Asthma management Application for Consumers: Nudging as a feature

Nawaf Almutairi, Elena Vlahu- Gjorgievska, Khin Than Win
University of Wollongong
Australia
Win@uow.edu.au

Abstract. Asthma is a serious global health problem and can be seen in all age groups and a number of asthma management applications have been created aiming to increase self-management. The aim of this paper is to identify nudging strategy for the asthma management application based on the context awareness. Nudging feature is proposed to increase the self-management, patient engagement, and symptoms control. The final proposed application was implemented from a theoretical perspective.

Keywords: Nudging, Persuasive technology, Asthma management, Asthma management application, self-management.

1 Introduction

Globally, there is a rise in mobile health applications and gadgets related to health behaviour. The usage of this novel technology has increased the effectiveness of interactions between patients with chronic health conditions and their health-care providers and assisting patients towards their health behaviour change perspectives. Studies reported how health behaviour change can support in self-management and health outcome [1]. Technology has assisted patients in communicating the internal drivers such as motivation, understanding of the illness and self-efficacy. Additionally, mobile health applications support external drivers such as sickness information, social networking and end-user compatibility, helping the facilitation of behavioural change [2].

In this context, mobile health applications can support self-management, increase patient engagement and support patient's symptoms control. Self-management goals are important in raising the quality of life for patients, their families and the society in general, as well as in minimizing or averting emergency visits to healthcare centers and hospitals.

Asthma is a serious global health problem and can be seen in all age groups. It is a chronic airway disorder, that varies from simple discomfort to fatal conditions when it is uncontrolled [3]. In Australia, 1 in 9 Australians (around 2 million people) reported having asthma in 2014 and 2015. Australian recorded figures in 2015 indicate that 421 people died from asthma[4].

To reach a targeted health behaviour, a person must be motivated and have the ability as well as the presence of an effective trigger [5]. The aim of this research is to develop a model for asthma management application. The proposed model is based on the four self-regulation components and incorporates the nudging strategy which will promote long term behaviour change. The features integrated in the application can be very beneficial for patients' self-management, engagement and symptoms control.

2   Background

2.1   Theoretical background

Asthma self-management indicates the health maintenance that patients can engage in to control their asthma, minimize the symptoms and effects of their sequelae [6]. Self-management behaviour includes three aspects: self-observation, self-judgment, and self-reaction. The self-observation consists of monitoring symptoms. The self-judgment involves evaluating condition severity based on the information collected during the process of the self-observation, and self-reaction entails how an individual responds to the self-observation and self-judgments [6]. Research by [7] has stated that when asthma patients are well engaged in their care process and follow an action plan, there are fewer occurrences of an asthma attack and decreased need for asthma medicine.

Self-Regulation Theory (SRT) outlines the process and components involved in self-regulation, where self-regulation can be described as the capacity of humans to change their behaviour by making "good" choices. There are four components of self-regulation process: standards, monitoring, willpower and motivation [8]. Standards refer to goals that we want to achieve through the process of monitoring and evaluating the progress. In this process of creating positive behaviour, the individual must find power and strength to overcome the distractions and have the motivation to achieve the desired behaviour. Applying a self-regulation approach to health behaviour should result in a better understanding of long-term health goals and health promotions [8, 9].

Nudging is a strategic approach used to produce a positive influence on changing human behaviour [10]. [11] define nudging as "the careful design of users' choice environments in order to steer their behaviour in desired directions". The changes in human's behaviour are influenced by designing the environment with limited choices. In this context, nudges are not only messages but aims, such as motivating a user to engage and continue with daily activities and not giving up [12].

The aim of nudging is to influence choices subtly without the use of regulation but as an alternative to restrictions and incentives. It helps people in making decisions and promoting them to choose in their wider self-interest. Although, the intentional alteration of choices presented to people that aims to make them choose in the predicted way stirred a debate about paternalism and manipulation [13].

Nudging can be used to improve people's health and well-being [14]. Nudging strategies include incentivizing/disincentivizing, default rules, framing, and priming.

Incentivizing/ disincentivizing initiate the strategy to be self-explanatory. The default rules are preset plans based on the idea that people tend to lean towards previously defined options. Framing is the applied style of displaying information about potential options. It is indicating that behaviour can be affected (i.e. changed) by presenting information with a straightforward focus on the "normal choice". While priming is making some little changes in the environment or presenting simple hints by raising the visibility and salience of certain things and choices that influence a person's unconscious behaviour [10].

The way that the options and choices are presented to people can influence the way they made decisions. Even though the decision-making can be easier when some suitable options are available, making decisions can become harmful when there are many options. A study by [15] found that there was increasing participation in cancer screening programs for a group of low-income, minority, and uninsured Americans because they received telephone reminders. In contrast, [16] indicated that physicians faced with too many options were more likely to make a non-optimal decision.

In the proposed model, four components of the Self-Regulation Theory (standards, monitoring, willpower and motivation) in combination with the nudging strategy are applied, by limiting the options the users can be steered in a certain direction that supports; self-management, patient engagement and increase patient's symptoms control.

Nudging can be considered in the larger context of the behaviour change support systems (BCSS) for healthy behaviour utilizing mobile technology as introduced and defined by [17]. The way that the options and choices were presented to people influenced the way they made decisions. Decision-making is noted to be easier when some suitable options are available. However, making decisions can become harmful when there are many options.

2.2   Applications for Asthma Management

There is an advantage of mobile applications over other technological interventions because people carry their smartphones all the time [18] and most applications do not require purchasing another device or gadget. According to the study conducted by [19], 74% of the participants were pleased with the usability of technology and specified that mobile technology assisted in reducing their symptoms. Also, a lot of users prefer features like reminders, tracking, emergency support, expert access, information, feedback, recommendations, social engagement [20, 21].

Using asthma applications that offer features like disease and prevention related information, gives an opportunity to reach a large number of asthma patients. These applications can improve health outcomes and lead to better overall asthma self-management [22].

[23], state that multifunctional mobile health applications have good prospects in asthma control and in improving the quality of life of patients compared with traditional interventions. But, even though most of the evaluated asthma applications had the functionality of recording patients' data and utilize more than one functionality,

the researchers concluded there were no applications that provided reliable and comprehensive conditions for self-management.

For a health application to be successfully adopted and continuously used, it has to be functional or usable by users as part of their daily routine or concerning a particular behaviour or activity that they wish to alter. For example, [22] present an application that supports asthma medication reminders and other self-management features easily applicable to daily life routine.

The analyses of 147 asthma apps [24] showed that the number of asthma apps has increased between 2011 and 2013 to more than double, but there was no significant difference in providing information content and self-management details. Eight out of 147 analyzed apps were for adolescents and children, and four of it had self-management features, such as peak flows, triggers, chart symptoms and document, and only two apps included reminder features to help young people comply to their medication.

The results of [25] study show that 52% of the reviewed asthma apps provided health education to patients, 22% helped with symptom and medication tracking and 18% were medical providers directed applications. Analyzing the five top rated and five lowly rated asthma apps [26] found that 70% of features were common among all applications.

Asthma self-management involves the daily activities that patients can engage in for asthma control, minimizing its symptoms and effects on their physical health with their psychosocial sequelae [6]. It was noted that when asthma patients are involved in their self-care and follow the asthma action plan, the number of asthma attacks become lesser [7]. [22] conducted interviews with adolescents and found out that adolescents prefer to have customization of asthma management applications.

3 Model for Asthma Application Implementing Nudging Feature

Asthma affects the quality of life in various domains. Uncontrolled asthma causes the inability for people to engage in daily activities. One of the ways to overcome it is by practising self-management, including avoiding triggers, medication adherence, emergency plan, symptoms monitoring, and regular follow up with their respective health care providers [27]. Unfortunately, a lot of patients do not self-manage their condition properly. For example, medication adherence in young people is between 50% and 70% [28].

Young people with asthma need to be directed in a better way without forbidding any options. Thus, applying nudging features can be a good asset for asthma management applications. It will help the users to be more in control, engaged in daily activities, as well as increasing the quality of life. Also, hints or restrictions in the information environment can impact decision processes in either deleterious or facilitative ways [29].

Nudging as a feature can be provided by combining reminders and suggestion, and utilizing tools to promote changes in people behaviour. It can be complemented by

context-awareness and BLE Beacon tool, that used to ensure and support the application of nudging strategies. In the presented model we utilize nudging as a feature to motivate users and guide them towards better decisions.

The context-awareness is the capability of smartphones to recognize the environment that surrounds, collect data, and presenting information to the end user based on the user's situation and location [30]. The context-awareness can provide suggestions in order to increase self-management and symptoms control. In the presented model, to avoid the trigger the user will need to know if there is a severe weather condition, a strong wind, or the high percentage of air pollution. This information can be presented to the user as weather and air pollution notifications.

The Bluetooth Low Energy (BLE) beacons tool supports the reminder principle. People with asthma always need to have their reliever medication. The BLE tool can help users by sending reminders when their reliever medication is not with them.

Figure 1 presented nudging feature combines a decision tree method and an if-then rule focused on guiding users with asthma.
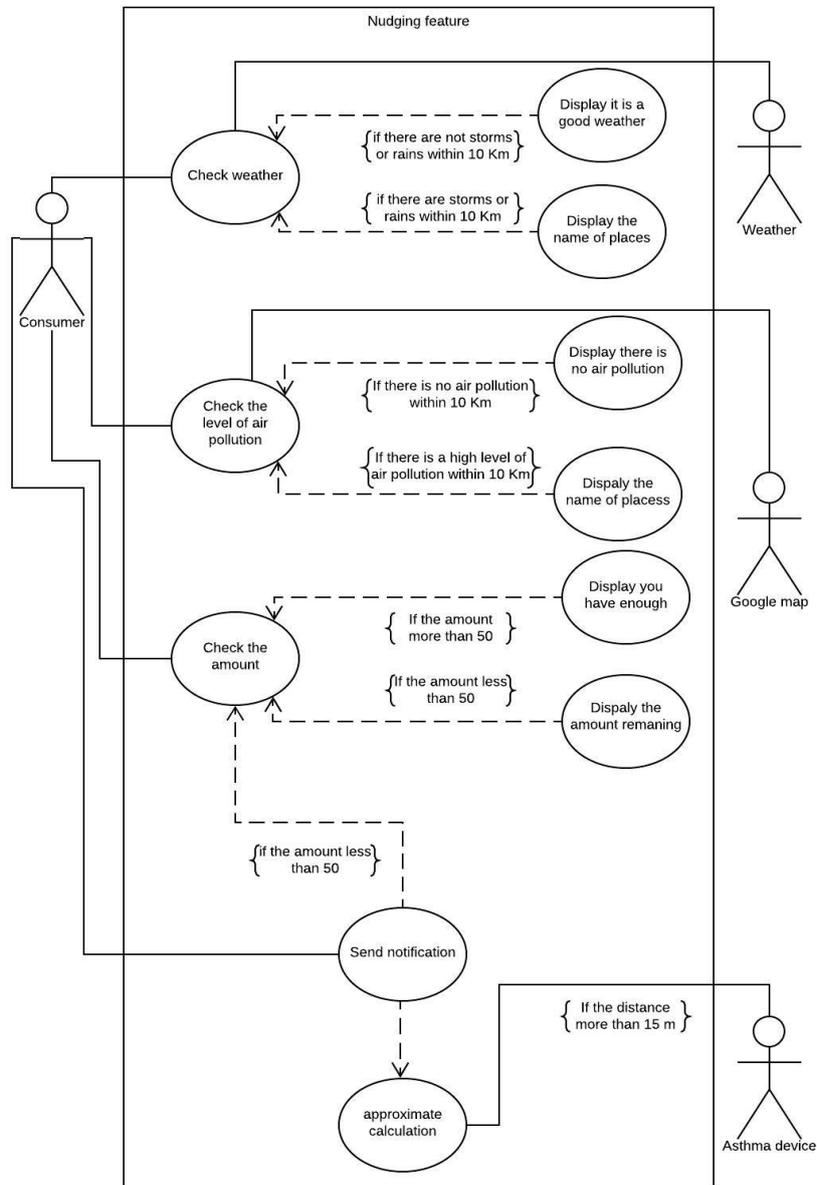
The application is connected with two servers, weather server and Google map, thus collects two types of data. Based on the weather data, the app displays a notification if there are any storms, rain, or extreme weather conditions (within a radius of 10 km) that could affect the user's asthma condition. If the weather is good, the application will simply display "It is good weather today". Based on the Google

map data, the app displays notification regarding the air pollution within the radius of 10 km. The notification includes all the places that are having high levels of air pollution or "There is no air pollution". Additionally, the presented nudging feature provides a "reminder" activated in two steps. The user can check the number of doses left in the asthma device and if the amount is more than 50, the screen displays "You have enough". If the amount is less than 50, the display shows the remaining amount. Also, if the asthma device reaches less than 55 doses, the application will send a notification as a reminder to the user "Reminder: you have 50 doses left". To calculate the distance a small chip called a *Beacon* should be implanted into the asthma device. This chip can be used by the app for calculation how far or near from the asthma device the user is, allowing different events to be triggered based on whether user's smartphone is within 5, 25 or 100 meters of the beacon. If the user wants to leave the house or leave the car and he/she forgets the device within 15 meters, the application will send a notification "Reminder: you are getting away from your asthma device".

The proposed nudging feature can also provide self-management like a reminder for the user on how many doses of the inhaler are left. This not only reminds the user that the medication is going to run out but also suggesting that the user should buy a new inhaler medication. From education and training point of view, nudging can clearly fit into the nature of medical practice to "steer" or "direct" the user toward maximization of user's well-being. The proposed model allows users to make choices for the avoidance of allergen or the precipitating factors of asthma.

4   Discussion

Having appropriate data for managing asthma is important for asthma sufferers. The proposed model provided necessary information such as; weather information and air quality to avoid asthma trigger, reminding them to keep their medication with them in case there is a need. With the advancement of technology and the availability of smart devices, many applications have been developed for consumers. Asthma management applications have been available in Android and iOS operating systems. The proposed model filled the gap that is needed in asthma management as it could assist users possible to make an informed decision to avoid the asthma trigger. Thus, nudging features provided in this model do not act in a negative way of any ethical grounds such as ethical, societal or cultural. The features supported the four components of self- regulation strategy by monitoring the environmental condition, reminding and suggesting regarding the asthma inhaler.

The behaviour change support provided in this model would provide effective communication to the user as it will provide context-aware information and reminding them regarding their asthma management. Having inhaler available when it is required will ensure compliance of the medication use. Thus, this model provides necessary information for asthma management and reinforce and maintain the behavior through nudging.

A nudging feature for asthma management applications was proposed in this paper by combining reminders, suggestions, self-monitoring and tailoring. The provided

model illustrates how the nudging feature can work within an asthma management application and asthma device. Thus, it can be seen that maintaining the asthma management goal can be attained by monitoring, tailoring, reminder and suggestion of Persuasive systems design features. Thus, providing information/data such as weather, air quality, inhaler status in addition to other asthma education information and action plan are required for asthma self-management. This would also promote patient engagement towards their disease management, empowering them and promoting behaviour change.

5 Conclusion

The nudging approach provided for asthma self-management is novel and will alter people's behaviour by prompting towards the right choices. The approach provided context aware information that will promote sustained behaviour change.

This paper will help researchers and software developers to improve asthma management applications by adding nudging features that will increase user's self-management, engagement and symptoms control. The next step in this research will be developing an application that will allow testing and monitoring of the proposed design. The results should ensure safety, effectiveness, and sustainability over time of the proposed nudging feature.

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