Evaluation of mHealth features on user experience

Alana Platt, *University of Wisconsin-Whitewater, platta@uww.edu*
Christina Outlay, *University of Wisconsin-Whitewater, outlayc@uww.edu*

Abstract

mHealth apps have been heralded as a means to improve wellness. Although prior research has addressed the medical validity and usage of certain apps, little work exists to determine the features that compose an effective mHealth app. In this work, we built a mHealth app whose features were directly informed by previous research and then conducted a user study of the software. Findings from our study indicate that wellness app was well received by respondents and further support the findings of prior research. Several features positive contributed to perceived ease of use (PEU) or were found to be desirable features to the users. Further, we found that users who currently have a health concern had stronger motivation to use the app than those who were using it for general wellness

Keywords: Mobile Health, mHealth, Wellness app

Introduction

The use of mobile technology to improve health – or mHealth – is an area that has drawn the interest of researchers and the general public due to its potential to support healthy lifestyle choices. Individuals who understand the health implications of their lifestyle choices may make healthier choices. For example, poor lifestyle habits such as insufficient sleep can increase the risk of obesity, hypertension and cardiovascular disease (St-Onge et al 2016), while positive lifestyle habits such as good nutrition, regular exercise, and sufficient sleep have a mediating effect on major depression (Lopresti, Hood, and Drummond 2013). However, patients may not be receiving sufficient physician guidance in these areas. Wynn, Trudeau, and Taunton 2010 found that responding physicians believed 60% of their patients would benefit from nutritional guidance, but only 41.7% of rural and 21.7% of urban patients were referred to a nutritionist. At other times, patients fail to follow their physicians' advice, known as medical adherence. Approximately 40% to 50% of patients who are prescribed medications for management of chronic conditions are nonadherent, leading to at least 100,000 preventable deaths and $100 billion in additional healthcare fees (Kleinsinger 2018).

Given the importance of healthy lifestyle habits and the demonstrated need for support, it is perhaps unsurprising that mHealth apps are growing in popularity. 46 million people used fitness apps in January 2014, which is roughly 1/3 of American smartphone owners (Nielsen, 2014). A recent national survey found that among their respondents, the use of mHealth at least twice a day was reported by 21.3% of respondents without a condition, and from 2.7% - 16.6% of respondents with a chronic condition (Robbins et al. 2017).

Through prior mHealth studies, most researchers have examined whether mHealth applications overall are (1) medically valid and (2) used regularly enough to be effective interventions. However, little research

examines the individual features that compose an effective mHealth app. Informed by prior research, we identified a set of features related to user engagement with mHealth apps. Based on these findings, we implemented a mHealth app and performed a user study with 12 participants. The user study consisted of two phases: a concurrent-think aloud software evaluation and the completion of a survey. Two student research assistants administered the usability study, took notes on the session, and recorded user feedback. With this approach, we were able to (1) Validate the set of features that are desirable to wellness app users, and (2) Identify the impact of usability and user preference on perceived ease of use (PEU) and the users' preferences (UP). This contributes to research in mHealth by providing a list of features that have been empirically demonstrated to be attractive to users to inform future mHealth app design.

The remainder of this paper is organized as follows: in Section 2, we present the previous work on mHealth applications and design, focusing on motivating engagement, mHealth for healthy lifestyles, and mHealth for mental health. In section 3 we present the wellness app framework, and in section 4 we present our methodology. We present our results in Section 5, and conclude in Section 6.

Prior Works

Lifestyle choices and medical adherence contribute significantly to the health of an individual. Consequently, mHealth that helps users maintain a healthy lifestyle is gaining popularity. mHealth apps have been used to support a variety of health-related issues such as weight loss (Freyne et al. 2012, Freyne et al. 2017), smoking cessation (Borrelli et al. 2015), birth outcomes (Foster et al 2015, Joos et al. 2016, Wang 2020), stress management (Chiauzzi et al. 2008), and overall health (Kim et al. 2019).

Impactful mHealth apps often engender a change in the user's behavior, and several prior works have investigated factors related to modifying user behavior. Alagöz et al. (2010) looked at the perceived ease of use (PEU) of mHealth, and found that demographic factors of age and technical inexperience have a negative impact. Beldad & Hegner (2017) expanded the Technology Acceptance Model (TAM) to include trust, social influence, and health valuation. They found that continued use was predicated on perceived ease of use, perceived usefulness, and injunctive social norm. These findings demonstrate that mHealth applications that are perceived as easy to use and useful to continued use. Other authors investigated how features impact the users' interaction with a mHealth app. In Mattila et al. (2010), the authors presented an app called Wellness Diary (WD) to support a healthy lifestyle, and suggested the addition of "…alarms, rewards, analysis or other such motivational features," would increase long term use (Mattila et al. 2010). Lin et al. (2012) developed a mHealth app, BeWell+. The authors conducted a research trial and found the community adaptive wellbeing feedback mechanism helped to give people better understanding and encouragement. Platt et al. 2016 studied users' expressed needs for a wellness oriented mHealth app through a survey of potential users and an extensive literature review of mHealth applications. The authors performed a survey of prior works and a questionnaire administered to 521 potential mHealth app users to identify features most important to potential mHealth users. Kim et al. 2019 found that user engagement, content quality and reliability were all key for user continuance intenion. Based on these prior works, five key areas categories of features are identified, as described in Table 1.

Table 1: Feature categories for mHealth applications

Category	Description	Prior Works
Prompting user activity	A prompt for a user to engage with the app – often in the form of alerts or reminders.	*Mattila et al. 2010; Freyne et al. 2012; Freyne et al. 2017; Kim et al. 2019; Platt et al. 2016*
Rewards	Incentives such as badges, points or high scores earned for healthy behavior.	*Mattila et al. 2010, Freyne et al. 2012; Platt et al. 2016*
Personalization	The app is tailored to the user's needs or preferences.	*Mattila et al. 2010; Platt et al. 2016*
Tracking features	Tracking activity explicitly or passively through a device.	*Mattila et al. 2010; Freyne et al. 2012; Lin et al. 2012; Platt et al. 2016*
Positive Feedback	Messages or social components that offer support and encouragement to the users.	*Freyne et al. 2012; Freyne et al. 2012; Lin et al. 2012; Platt et al. 2016*

Previous works indicate that wellness apps with features belonging to the categories shown in Table 1 are important to users, but little research has investigated user perceptions and interactions a general wellness app that implements these features. Thus, we built our wellness app to incorporate a set of features that covered the needs outlined in Table 1 to enable us study how users interact with such an app and allows us to evaluate the following:

(1) What is the usability of the wellness app?
(2) How engaging is interacting with the wellness app?
(3) What is the perceived ease of use (PEU) of wellness app?
(4) How well do the users like the app e.g. User Preference (UP)?

Methodology

We developed the wellness app as a daily, stand-alone intervention that enables users to track both their actions and how they feel and has features belonging to the categories shown in Table 1. In the Wellness app, users can explore their health trends, tailor the app to their needs, and receive encouragement. Figure 1 shows the flow of user interaction the wellness app, which we will explain in detail below.

The Dashboard (Figure 1 – screen 1) is where the user begins their interaction with the app and provides an overview of how effectively they are managing their health. The app displays a color-coded Wellness Score [1-10] that represents the users' health choice and their reported health. It also displays key metrics, such as hours spent sleeping or exercising, as well as highlights of user behavior and rewards earned. The Daily Wellness Report (Figure 1 – screen 2) allows users to record their lifestyle choices and symptoms by answering a set of questions developed by physicians. Questions are also tailored to the user (e.g. if a user's profile indicates they have arthritis, arthritis specific questions appear.) The Wellness journal (shown in Figure 1 – screen 3) is a tracking feature that allows users to reflect on their health. Users who are on medication or supplements can also track their adherence using the Pillminder (Figure 1 – screen 7).
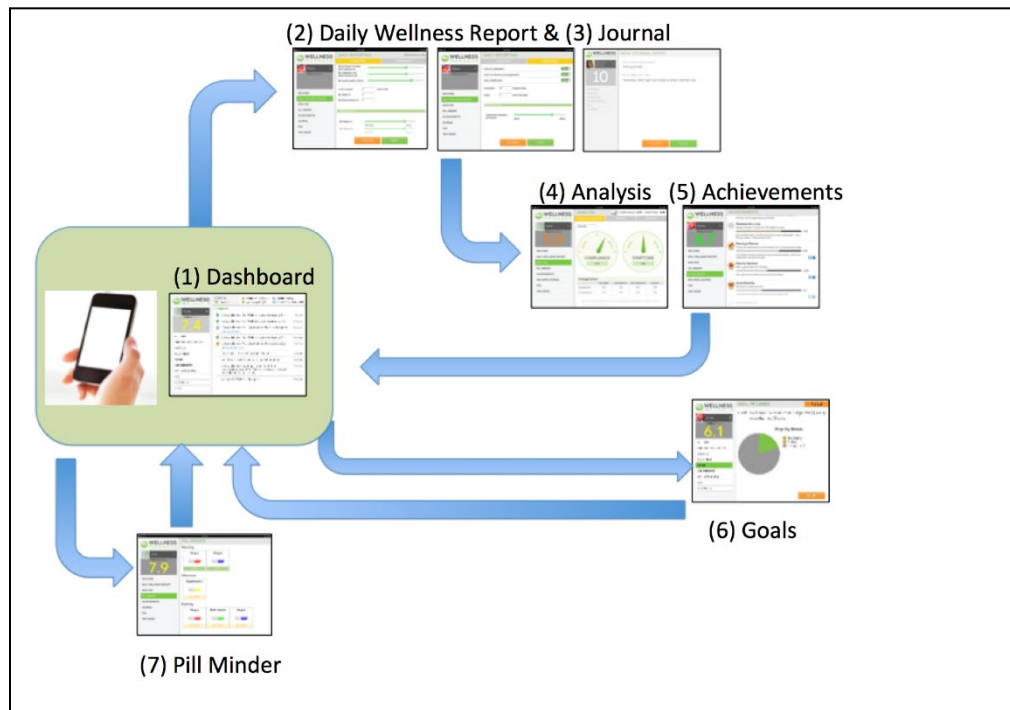
Figure 1. Flow of the wellness app

Providing user feedback is an important aspect of user engagement (Platt et al. 2016). The wellness app provides feedback via the Analysis Page (Figure 1 – screen 4). The Analysis page consists of three tabs: The Road to Wellness, which provides an overview of recent user activity through a speedometer metaphor and provides specific feedback (e.g. the user is getting enough exercise, the user is not reporting the recommended amount of sleep). The Trends tab shows a graph of user data, while the Reports tab allows the user view her past wellness reports by day. The app's mechanisms to provide user feedback are Achievements (Figure 1 – screen 5) and Goals (Figure 1 – screen 6). Achievements show user progress towards earning badges by engaging in healthy behavior (e.g. remembering to exercise). The Goals page allows a user to set and track her wellness goals. Both of these pages may be connected to social media to share progress earning badges and meeting goals.

We conducted a user study as described below to assess the wellness app's set of features and their attractiveness to mHealth users. We recruited a convenience sample of participants for the pilot study from the student population at a public Midwestern University in the United States. Participants had responded to a survey done to assess interest in health and wellness, and were asked to note if they would be interested in participating in a usability test. 12 students agreed to participate in the usability test. It has been shown that as little as 7 users can be sufficient for usability testing (Neilsen and Landauer, 1993). 8 of the respondents were men and 4 were women. All respondents indicated that they were comfortable or very comfortable with technology and frequently or very frequently used mobile devices. The sessions were conducted in a private office environment and they access the wellness app on a tablet.

Users were prompted to perform various tasks utilizing features that: prompted user activity, provided rewards, personalized their experience, tracked activity, and provided positive feedback. Participants were asked to talk through what they saw and what they did, and to make comments as they wished, such as what they liked, if they were confused, etc. Users were guided through each aspect of the app, from account

creation, to logging a daily entry, to viewing the feedback features (the latter required them to log into a previously set-up account with several days data already recorded.)

Users were then prompted for their perception of the app immediately after they concluded their interaction with the app, (On a scale of 1 to 5, where 1 means you strongly disliked this feature and 5 is you strongly liked this feature, what did you think of [feature name]?) They were asked to rate their opinions of the different sections (Setup, Wellness Reports, Achievements, Journal, Analysis, Goals, and the Pillminder) on a 5-point Likert Scale, with 1 representing not easy and/or enjoyable to use and as 5 being easy and/or enjoyable to use. We concluded by asking the users how likely they were to use the app (On a scale of 1 to 5, where 1 is certain you would not and 5 is certain you would, how likely are you to use this app if it were available to you?), and how likely they were to recommend the app (On a scale of 1 to 5, where 1 is certain you would not and 5 is certain you would, how likely are you to recommend this app to a family member, friend, or acquaintance?)

Results

Overall, users stated that the system was intuitive and feedback was positive. One respondent stated "[It is] fairly easy to use. Anybody can use it." The addition of an initial tutorial may be helpful for the latter group, as one such respondent requested the addition of "…a screen for seeing how to get the full use of the app and how to make the most of it."

We investigated the impact perceived ease of use (PEU) and user feature preference (UP) on intention to adopt it. A number of statistically significant correlations were identified, as shown in Table 2. The users first interacted with the Set-Up Wizard, which is a personalization feature and had a positive correlation on PEU (0.357) and UP (0.420). Respondents appreciated the simplicity with which they could tailor the app to their needs. One respondent stated "[It's] easy and a nice set up… straight to the point and not complicated." The users then interacted with the Daily Wellness Report, which is a page with elements that that provides: prompting user activity, tracking features, and positive feedback. The Daily Wellness Report had a positive relationship between PEU (0.360); however, it had a negative relationship with UP (-0.290). Most users gave positive feedback regarding the Daily wellness report. Users found using the non-numeric sliders to be "easier and faster" than other forms of user input and "user friendly". Then they were prompted to make a journal entry, another prompting user activity feature. The Journal had a negative relationship with PEU (-0.405), whereas the Journal had a positive relationship with UP (0.355). The respondents had numerous recommendations for the improvement of this feature, focused on difficulty understanding how to start a journal entry and navigating through the entries. Users then created a personally tailored goal with the goal setting feature, which is feature with elements of personalization, rewards, and positive feedback. The goal setting feature had a positive relationship with both PEU (0.346) and UP (0.561). The respondents indicated that they liked the feature and found it easy to use. Specifically, one user noted he "like (sic) how the goals are set up" and the page was easy to navigate. However, the graph element received mixed results, with some users finding it intuitive while others expressed confusion over how the duration was presented.

The users then were instructed to log into the previously made account, which had been populated with several days of data. The users were first instructed to view the analysis dashboard, which has rewards and positive feedback elements. The analysis component had a positive relationship with UP (0.632*), although it was not statistically significant. Users responded that they found this interesting as it will "show different levels (sic) of your health over time". Multiple respondents commented on how these pages show a lot of information in a way that is easy to understand and navigate through. Another user specifically liked the

speedometer metaphor, but stated they should have had a better description. There was no correlation between the analysis feature and PEU. Users were then prompted to interact with the Pillmidner, which has elements of prompting user activity, personalization, and tracking features. The Pillminder has a positive relationship with UP (0.585). Respondents generally liked this feature and observed it was useful. However, there was some feedback regarding how Pillminder was implemented. Three respondents stated that the user interface did not make it clear enough if a pill was taken. Finally, users navigated to the achievements page, which has elements of rewards and positive feedback. Achievements had little correlation to PEU (0.013) or UP (-0.192). Respondents indicated that this gamification feature would be effective in motivating use and healthy behavior. One respondent stated "It makes me want to win those awards...makes me want to enter in the information." Respondents also described it as being "well organized", "easy to use", "interesting" and "cool". Respondents also reported liking the ability to share on social media. It is possible that the discrepancy between the user ratings and verbal feedback is due to the achievements being shown in the account with prepopulated data as opposed to reflecting the user's own achievements.

Table 2: Pearson correlations between ease of use/user preference on likelihood to adopt. Positive correlations (>0.2) are shaded in green and negative correlations are shaded in orange (<-0.2). All relationships are statistically significant (P=0.05) unless noted by *.

Features	Perceived Ease of Use (PEU)	User Preference (UP)
Set-up Wizard	0.357	0.420
Daily Wellness Report	0.360	-0.290
Journal	-0.405	0.355
Achievements	0.013	-0.192
Pillminder	0.058	0.585
Analysis	-0.158	0.632*
Goals	0.346	0.561

Discussion

Healthy lifestyle choices, or wellness, is important to an individual's physical and mental health. Mobile Health Apps – or mHealth Apps – show promise helping people adhere to healthy lifestyles. In this work, we assess the appropriateness the app in supporting wellness in the real world. We performed a user test and survey to gain insight into users' perceptions of a wellness app with features in the five key categories identified from prior works. Feedback on the app was overall positive. Users found it to be easy to use and comprehensive in terms of features and information that was tracked. When queried about their overall impressions of the system, the feedback was primarily positive and the results support the app as an appropriate tool. Furthermore, this is provides further support for the previously cited works.

Some improvements to the design of the app are suggested by respondent comments. In the Daily Wellness report, respondents were concerned they were unable to input their blood pressure, so in the future it may be advisable to give user the options to hide questions they are unable to answer. Additionally, Achievements had little impact on PEU (0.013) and UP (-0.192). Given that the overall feedback for this feature was positive, it may be that the Achievements may be useful in keeping users engaged in the app but does not motivate them to begin to use it. Future work in this area should assess if this feature is helpful for ongoing user engagement. Additionally, both the Pillminder and Goal Setting features should be refined in future work. In the case of the Pillminder, users indicated that the interface did not make it clear enough if the pill was taken. Goal Setting received mixed feedback, with some users confused about the duration of the goal.

However, when asked about whether or not respondents would personally use the system, users who currently had a health challenge (e.g. "watching health" or arthritis) were more interested in using such an app than those who did not. Although the app is designed for all users, respondents without health concerns did not see as great a value in using it. One respondent stated "[It] seemed like it was more for people with health issues". Two such respondent raised concerns their ability to continue using such an app for an extended period of time. One respondent indicated forgetfulness was a concern, while another said "There are benefits [to using the app], but I'm not sure if I would be committed to use it constantly." The causes for this were not apparent from the study and warrant future investigation.

Additionally, this work focused on a young population for usability testing, with 11 of 12 participants under the age of 30. While there is a dearth of studies on mHealth and young populations (Dennison, Conway & Yardley, 2013), this also represents a limitation as it is unclear how the findings are generalized to older populations. However, this work could be extended by investigating how the needs of older users may be different with an app, such as the work done in (Leung, Mcgrenere, Graf, 2011). Additionally, the app has the limitation of not being integrated with wearable technologies (e.g. FitBit, Garmin) which can impact the PEU of a platform by reducing manual entries of data. We believe a larger scale, long-term study of the wellness app or a similar platform that integrates data from wearables and draws from a more diverse pool of respondents is the next step to advance this line of inquiry.

References

Beldad, A. & Hegner, S. (2017) Expanding the Technology Acceptance Model with the Inclusion of Trust, Social Influence, and Health Valuation to Determine the Predictors of German Users' Willingness to Continue using a Fitness App: A Structural Equation Modeling Approach. *International Journal of Human–Computer Interaction*, DOI: 10.1080/10447318.2017.1403220.

Borrelli, B., Bartlett, Y. K., Tooley, E., Armitage, C. J., & Wearden, A. (2015). Prevalence and frequency of mHealth and eHealth use among US and UK smokers and differences by motivation to quit. *Journal of Medical Internet Research*, 17(7), e4420.

Chiauzzi, E., Brevard, J., Thurn, C., Decembrele, S., & Lord, S. (2008). MyStudentBody–Stress: An online stress management intervention for college students. *Journal of Health Communication*, 13(6), 555-572.

Dennison, L., Morrison, L., Conway, G., & Yardley, L. (2013). Opportunities and challenges for smartphone applications in supporting health behavior change: qualitative study. *Journal of Medical Internet research*, 15(4).

Freyne, J., Brindal, E., Hendrie, G., Berkovsky, S., & Coombe, M. (2012). Mobile applications to support dietary change: highlighting the importance of evaluation context. In *CHI'12 Extended Abstracts on Human Factors in Computing Systems* (pp. 1781-1786).

Freyne, J., Yin, J., Brindal, E., Hendrie, G. A., Berkovsky, S., & Noakes, M. (2017). Push Notifications in Diet Apps: Influencing Engagement Times and Tasks. *International Journal of Human–Computer Interaction*, 33(10), 833-845.

Foster, J., Miller, L., Isbell, S., Shields, T., Worthy, N., & Dunlop, A. L. (2015). mHealth to promote pregnancy and interconception health among African-American women at risk for adverse birth outcomes: a pilot study. *Mhealth*, 1.

Kleinsinger, F. (2018). The unmet challenge of medication nonadherence. *The Permanente Journal*, 22.

Kim, K. H., Kim, K. J., Lee, D. H., & Kim, M. G. (2019). Identification of critical quality dimensions for continuance intention in mHealth services: Case study of onecare service. *International Journal of Information Management*, 46, 187-197.

Joos, O., Silva, R., Amouzou, A., Moulton, L. H., Perin, J., Bryce, J., & Mullany, L. C. (2016). Evaluation of a mHealth data quality intervention to improve documentation of pregnancy outcomes by health surveillance assistants in Malawi: a cluster randomized trial. *PloS one*, 11(1), e0145238.

Lopresti, A. L., Hood, S. D., & Drummond, P. D. (2013). A review of lifestyle factors that contribute to important pathways associated with major depression: diet, sleep and exercise. *Journal of Affective Disorders*, 148(1), 12-27.

Leung, R., McGrenere, J., & Graf, P. (2011). Age-related differences in the initial usability of mobile device icons. *Behaviour & Information Technology*, 30(5), 629-642.

Lin, M., Lane, N. D., Mohammod, M., Yang, X., Lu, H., Cardone, G., ... & Choudhury, T. (2012, October). BeWell+ multi-dimensional wellbeing monitoring with community-guided user feedback and energy optimization. In *Proceedings of the Conference on Wireless* Health (pp. 1-8).

Nielsen, J., & Landauer, T. K. (1993, May). A mathematical model of the finding of usability problems. In Proceedings of the INTERACT'93 and CHI'93 conference on Human factors in computing systems (pp. 206-213).

Nielsen: 46 million people used fitness apps in January. (2014, April 17). Retrieved May 19, 2022, from http://mobihealthnews.com/32183/nielsen-46-million-people-used-fitness-apps-in-january/

Platt, A., Outlay, C., Sarkar, P., & Karnes, S. (2016). Evaluating user needs in wellness apps. *International Journal of Human-Computer Interaction*, 32(2), 119-131.

Robbins, R., Krebs, P., Jagannathan, R., Jean-Louis, G., & Duncan, D. T. (2017). Health App Use Among US Mobile Phone Users: Analysis of Trends by Chronic Disease Status. *JMIR mHealth and uHealth*, 5(12), e197. doi:10.2196/mhealth.7832

St-Onge, M. P., Grandner, M. A., Brown, D., Conroy, M. B., Jean-Louis, G., Coons, M., & Bhatt, D. L. (2016). Sleep duration and quality: impact on lifestyle behaviors and cardiometabolic health: a scientific statement from the American Heart Association. *Circulation*, 134(18), e367-e386.

Wang, W. (2020). The Impact of Mobile Applications on Maternity Education: A Quantitative Study of Kenya. *Issues in Information Systems*, 21(2), 314-320.

Wynn, K., Trudeau, J. D., Taunton, K., Gowans, M., & Scott, I. (2010). Nutrition in primary care: current practices, attitudes, and barriers. *Canadian Family Physician*, 56(3), e109-e116.