthcare provider. The presiding pediatric pulmonologist, a Co-Investigator in this study, had both apps installed on her iOS mobile device and received summary information from the study participants during the course of their time using the apps. Ten teens tested AsthmaMD, and six tested AsthmaPulse before repetitive insights were reached.

DATA ANALYSIS

Interviews were audio-recorded and transcribed; transcriptions were then coded by three experienced analysts using *a priori* codes relevant to features, content, and product design. Data management and coding were performed using NVivo version 9.0 software (QSR International, Doncaster, VIC, Australia). Coding discrepancies were discussed and resolved by the coding team. Summaries of grounded insights from participants are presented.

Results

Five main themes were drawn from participant interviews (*Table 1*): content, useful features, suggested improvements, interface, and operation. Each of these themes is presented in some detail below.

CONTENT

Participants showed interest in receiving asthma education through the app through either concise text or short video clips of 10 min in duration or less. Topics of interest included general information about asthma, instruction on how to use peak flow meters and inhalers, and how to cope with exacerbated asthma symptoms.

Participants also wanted to receive messages through the app. Desired message content included reminders to measure peak flow, refill prescriptions, make doctors' appointments, and take particular medications at appropriate times. Teens preferred entering their peak expiratory flow and their symptoms.

Participants also expressed interest in receiving automatic alerts from the system in response to their self-entered asthma data. They reported that these alerts should indicate worsening asthma status and provide immediate guidance such as suggested behavior changes, advice based on environmental conditions, and medication use. Additionally, teens desired motivational and supportive messages that encouraged specific asthma management behaviors.

USEFUL FEATURES

Participants identified app features they found useful. Participants appreciated visual aids provided by the apps.

Visual aids helped participants understand trends and patterns in their asthma condition. They specifically enjoyed measuring their peak expiratory flow and putting these data into the app, which resulted in a color-coded zone for their symptoms. This color-coded signal is part of an asthma action plan similar to progressive colors of a traffic light.²⁴ A green zone indicates controlled asthma, and signals change to yellow and then red with worsening asthma symptoms.²⁴

Both tested apps offer the option to share asthma reports with selected e-mail recipients. Participants valued this feature and suggested that sharing information and direct communication with healthcare providers would help them monitor asthma status continuously. Participants named parents, school nurses, coaches, and teachers as other possible recipients of their asthma information. Participants preferred using text messaging to deliver asthma updates and to communicate with their healthcare providers.

SUGGESTED IMPROVEMENTS

Participants suggested features that would improve app usability, ease, and enjoyment. They felt these improvements would inspire regular use by other teens. Participants suggested a personally designed avatar that would reflect the user's asthma status. Participants would like the ability to change the appearance of the avatar according to their preferences. They also suggested developing interactive games using the avatar to train the user to identify the characteristics of asthma status, to understand collecting and utilizing their own asthma data, and fun activities to learn action steps to improve their asthma and make the use of the app more compelling.

Table 1. Adolescents' Recommendations on Application Features: Main Themes

APP CONTENT	FEATURES		INTERFACE	APP OPERATION
	USEFUL	ADDITIONAL AND SUGGESTED		
Asthma educational material: what to do during asthma attack, how to use peak flow meter, etc. • Format: short text or informative video clips Alerts on asthma status and action needed: "Please contact your clinic" Reminders to take medication, doctors' visit, refill prescription Empowering messages: "well done, your asthma is balanced for x days" • Format: text message, e-mail, notification button Environmental condition: humidity, pollen level, etc. • Format: notification bubble or pop-up window	Direct communication with the provider Personalized features and information Medication log Visual aids: graphs and charts Asthma journal	Prompt to use the app Reminders to take medication or purchase refill Fun factor: asthma-related games and customized design Built-in peak flow meter	Teen-friendly graphics and colors Font size, style, and colors Clear action and verification buttons	Ease of operation Fewer steps Self-explanatory, intuitive process Automatic progression of the process Verification of sent messages

App, application.

Some participants showed interest in keeping an asthma journal. This feature would allow them to describe how they are feeling using text. Youth felt this would be helpful to them when trying to stay healthy.

The need for a peak expiratory flow meter as an additional device to perform lung function testing hindered many participants from adding these measures to the app more frequently. These youth felt that the use of more than one device defeated the purpose of the mobile device as a solitary asthma management tool. Based on this perception, youth recommended developing peak flow meters built into the app or an additional peak flow app that would share results with the asthma management app.

Several participants noted that certain allergens and weather patterns upset their asthma status. These youth expressed interest in having real-time reports concerning environmental conditions such as pollen level and weather forecast within the app. They felt that this improvement would heighten the value of the app as a solitary tool.

Participants faced difficulties distinguishing between their daily and emergency medications. Although they appreciated the ability to record treatments and medication delivery, they suggested providing clearer categories of the two medication types would improve this feature. They felt that data about each medication category (emergency and daily) should be kept separately.

INTERFACE

Participants described the app interfaces as “boring,” “too serious,” and “unappealing.” According to youth, the colors, graphics, and font sizes and types used in the apps were unsatisfactory. To improve app interfaces, participants described “fun” graphics, bold colors, and “bubbly” or “cool” fonts. Participants emphasized tailoring app interfaces for teen preferences to increase the chances of routine use.

In some cases, participants were unsure whether actions performed were completed. For instance, these youth e-mailed reports to the pediatric pulmonologist via the app but reported not receiving any confirmation that the information was received successfully. This resulted in multiple reports being e-mailed. They suggested creating large, clear verification “buttons” such as “saved” and “sent” to confirm the completion of actions.

OPERATION

Several participants suggested creating a tutorial that describes app features and provides a training function. Information related to opening and using the app also was desired.

Once again, participants preferred video clips and animations over a plain text tutorial. A group of participants found operation of the apps unintuitive and therefore suggested that such tutorials would help teens overcome this barrier. Additionally, they recommended a system that automatically progresses when entering asthma values, whereby one action automatically follows another. The described ideal experience using an asthma management app would go as follows: after entering peak expiratory flow values, the app would then move immediately to a symptoms list, then to the medication list and chart, followed by the save option, and finally to sharing information with the pediatric pulmonologist and others. Once the process is completed, the app would then notify the user that information was saved and sent successfully.

Discussion

Research continues to support mobile devices and software designed specifically for health behavior change among youth.^{25,26} The present study explored patient-centered experiences of teens using two currently available asthma tools. Whereas asthma apps are available,⁷ an app that provides a comprehensive array of self-management tools and is designed to accommodate the desires, values, and interests of teens is not currently available.²⁷

Our work revealed teens’ recommendations for developing a novel tool that uses comprehensive support features and satisfies their needs and design preferences. According to research participants, developers should continue adjusting asthma apps specifically for tracking important asthma health indicators to aid self-management. The communication of important health information with parents and professionals, with special consideration to a teen-centered interface that includes visual aids along with concise textual content and easy sharing options, is vital to overall design.

Licksai et al.¹³ demonstrated satisfactory ease of use, timeliness, clarity, and simplicity of a smartphone-based asthma self-management app with older patients, yet the targeted groups were not included explicitly in the design phase. Burns et al.¹² made immediate adjustments to their tool, Asthmawise, to conform to real-time elderly participant feedback in their pilot-testing phase. The present study represents in-depth feedback from teen asthmatics gathered while pilot testing existing apps prior to novel app development. Despite this major difference, our results and findings of others support strengthening the end-user experience to build stronger asthma self-management behaviors through apps.

This study also emphasized that development of apps to support disease self-management must involve targeted groups. Ramachandran and Pai²⁸ also proposed a design

approach to chronic disease management apps that is patient-centered. Their design approach incorporates tracking of symptoms, medicines, and appointments, as well as transmitting tracked information to physicians chosen by the user.²⁸ Others have used a build-measure-learn framework for the development of health intervention products that also involves intended users iteratively in the design phase.²⁹ Existing approaches to the development of effective, patient-centered apps should be explored further.

Concerns about app maintenance, security, appropriateness, and reliability of presented content persist. Further concerns about the use of more than one device for asthma management, forgetfulness,²¹⁻²³ and variable wireless Internet access inhibit the routine use of app-based asthma self-management, which supports Web-based tools that are accessible via smartphones.¹¹ Whereas nationwide rates of teen ownership of smartphones are on the rise, almost half of our sample did not own their own mobile device. Therefore, persons attempting to develop solutions must be mindful of lingering digital divides. Qualitative discoveries, although not generalizable, provide richer understandings and practical insights from teens using asthma self-management apps.

Currently active funding will be used to design a patient-centered asthma self-management app that meets the stated needs of teen patients. Part of the design plan is to continue iterative usability tests throughout the development phase to ensure the tool is optimally tailored. Once designed, a randomized control trial will vet the effectiveness of the app at supporting fewer asthma complications and stronger behavioral measures.

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