Nursing Informatics 2016
W. Sermeus et al. (Eds.)

doi:10.3233/978-1-61499-658-3-481

Usabilty Evaluation of a Prototype Mobile App for Health Management for Persons Living with HIV

Rebecca SCHNALL[a,1], Suzanne BAKKEN [a,b] William BROWN III [b,c], Alex CARBALLO-DIEGUEZ [c], Sarah IRIBARREN [a]
[a] *School of Nursing, Columbia University, New York, NY, USA*
[b] *Department of Biomedical Informatics, Columbia University, New York, NY, USA*
[c] *HIV Center, Division of Gender, Sexuality and Health, New York State Psychiatric Institute, New York, NY, USA*

Abstract. Mobile health (mHealth) applications (apps) have the potential to support self-management and improve health outcomes in persons living with HIV (PLWH). In this paper, we report on the final step in a three-stage user-centered design process for the development of a mHealth app for PLWH. We conducted a usability evaluation with 10 targeted end-users and a heuristic evaluation with 5 persons with informatics expertise to assess the usability of a prototype mHealth app for PLWH to manage their health. At the end of our usability evaluation, we finalized a Design Document that included the user interface design and functional specifications of the mHealth app. The functional areas which were identified at the end of our iterative process included: Communication, Reminders, Medication Logs, Lab Reports, Pharmacy Info, Nutrition and Fitness, Resources and Settings.

Keywords. mHealth, apps, HIV, self-management, end-user design, usability

1. Introduction

Mobile health (mHealth) technology shows potential as a highly valuable tool in the management and prevention of chronic illnesses such as HIV [1]. There are a limited number of mHealth applications (apps) specifically designed for persons living with HIV (PLWH). Of those mHealth apps that do exist, few have been developed with end-users' input or rigorous evaluation [2]. This paper reports on the third part of a larger study that employed user-centered design methods to create a Design Document, outlining the blueprint of a health management app for PLWH.

The development of the final Design Document involved the analysis of data from: focus groups, design sessions, and usability testing (heuristic evaluation and end-user). Detailed methods for the focus group data collection study are published elsewhere [3]. Building on the information gathered in our focus group sessions, we conducted two user-centered design sessions [4]. Following these sessions, we created an initial visual framework of the screen content and layout for the app in PowerPoint. The purpose of this paper is to report on the usability evaluation of the mock-ups of a mHealth app for self-management for PLWH.

[1] 617 West 168th Street, New York, NY 10032; Phone: (212) 342-6886; Email: rb897@columbia.edu

To increase the likelihood of technology acceptance, we conducted two types of usability assessments [5]: 1) a heuristic evaluation of the PowerPoint prototype using informaticians with experience in interface design and/or human computer interaction, 2) end-user usability testing by systematically observing how well PLWH used the PowerPoint prototype.

2. Heuristic Evaluation

2.1 Sample

Five informaticians participated as usability experts. Each expert was at minimum master's prepared in the field of informatics, had training in human-computer interaction, and had published in the field of informatics.

2.2 Procedures

The usability experts were provided with a description of the full functionality of the prototype app. Each expert tested the prototype user interface independently with the use case scenarios (Table 1) for approximately 45-90 minutes. The process was recorded using Morae software™ (Techsmith Corporation, Okemos, MI), [6]. The experts were asked to evaluate the app using a think-aloud protocol and to complete a Heuristic Evaluation Checklist (Likert scale from 0 (not a usability problem) to 4 (usability catastrophe) to evaluate the extent to which the user interface violates a set of usability heuristics [7].

Table 1. Use Cases for mHealth App Usability Testing

1.	Please check your viral load
2.	Please check what medications need to be refilled soon
3.	Please find a needle exchange program in your area
4.	Please change your user name
5.	Please find information on the second thing you would do when putting on a condom
6.	Please enter what you had for dinner yesterday
7.	Please find the definition for antibodies
8.	Please locate HIV specialists in your area

Mean severity scores were calculated for each heuristic principle from Nielsen's checklist. Evaluator's comments about usability problems on the evaluation form and the Morae recordings were reviewed and analyzed [8]. Based on these findings, we refined the low fidelity PowerPoint prototype.

2.3 Results of Heuristic Evaluation with Experts

A total of 77 changes were made to the HIV mock-up based on the heuristic evaluators' recommendations. Mean scores and sample comments for each usability factor related to the mHealth App are reported in Table 2. In response to a *Match between System and the Real World* issue, an expert suggested that the screen for current prescriptions should be renamed medication refill, which better reflects its functionality. The slider bar should include yellow to represent the medications that are midway the refill mark. To maintain *Consistency and Standards,* one expert recommended that the search button should look the same every time it appears in the app. To improve the design, one expert recommended that the food diary screen include a date at the top, and a scroll bar with the word "Yesterday" on the left side, "Today" in the middle and "Tomorrow" at the right side.

Table 2. Mean Scores and Sample comments of Heuristic Evaluation of HIV App

Usability Factor	Mean (S.D.)	Sample Comment
Visibility of System Status	1.80 (0.45)	Screen headers should be changed to words that represent the content
Match between System and the Real World	1.20 (1.10)	Section headings not always ordered in the most logical way
User Control and Freedom	1.40 (0.89)	No clear exit on each document screen
Consistency and Standards	2.20 (0.84)	Should be medication adherence first
Help Users Recognize, Diagnose, and Recover From Errors	0 (0.00)	Did not see any error messages
Error Prevention	1.00 (1.41)	Wellness section was cluttered
Recognition Rather Than Recall	1.20 (1.30)	At times it was difficult to know where to access information
Flexibility and Efficiency of Use	0.20 (0.45)	Search didn't work
Aesthetic and Minimalist Design	1.40 (0.89)	Simplify color scheme, get rid of unnecessary shapes
Help and Documentation	1.00 (1.41)	No help function

3. Usability Testing

3.1 Sample

We recruited ten PLWH who did not participate in the design sessions to evaluate the prototype user interface screens. Ten participants were selected because past research has shown that the minimum percentage of problems identified rose from 55% to 82% and the mean percentage of problems rose from 85% to 95% when the number of users was increased from five to ten [9]. There were 4 female and 6 male participants. Six of the participants were current smartphone users.

3.2 Procedures

Participants were provided with the same use cases as the heuristic evaluators and a description of the full functionality of the prototype system. After the usability evaluation, participants were asked to rate the prototype's usability using the Post Study System Usability Questionnaire (PSSUQ) which is a 19-item survey instrument to assess user satisfaction with system usability on a scale ranging from 1 (strongly agree) to 7 (strongly disagree) [11].

The analysis was based on the Morae recordings of user sessions, transcriptions, notes and the PSSUQ survey. The team searched for critical incidents characterized by comments, silence, and repetitive actions. We reviewed these incidents in detail using Morae software. The incidents identified and the users' written comments were summarized. Results from the PSSUQ were analyzed using SPSS version 22.0 (IBM, Armonk, NY) to calculate the descriptive statistics.

3.3 Results of Usability testing with End - Users

Our iterative usability testing resulted in five versions of our mHealth app prototype. At each version, we refined the content, potential functionality and interface. A total of 83 changes were made to the mock-ups based on the end-users' recommendations.

During usability testing, one end-user suggested that HIV medical providers/clinics should have more options, especially from the outer boroughs of New York City. To address this issue and make the app more generalizable in its functionality, we added a box to enter zip code as well as a scroll bar. Information on insurance taken by facility/provider and pharmacies was also added. Another participant commented that the medication refills screen was hard to understand because the colors confused her. She suggested they be taken out and only have the data. Instead, we added a key to the bottom of the screen to explain the colors. PSSUQ scores from the HIV end-user testing were variable over time and related to whether participants were smartphone users. The PSSUQ score was lower at the end of the usability testing process, indicating a more usable app.

At the end of our usability testing, we finalized the Design Document, which included the functional specifications and user interface design of a mHealth app for PLWH to self-manage their illness. Our final Design Document included the following broad functional categories: Communication, Reminders, Medication Logs, Lab Reports, Pharmacy Info, Nutrition and Fitness, Resources and Settings. Screenshots of the mock-ups from version 1 and the final version of our Design Document are included in Figure 1.

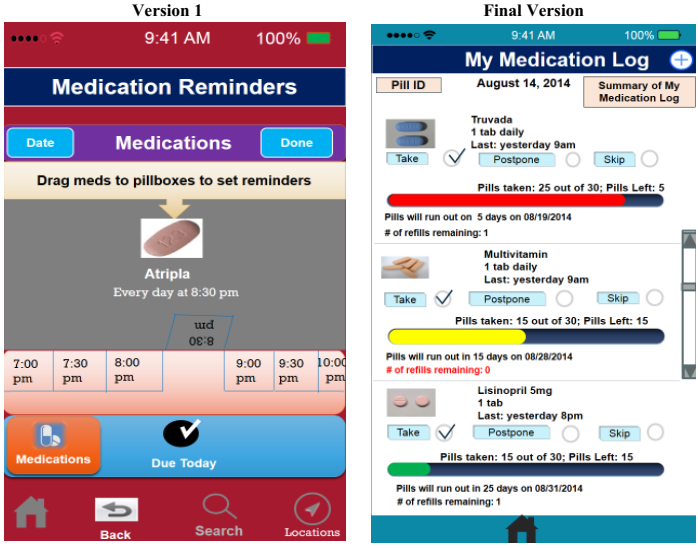

Figure 1. Mock-Ups of App for PLWH.

4. Discussion

In recent years there has been a proliferation of healthcare–related apps designed to promote behavior change and support self-management of chronic diseases. Currently there are more than 40,000 health-related apps available on the app marketplace [10]. Many of the mHealth innovations for PLWH have not gone beyond the pilot stage, or have not been rigorously evaluated [11].

There are a limited number of apps for PLWH and few have been developed with end-user feedback. An additional challenge is that currently available apps for PLWH may be off the marketplace in a few years. For instance, of the 55 apps for

PLWH -which were reported in a 2013 review [2], 15 are no longer available. By contrast, our work employed user-centered design and usability evaluations to identify the functional specifications and user-interface for a mHealth app for self-management in PLWH prior to development.

Previous work has demonstrated the usefulness of rigorous user-centered design methods for informing the development of mHealth applications [12]. The developmental research reported in this paper improves our understanding of how mHealth tools can be appropriately designed by end-users. Despite the growing interest across sectors in mHealth apps, there remains limited evidence on their acceptability and impact on health care outcomes [13]. Further work is needed to compare existing apps for PLWH to the mHealth app that we proposed after our iterative design process. In addition, rigorous evaluation of the app through a trial is needed to assess whether mHealth technology that is designed by end-users results in improved health outcomes.

5. Acknowledgments

This publication was supported by a cooperative agreement between Columbia University School of Nursing and the Centers for Disease Control and Prevention (CDC; 1U01PS00371501; PI: R Schnall). The findings and conclusions in this report do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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