Designing a diabetes mobile application with social network support

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Abstract. Although mobile applications and social media have emerged as important facets of the Internet, their role in healthcare is still not well-understood. We present design artefacts, inspired by persuasive technology concepts, from a study of social media as part of a diabetes mHealth application. We used the design science approach for mobile application design, and real-life user testing and focus group meetings to test the application over a 12-week period with 7 participants. Based on the System Usability Score (SUS), the mobile application scored an average of 84.6 (SD=13.2), which represents a fairly high usability score compared to the literature. Regression analysis on the daily blood glucose levels showed significant decreases for some patients, and although the study is not powered, the HbA1c showed a promising trend, and self-efficacy marginally increased. Incorporating persuasive elements such as blood glucose tracking and visualization, and social media access directly from the mobile application produced promising results that warrant a larger study of behaviour change for people with diabetes.

Keywords. Mobile health, Diabetes, social media, persuasion

Introduction

Social media such as Facebook and YouTube have transformed the way people interact in general and on the Internet, but the role social media play in healthcare is still not well-understood. Recently, there has been an exponential growth of interest in diabetes mobile application as documented in a review by Holtz and Lauckner (2012), as well as healthcare social media [1]. Little attention has been paid to the impact these emergent tools have on health outcomes [2] and whether patients are actually persuaded to adopt healthy lifestyles. In this work, we designed a mobile application with social media features and tested the application’s persuasive elements with diabetes patients attending a 12-week group education course.

There seems to be conflicting evidence on the long term benefits of group education for diabetes patients. Many studies have found no significant benefits [3-5] while a review by Deakin et al. [6] reported some benefits. Mobile devices and social media may have a role to play in exploiting the latent benefits of group learning.

Social media hold a potential as a motivational agent for actioning the knowledge people acquire while self-managing their diabetes. Studies have shown that knowledge about a disease does not necessarily translate into action [7]; patients normally require

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further persuasion and re-minders [8]. Another concept that has not been fully explored in the literature is that social media could also be a social platform for fostering better health behaviour based on social comparison theory [9], for example, people comply with certain behaviours as a way of seeking validation or “fitting-in”.

Although there is now a sizable volume of studies on mHealth and social media, the generalizability of much of this research is problematic. First, because these studies have not related the fundamental aspects of the intervention application functions to the outcomes [10] and second, there have been only a few impact studies for specific disease cases. The goals of this paper are threefold - first we: (i) present design artefacts of the mobile application, then (ii) assess application usability and user feedback, and (iii) access the baseline and follow up HbA1c, and self-efficacy.

1. Methods

We used design science approach in developing a mobile phone diary (for the Android operating system) with social features, to track diabetes-related activities such as blood glucose measurements and carbohydrate intake. In addition, we tested the application using focus group meetings with 7 participants attending a 12-week motivation course. The inclusion criteria were people with Type 2 diabetes and over 18 years old. We excluded people with serious comorbidities.

1.1. Mobile Application Design Artefacts

The mobile application comprises an extension of the FewTouch application (FTA), a well-studied mobile application [11], with semi-integrated social forum. Fig.1a shows the blood glucose measuring kit with a Bluetooth module for data communication with the mobile application.

The data in the forum is totally decoupled from the FTA data to enhance security by allowing users to determine the data they want to share with peers on the Internet. It is important to note that the forum connects to a social forum engine in “the cloud”. The main component of the social forum engine is the recommender system responsible for tailoring content for each user.

Figure 1: Overview of the mobile application architecture. First is the blood glucose measuring kit that has an attached Bluetooth module to send readings to the mobile phone as discussed in [12]. Fig. 1b and 1c shows the Android screenshots for FTA’s blood glucose tracking and the personalized social media interface with posts.
Our design of the mobile application is not based on any persuasive technology philosophy such as the Persuasive system Design model (PSD) [13], but is based on experience from previous user studies on similar patient groups. Modern mobile platforms already provide native support for core persuasive design concepts. Table 1 shows some of the persuasive features.

**Table 1**: Some of the persuasive features of the application, based on what is already part of the mobile device, and what needs some effort to design and test.

<table>
<thead>
<tr>
<th>Part of mobile platform</th>
<th>Efforts added</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Convenience</em>; easy to carry everywhere</td>
<td><em>Information quality</em>; we delivered relevant information such as BG values</td>
</tr>
<tr>
<td><em>Attractiveness</em>; most mobile platforms natively support attractive user interfaces and appealing device hardware</td>
<td><em>Social facilitation</em>, <em>social comparison</em>, <em>Normative influence</em>, <em>competition</em>, <em>cooperation</em>; all done through sharing information on the web forum with peers</td>
</tr>
<tr>
<td><em>Trustworthiness</em>; use of sensors minimizes user error and tampering</td>
<td><em>Tailoring</em>, <em>suggestion</em>; through the recommender system</td>
</tr>
<tr>
<td><em>Simplicity</em>; mobile devices have now simple touch-screen interaction and simple device hardware</td>
<td><em>Self-monitoring</em>, <em>surveillance</em>; users self-monitored BG values and they knew their measurements would be reviewed by the researchers.</td>
</tr>
</tbody>
</table>

In addition to the previously tested persuasive elements such as “self-monitoring”, the current iteration embodied social support elements such as “social comparison”. We wanted to examine if participants themselves could carry on without an external force behind conversations.

All the people who filled in the questionnaires had used the diabetes mobile application for at least 12 weeks. We used the System Usability Score (SUS) [14] to assess the usability at the end of the study. The Health Education Impact Questionnaire (HeIQ) and the Diabetes Empowerment Scale-Short Form (DES-SF) were used to assess self-efficacy.

**2. Results**

The focus group had 7 participants between the ages of 46 and 70, with an average age of 62.7 (sd=9.0) and 4 of them had been diagnosed with diabetes more than ten years ago, and four of them reported using the Internet for finding health information.

A shortcut to the application was put on the phone’s home screen for easy access, and the Bluetooth data communication with the blood glucose system was set to work in the background. In the main screen of the application, the users could see their blood glucose values and other recorded parameters (physical activity, food and medication) and were able to switch to the social forum or other features such as the blood glucose graphical plot. Users also received personalized tips and information using email alerts.
The mobile application had a comparatively higher usability score of 84.6, SD=13.2, compared to similar studies in the literature; we aimed at simplicity, which is one of the key pillars of persuasion.

2.1. Analysis of HbA1c and Self-efficacy

The results in Table 2 show that there was a marginal decrease in the average follow-up HbA1c from 6.97% to 6.79%, sd= 0.68%. The decrease may seem insignificant but considering the baseline average HbA1c was below the recommended threshold of 7.0%, these results deserve some attention because many studies have observed improvements only in people with very high A1c values [4]. Additionally, there was an increase of self-efficacy based on the HeiQ and DES-SF (see Table 2). Self-efficacy is an important outcome that facilitates change in health behaviour [15].

Table 2: summary of the health outcomes and self-efficacy results

<table>
<thead>
<tr>
<th>A1c</th>
<th>SUS</th>
<th>HeiQ</th>
<th>DES-SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>6.97, sd=0.69</td>
<td>2.96, sd=0.27</td>
<td>4.14, sd=0.62</td>
</tr>
<tr>
<td>Follow-up</td>
<td>6.79, sd=0.68</td>
<td>84.6, sd=13.2</td>
<td>3.10, sd=0.23</td>
</tr>
</tbody>
</table>

To further reflect on the BG values that resulted in the lowered HbA1c, we used regression analysis on the daily blood glucose levels as shown in Table 3. It is easy to observe that some users have significantly decreased BG values which resulted in reduction in their HbA1c. Further analysis of blood glucose variability and the time of measurement could be done to more clearly understand these outcomes.

Table 3: Blood glucose Kendall’s tau statistic compared with the respective change in baseline and follow-up HbA1c of the participants.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Tau (2-sided p)</th>
<th>Baseline to follow up HbA1c change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Female</td>
<td>-0.156 (0.000)</td>
</tr>
<tr>
<td>2</td>
<td>Female</td>
<td>-0.058 (0.357)</td>
</tr>
<tr>
<td>3</td>
<td>Female</td>
<td>-0.031 (0.676)</td>
</tr>
<tr>
<td>4</td>
<td>Male</td>
<td>-0.077 (0.030)</td>
</tr>
<tr>
<td>5</td>
<td>Female</td>
<td>-0.027 (0.572)</td>
</tr>
<tr>
<td>6</td>
<td>Male</td>
<td>-0.037 (0.342)</td>
</tr>
<tr>
<td>7</td>
<td>Male</td>
<td>-0.146 (0.001)</td>
</tr>
</tbody>
</table>
2.2. Mobile Application and Social Media Usage

Participants measured their BG an average of three times a day, perhaps due to the excitement of self-monitoring, but the recommendation is that people with type diabetes measure their BG once a day. Use of social media was very low, with only three participants initiating conversations, for example sharing recipes for healthy home-made bread and cooking fish.

3. Discussion

The current study is based on two major emerging technologies; smart mobile phones and social media. We tested social media in a closed and controlled environment, and the fact that participants met in person seemed to have helped create meaningful bonds absent in general healthcare social media. Social media holds great promise as a tool in diabetes self-management as shown by recent advances in diabetes mobile applications [16].

From our study, it is not clear what may have had the most impact on the results. Participants seemed to enjoy interaction with peers at every face-to-face meeting, and online social media was only used to coordinate meetings and share recipes. It would seem the participants were mostly motivated by tracking their blood glucose and being able to discuss and share results with peers, and social media only facilitated communication.

Our results are consistent with what has been reported in recent studies such as by Velden [17], who reported low usage of Facebook for managing disease by juveniles. Content analysis of breast cancer groups in Facebook done by Bender [18] showed that although the total membership was more than one million, an overwhelming majority of the groups had under 25 wall-posts, indicating low utilization. Other earlier studies have also shown that mostly the newly diagnosed patients turn to online communities for help, but they remain active for less than a year [19] in some diabetes forums.

Our study is subject to at least two limitations. First, our participants are people that have been recruited using newspaper adverts and direct phone calls based on their membership in the diabetes association. Therefore, it is conceivable that these individuals are more highly motivated to use mHealth technology than the average person with diabetes.

Second, this study was based on a comparatively small sample for studying social media. Although it is difficult to reason about the significance of the health outcomes and self-efficacy with this small sample, our qualitative analysis provides useful feedback.

4. Conclusion

Current results show that social interaction by regular meetings and online interaction can influence self-management outcomes positively. The use of a mobile application contributed to persuading the participants to measure their BG values more frequently, and social networking seemed to have influenced the motivation of just a few of the participants to remain engaged. Summed up, these results provide some evidence that warrants further investigation because larger studies are required before much of the results can be more fully exploited.
Acknowledgements

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References


