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Persuasive Social Support Features in Diabetes Self-Management mHealth Applications

Full Paper

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Abstract

Diabetes self-management is a challenging task and mobile health (mHealth) applications are one of the options that can assist and support the users in that process. The aim of this paper is to identify the social support features presented in these mHealth applications. Ten applications were selected and analysed based on the literature review and search of the phrase 'The Best Diabetes Apps of 2018' with the Google search engine. The results indicated that some social support features have been implemented in these applications however, its presence is sporadical. There is a need for further development of these apps, introducing and utilising features for social support such as social facilitation, cooperation, competition and recognition.

Keywords: diabetes management, mHealth applications, persuasive technology, social support features.

1 INTRODUCTION

The prevalence of diabetes is a major health challenge affecting the world population today. Many factors (family history, limited health awareness, social behaviours, and poor physical exercise habits) have contributed to the prevalence of this chronic disease (Moradi-Lakeh et al. 2016). Diabetes care relies on patient empowerment and self-management. Some health interventions provide information and symptom control, and others attempt to alter behaviour through various social support features which refer to strategies that encourage behavioural change through social influence and persuasion (Win et al. 2016). With the advancement of technology, information technology artifact can be designed to facilitate the self-management of diabetes.

Smartphone features can be beneficial in delivering behavioural interventions as use of technology can assist in the interaction of patients and healthcare providers, supporting their health management and providing better health outcomes (Boschen and Casey 2008; Dennison et al. 2013; Almutairi et al. 2019). Mobile applications offer less expensive solutions that enable information-sharing between users/patients and health specialists or friends (Patrick et al. 2008). mHealth applications have been also identified as an innovative way of influencing positive behavioural changes (Vlahu-Gjorgievska et al. 2018). Additionally, smartphone ability for matching users' geographic location and enhancing social participation, increases the possibility of behaviour-tracking and follow-up in real-time (Dennison et al. 2013).

Persuasive health intervention designs are theoretically developed methods that support the treatment process by promoting behaviour change with socially persuasive strategies. These designs incorporate fun and challenging activities that have a tendency to simplify or encourage certain behaviour, thus motivate patients to perform behaviours that are instrumental in the recovery and treatment process (Oinas-Kukkonen and Harjumaa 2009).

Social support features introduced in the persuasive technology, such as normative influence, social learning, comparison, facilitation, cooperation, competition and recognition, can be considered as approaches that motivate users to pursue a targeted attitude (Matthews et al. 2016). These features provide ways for users to monitor, compare behaviour with, and engage in competition with other users, thus gain perceived empathy and support thru socially driven persuasive health interventions (Orji et al. 2018).

This study will analyse the presence of persuasive social support features in mHealth applications and identify its importance in promoting healthy behaviour. For the purpose of the paper, several mobile applications for diabetes management will be analysed in order to determine the most common social support features implemented within, as well as the support of these features towards behaviour change in people with diabetes.

Next section gives an overview of the persuasive social support features and its importance in behaviour change management. The Methodology section explains the criteria used in the selection of mobile applications, and section Results presents the functionalities and implemented social support features in selected applications. Following section, discuss the findings and advantages of the implemented features, and the final section is the Conclusion.

2 BACKGROUND

The health support provided through mobile applications has significant advantages for people with diabetes (Cafazzo et al. 2012). Self-management can be supported and improved by mHealth applications offering activities such as monitoring of blood glucose, insulin injections, exercise, or diet tracking. The Food and Drug Administration in the United States has already approved the use of some applications as medical devices for managing diabetes, which signifies that mHealth apps are considered as a valid diabetes management tools (Brzan et al. 2016). Therapeutics Good and Administration of Australia also has the guidelines for the mobile applications that meet the definition of a medical device (Therapeutics Good and Administration 2018).

Social support is the psychological uplift of perception that makes a person feel more appreciated in a particular social environment, surrounded by people that can offer aid. Patient support services that are capable of helping patients, accepting and coping from certain medical conditions, vary in form and access across health organizations. Many of it are considered to be a driving factor in the health management process, which shows the significance of social support in a health care environment (Tabong et al. 2018). Information system artifact, that could facilitate social support feature, would assist in patients' health management. Thus, designing such artifact needs to consider how these features would be supported.

Many researchers (Hamari et al. 2014; Oinas-Kukkonen and Harjumaa 2008; Oyibo et al. 2017; Win et al. 2018) acknowledged that persuasive technology has become an essential tool that influences people by stimulating their thoughts and support to take particular actions in behaviour change. Oinas-Kukkonen and Harjumaa (2008) used the idea of an 'effective loop' to demonstrate how persuasive technology systems cause an interaction between body and mind. They described persuasive technology as an information system designed to 'reinforce, change, or shape' the way people think and respond to external influences. Furthermore, Oyibo et al. (2017) indicated that persuasive technology is a tool with social influence, which motivates people toward behaviour change. To present the applicability of persuasive technologies in the health domain, Cafazzo et al. 2012; Cugelman et al. 2011; Iyengar et al. 2017; Orji et al. 2018 highlighted various aspects of how they motivate individuals towards more healthy behaviour such as weight management, reduce drinking, enhance physical activity and poor eating habits. Therefore, the existence of these systems plays a significant role in preventing and mitigating lifestyle-related diseases.

Behaviour modifications taxonomy identified by Michie et al. (2013) included facets such as covert learning, feedback and monitoring, goals and planning, comparison of outcomes among others. Several studies have included these behaviour change techniques such as self-monitoring, reinforcement and social support (Win et al. 2018). The social cognitive theory also explained how control and reinforcement could achieve the targeted behaviour. Reinforcement could be through internal self-initiation and external social support. The elements of **social learning** are based on a social cognitive theory that describes health behaviour as a result of a consistent process of observation, imitation or modelling of other behaviours (Matthews et al. 2016; Orji et al. 2018). These elements can be implemented by allowing users to view and follow activity information for other users with common interests (He et al. 2013) or through user-profiles and message boards where users could upload and share information (Dennison et al. 2013; Matthews et al. 2016). Win et al. (2017) stated that social learning usually happens through the process of interaction with other users in the social network. Social learning is an integral feature of persuasive technology, and mobile applications allow the user to observe other people's behaviours and experience new behaviours. After observation, the user adopts a positive attitude toward the behaviours and is motivated to imitate the actions - motivated to adopt the new healthy behaviour.

While social learning entails observation and imitation of peers' behaviour, **social cooperation** involves doing an activity together (with peers). Individuals with similar objectives engage in an activity, and they all adopt a common attitude toward the anticipated outcome (Orji et al. 2018). For example, participants work together and aim to maximise the outcome of the exercise. In this context, patients and care providers work toward maximising positive outcomes, which results in effective disease management and, therefore, health improvement.

According to Barrera Jr et al. (2006), with **social competition** the user struggles and expends more effort to qualify and fit in a given 'race' and, in order to qualify, the user is forced to adopt certain strategies or behaviours with a motive of realizing a positive outcome. In other words, the environment presents pressure for the competition based on a social class, thus influence the behaviour of a particular group of individuals.

The elements of the **social comparison** feature are based on the comparative theory, in which individual users compare their status with other people within the same social class or similar social environment (Oinas-Kukkonen and Harjumaa 2009). In this regard, the technology allows users to look at the wellbeing of peers living in the same environment and persuade them to adjust their own lifestyles emulating other people's behaviour.

Oyibo et al., (2017) described social influence as a powerful means to cause a change in human behaviour. Other researchers agree that through social influence one can experience growth and change harmful habits. In their researches, they found that persuasive systems use social influence strategies to effect behaviour changes in individuals (Iyengar et al. 2017; Orji et al. 2018). In this context, the application should support the **normative influence** to make users perceive the norms that would lead towards the adoption of a targeted behaviour (Oinas-Kukkonen and Harjumaa 2009).

Social facilitation allows users to encourage and support each other to reach their goals (Gasser et al. 2006; Matthews et al. 2016). According to Stibe and Oinas-Kukkonen (2014), social facilitation theory assumes that the presence of other people creates an atmosphere of assessment, which directly affects human behaviours in social attitudes. People are affected when surrounded or seen by others, so the effects of social facilitation can occur when the presence of others in the same activity is either passive or active.

The idea of 'recognition' as a central principle in human relations has a long philosophical perspective. The act of recognition usually leads to self-awareness and builds self- esteem in users (Houston, 2008). **Recognition** can be expressed in the form of love or care, as a means of granting rights to a person, and by verifying the validity of the achievement by the community of interest. It also leads users to share experiences with others on a social network and can generate public recognition of their problems. Horsch et al. (2012) and Oduor et al. (2014) stated that the principle of recognition in the persuasive systems design (PSD) model indicates that the system can increase the likelihood that users will modify the intended behaviours by receiving an acknowledgement from an individual or group.

The integration of mHealth applications with these persuasive social support features can present opportunities to create communities that can provide dynamic support for people with chronic diseases like diabetes. These apps can as well support health interventions and help users in overcoming the behavioural and social risk factors.

3 METHODOLOGY

To be comprehensive and inclusive of most relevant applications that consist of diabetes social support features, a library database search and the google search for the applications was conducted. Two databases, Google Scholar and Scopus, were searched in order to identify applications for managing diabetes in the literature. The keyword query was: "persuasive" AND "diabetes management" AND ["mHealth" OR "applications"] AND ["social comparison" OR "social learning" OR "social competition" OR "social facilitation" OR "recognition" OR "normative influence" OR "social cooperation"] AND "social support" AND "features". After reading the full-text articles, twelve diabetes apps were selected from the identified articles in this search. Additionally, the phrase 'The Best Diabetes Apps of 2018' was searched with the Google search engine in order to identify the apps that are currently popular on the market. Performed search returned eleven mobile applications.

The inclusion criteria for application selection were: intended for use by diabetes patients, provide support for patients, address issues regarding diabetes management, incorporate some social aspects of diabetes management, free. Thirteen applications that: not utilised diabetes self-management, not include social support aspects for diabetes management or required payment of a fee were excluded.

The applications were reviewed individually to determine their positive and negative attributes, appropriateness for assisting users with diabetes management, and apps' social aspect.

Even though there are a number of diabetes self-management applications available today, only ten applications that met the selection criteria were included for the review. Selected applications have been downloaded and used for further analysis between the period of March and June 2019. All applications were individually assessed and analysed by four researchers. Further discussion regarding the individual findings was performed by all researchers and the conclusions are presented in the next 3 sections.

4 RESULTS

Diabetes self-management promotion and social support were the criteria used in reviewing the freely-available diabetes self-management mobile applications. Two of the applications (Diabetes Tracker and BGMonitor) are for the Android and one app (Glucose Buddy) is for iOS, other seven applications have two versions one for Android and one for the iOS operating system. Five applications (Fooducate, Health2Sync, MyNetDiary, HelpAround, Glucose Buddy) include community support, and seven applications (Health2Sync, Glucosio, Diabetes Tracker, BGMonitor, Diabetes Connect, Glucose Buddy, GlucoLog Lite) support exporting user's data in various formats and sending reports by e-mail within the apps.

Applications Fooducate, MyNetDiary and Glucose Buddy support barcode scanner readings. Some other, like Fooducate, Health2Sync, MyNetDiary, Glucose Buddy and GlucoLog Lite, can be connected with various devices (like glucose meters, blood pressure monitors, weight scales or physical activities trackers) and perform an automatic reading of the measurements.

The purpose of the Fooducate app is to offer nutrition information by supporting barcode scanning for food content information. The app also proposes healthy food alternatives. Fooducate provides virtual tools that enable individuals to track their own levels of calorie consumption and physical activities, as well as to connect to a community of like-minded individuals. This feature allows users to share useful information and answer questions to members seeking help.

Health2Sync app documents weight, blood sugar readings, and other parameters that affect diabetes. It links diabetes users to family members and friends, making them act as the user's motivational glucose

regulator partners. The app allows direct e-mailing of the reports. MyNetDiary analyses food intake and weight management. It includes a community feature that enables users to set and share information from their accounts, or allow read-only diary permissions for care providers, partners and relatives. The MyNetDiary community forum enables users to seek help from registered dietitians. The app includes features like messaging, public groups (compete and win), report-sharing between users and their coaches or dietitians.

HelpAround app links individuals seeking solutions for their self-care-related problems with persons capable of providing help. The app provides space to share knowledge, chat privately, join a public discussion and ask questions, thus encouraging individuals to attain fulfilment. The main aim of the app is to supports its users by receiving emergency notifications and sending notifications to a nearby community capable of offering fast and reliable support or advice in a limited time. HelpAround uses geographic location in order to connect users nearby.

Glucosio app offers visual feedback on the patient's self-management trends with graphs comparing the measures with the target set by the user. It assesses HbA1c, weight, cholesterol, and blood pressure, among other variables. Similarly, Diabetes Tracker documents weight, food intake, exercise, net carbohydrate, HbA1c, cholesterol, and other health-related factors. Glucosio allows users to anonymously share their information with diabetes researchers, and Diabetes Tracker maintains an extensive list of doctors that can be called within the app.

Besides the monitoring features, BGMonitor performs analyses on the entered data and deliver warnings and notifications regarding the low blood glucose levels or insulin overdose. Diabetes Connect and Glucose Buddy document diabetes-related data allowing users to easily track meals, blood sugar, medications, insulin injections, and other data. Glucose Buddy additionally offers information regarding the foods and their impact on blood glucose, as well as community support.

Glucolog Lite app simplifies monitoring by supporting direct connection with the GlucoMen meter. The monitoring results are presented with graphs clearly indicating the out-of-range measurements. Exporting the user data into a printable report is as well supported in this app.

Applications' functions were further evaluated based on the social support features: Social Learning, Social Comparison, Normative Influence, Social Facilitation, Cooperation, Competition, and Recognition, as well as Learning through monitoring as a foundation for diabetes self-management and development/support of some social features. The results are shown in Table 1.

			Persuasive Social Support Features							
Application Name	**Functionalities**	**Platform**	**Learning thru monitoring**	**Social Learning**	**Social Comparison**	**Normative**	**Social Facilitation**	**Cooperation**	**Competition**	**Recognition**
	Number of app where the feature is included		9	1	1	8	4	3	1	0
Fooducate (https://www.fooducate.com)	-scans and grades foods based on their ingredients -provides recommendations for healthy alternatives -track calories, macros, and workouts -include a supportive community	iOS Android	✓			✓		✓		
Health2Sync (https://www.health2sync.com)	-tracks user's blood sugar, blood pressure, weight, A1c -quick analysis of the user's recent blood sugar history in table and graph formats -option for inviting partners (to review blood sugar changes or provide encouragements) -export of app data as a PDF or Excel file (e-mailing directly from the app) -personalized reminders and tips	iOS Android	✓			✓	✓			

Application Name	Functionalities	Platform	Persuasive Social Support Features						
			Learning thru monitoring	Social Learning	Social Comparison	Normative	Social Facilitation	Cooperation	Competition	Recognition
	-diary									
MyNetDiary (https://www.mynetdiary.com)	-tracks blood glucose, A1c, net carbs, carb count, insulin intake -calorie counter (including barcode scanner and food ratings), food catalogue, food diary -exercise tracker -reminders - notifications to log meals, enter weightings, sleep, and blood pressure -MyNetDiary members community - collaboration, seeking advice, sharing experiences -blog, library (healthy recipes, delicious meals, and dieting techniques), readings by registered dietitians about the latest diet science	iOS Android	✓	✓	✓	✓	✓	✓	✓	
HelpAround (https://helparound.co)	-info and resources about user condition -get help from people nearby -community - support from other members -private messages - chat one-on-one	iOS Android					✓			
Glucosio (https://apkily.com/glucosio)	-track blood glucose, HbA1c, cholesterol, blood pressure, ketones, body weight -estimated HbA1c and HbA1c conversion calculator -option to choose glucose target -general tips and reminders -daily, weekly and monthly graphs and analysis -option to share anonymously user's health information with diabetes researchers	Android iOS	✓			✓				
Diabetes Tracker (https://play.google.com/store/apps/details?id=migi.app.diabetes&hl=en_AU)	-track glucose levels, insulin intake, blood pressure, medications, doctor appointments, exercises, food intake -document important reports -present detailed or average readings in a list view or graphs -maintain an extensive list of doctors and allows calling them from within the app -reminders (for checking glucose, take medicine or doctor appointment) -document user's expenses	Android	✓							
BGMonitor (https://www.bg-monitor.com)	-track blood glucose, food, insulin, exercise -automatically calculate the insulin based on the user's entered blood glucose and food intake -perform analyses on the entered data and deliver notifications, comprehensive statistics and graphs -allows instant sharing of the reports with user's doctor	Android	✓			✓	✓			

Application Name	Functionalities	Platform	Persuasive Social Support Features						
			Learning thru monitoring	Social Learning	Social Comparison	Normative	Social Facilitation	Cooperation	Competition	Recognition
Diabetes Connect (http://www.diabetesconnect.de/en)	-track blood sugar, meals, bolus insulin, basal insulin, correction insulin, basal rates, temporary basal rate changes, exercises, medications, blood pressure, pulse, moods and notes -perform graphical analysis of blood glucose and meal data -export data in various export formats (PDF, CSV) -evaluate and display medically important statistics	iOS Android	✓			✓				
Glucose Buddy (https://www.glucosebuddy.com)	-track blood glucose, medications, meals, insulin, weight, blood pressure, A1c, steps, walks, and other cardio activities -Meal IQ - help the user to make better food choices and better understand how the food impacts the user's blood sugar -report changes in user blood sugar and carb intake on an hourly basis -export user data into printable PDF and CSV files -community support	iOS	✓			✓		✓		
GlucoLog Lite (https://www.glucomen.co.uk/blood-glucose-monitoring-software-and-app)	-track glucose and ketones -results and trends are organized and displayed in a graphic format where any out-of-range results (hyper or hypoglycaemia) are shown in different colours -export user data into printable PDF and CSV files and allows e-mailing it to healthcare professionals	iOS Android	✓			✓				

Table 1. Social support features observed in the evaluated mobile applications

The aim of the reviewed applications is diabetes management and 9 out of 10 apps include features for monitoring and tracking of blood sugar, blood pressure, food intake/calories, medications, insulin intake, and/or exercise plans. By implementing these features the applications support learning through monitoring. Furthermore, some of the applications (Health2Sync, MyNetDiary, Glucosio, BGMonitor, Diabetes Connect and GlucoLog Lite) use different colours or graphs to present the reference level or target range and how user's measures differentiate from it, thus support the normative influence. The normative influence feature is also supported by the use of recipes/meals (Fooducate, MyNetDiary, Glucose Buddy) or evaluations and warnings (BGMonitor, Diabetes Connect).

Social Facilitation is present in four apps (Health2Sync, MyHealthDiary, HelpAround, BGMonitor) and Cooperation is supported in three applications (Fooducate, MyNetDiary, Glucose Buddy). These features are mostly implemented by encouraging messages, recommendations or tips, and facilitating community discussions.

Only one application (MyNetDiary) supports Social Learning and Social Comparison by enabling the sharing of diet progress reports between users. This application also supports Competition feature by allowing users to create groups and compete in achieving desired goals. The Recognition feature is not implemented in any of the reviewed applications.

5 DISCUSSION

This study presents the social support features introduced in currently available mHealth applications. It can be seen that technology-based solutions have several features that could influence positive behaviour change. These apps include various diabetes management features like health parameters and calorie monitoring (through charts and graphs), recipes, food nutritional options, exercise plans and various helpful recommendations and tips. Thus, these applications support the use context of diabetes through the content available. On the other hand, social support features like Social Learning, Social Comparison, Normative Influence, Social Facilitation, Cooperation, Competition, and Recognition can be very helpful in enhancing behaviour change. These features are necessary for gaining perceived empathy and patient support, and they are extensively highlighted by researchers in many studies (Gasser et al., 2006; He et al., 2013; Oduor et al., 2014; Orji et al., 2018).

Blood glucose tracking is a common feature among diabetes applications. In addition, some applications are capable of recommending insulin dosages based on glucose levels and estimated carbohydrate intake. The use of mHealth applications can improve self-management of diabetes in terms of improvements in diet, oral medication compliance, and other risk factors. But, even though many people have an interest in using a mobile app to manage diabetes, not many of them take the next step to actually utilise these applications.

Based on the application analysis few observations can be noted. While the Health2Sync app has both medical and social support features, HelpAround is an application with a distinctive 'connection' feature whose main aim is to connect users with physicians, peers, friends, and other people who are capable of offering fast and reliable support to users without having to seek formal medical care. The application tends to lean more on social support features than medical and diabetes management features. On the other hand, MyNetDiary and Fooducate support diabetes management thru introducing healthy eating habits. Similar functionality "MealIQ" is introduced in Glucose Buddy. MyNetDiary also includes strong community offering with various social support features, while one of the advantages of BGMonitor is the delivering of warnings for low blood glucose and insulin overdose.

All applications support learning thru monitoring (users can observe their own readings and performance), but only one app (MyNetDiary) has expanded this feature and supports social learning. Social learning is the performance of health behaviours as a consequence of constant observation of other users' readings. So, allowing users to share their readings and performance within the app community can enhance user's personal capability of behaviour change. These insights in other users' behaviour can as well influence the social comparison, thus persuade the individuals to demonstrate healthy lifestyles. Not many applications implement Cooperation or Competition. These features can have a great impact on the user's reinforcement in adopting healthier behaviour. Engaging the individuals with similar objectives in collaborative or competitive activities can lead towards the adoption of a common attitude aiming to maximize anticipated outcome. These features can as well influence user's self-efficacy and strengthen its confidence in managing diabetes.

Another important observation is the Social Facilitation. The effects of social facilitation occur in the presence of others, either passively or actively participating in the same activity. People are affected when surrounded or seen by others; with these apps, users can recognise peers that are using the system with them. Only four of the analysed application include some kind of social facilitation (thru encouragement and support), and none of the apps supports recognition. Recognition as an approach that allows users to be recognized for their successes, can be very helpful for the users' self-awareness and self-esteem. Furthermore, recognition in combination with social facilitation will ease user's struggles and strengthen user's efforts of adoption strategies for behaviour change.

Some of the applications have introduced creating and sending the reports of the monitored health parameters within the app. This is a good start and facilitation of the future cooperation between the users and their health provider, but this feature can be as well further advanced.

6 CONCLUSION

People with diabetes require attention, motivation and support. Another aspect of the self-management and control of diabetes is a change of behaviour. Social support strategies in persuasive systems are designed to stimulate users by taking advantage of social impact, thus implementing social support features will help users to adjust changes and work towards self-care, healthy eating habits and regular physical activities. By introducing persuasive social support features, mHealth applications can support the required behaviour changes and present opportunities for people with diabetes to find similar users and communities that can provide dynamic support.

Based on the analysis conducted, all applications (except one) include different types of monitoring tools, half of the analysed applications implement community support, and only few apps have introduced two or more persuasive social support features. These results show that integration of persuasive social support feature in the mHealth applications for diabetes is still in its infancy and there is a need for further development of these apps by implementing and replenishing features for social support that would be significantly beneficial for the users.

The greatest benefit of these features is the influence towards users' self-efficacy, self-esteem, self-awareness and encouragement in embracing behaviour change that supports the improvement of users' wellbeing. So, there is a need not only to employ social support features but as well to introduce a level of personalisation by implementing social facilitation and recognition. Furthermore, implementing the cooperation and competition features can be a good way to enhance the users' support and create a strong relationship between the community members. Another aspect for further development of the apps' features can be the integration of the cultural context into the social strategies implemented in the applications.

The study analysed the social support features present in apps through the app evaluation. Further analysis is needed to understand the theoretical models and frameworks of how these applications were implemented and the effectiveness of these features. Understanding the technology-based artifacts and the people based artifacts would provide a better understanding of the role of information system in diabetes self-management.

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