Development of a Digital Health Application Prototype among Adult Asthma Patients

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─────── **ABSTRACT** ───────

Asthma is a chronic respiratory disease affecting more than 334 million people of all age groups globally. Although there are innumerable evidence-based guidelines and effective treatments for this disease, many patients with asthma still have uncontrolled symptoms. The effective control measures of chronic diseases primarily depend on the proper patient care in collaboration with healthcare providers. Currently, healthcare facilities are using the manual asthma action plan to customise each asthmatic patient to understand and manage asthma safely on their own. Thus, this article introduces a preliminary study of a digital health application prototype design based on the asthma action plan among adult asthma patients. The findings regarding the accessibility of this prototype among asthma patients will give a promising alternative tool to empower asthma patients to manage their asthma safely.

Keywords: *Mobile health device, Asthma management, Self-care education, Prototype development, Health technology innovation*

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INTRODUCTION

Asthma is a chronic respiratory disease affecting a large population worldwide. The global prevalence of clinical asthma was 4.5% in 2002 (1). The prevalence of clinical asthma varies from 1.0% in Vietnam to 21.5% in Australia (2). According to the National Health and Morbidity Survey conducted in 2006, the prevalence of asthma in adults (18 years and above) was 4.5% in Malaysia (3). Of this, the follow-up rate in clinics and hospitals was only 32.6% (2). Asthma is a chronic disease that affects more than 334 million people irrespective of age and gender estimating the number of patients will increase by 100 million more by 2025 globally (4).

Despite many evidence-based guidelines and effective treatments, asthma symptoms remain uncontrolled in many patients. The successful control of chronic diseases mainly depends on patient's understanding and management their disease conditions with the help of healthcare providers (5). Over the last three decades, important improvements have been made in adherence to treatment in asthmatic patients with the help of the internet and other electronic modalities. Studies found that the key components to improve asthma outcomes with the help of mobile devices are: the provision of information and self-care education, self-monitoring, creation of asthma action plans, feedback from devices, sending alerts and messages to patients, and making the device accessible for daily use (6).

Multiple strategies or healthcare measures have been developed and implemented to combat asthma management. One strategy to approach asthma management is engaging allied and healthcare professionals to create awareness through patient empowerment. Currently health professionals are applying the hardcopy of clinical practice guidelines to share the information and knowledge with patients. Patients with asthma may not always adhere to their asthma medication plans, with non-concordance estimates ranging between 30% and 70% (7, 8). Self-management of disease plays a role in overall disease management and prognosis because patients have an ownership and responsibility for their health and wellness. All this information that patients provide, helps a more accurate health information data thus empowering patients to take charge of their own disease management (9). Hence, a digital health application that is evidence-based has the opportunity to be the tool for patient self-empowerment. The US Food and Drug Administration recognises the utility of digital health tools, including application and clinical decision support software, for health improvement (6).

Mobile health and web applications (apps), and various other monitoring devices have a crucial potential to improve the management of asthma. More than 500 asthma-related apps, alone or paired with sensors on inhalers, are used for health education, symptom recording, tracking of inhaler use, displaying environmental alerts, and providing medication reminders (10). The ability to recall trigger symptoms, and inhaler usage data of these tools detect significant changes over time to alarm patients and their caregivers about the worsening symptoms (6). Mobile applications are one of the convenient tools applied as an option for disease self-management (11). This application can support self-management by providing evidence-based information and educational support, improving medication

concordance and symptom monitoring of their disease (12, 13). Researchers found that some asthma applications had improved the quality of asthma self-management (14). Couture et al. (15) reviewed an implementation of mHealth, namely a web-based multi-dimensional education, monitoring, and communication, that has helped improve asthma knowledge. Therefore, the present is undertaken to develop, prepare, and test a digital health application for asthma patient management.

METHODS

This manuscript is a description of the development of a digital health application prototype basing on an asthma action plan. There is groundwork preparation in developing prototype builders of the digital health asthma application. This process includes coding the paper-based version of the written asthma action plan and converting it to a digital health application for adult asthma patients. This prototype applies the knowledge-based system as its principal system. This unique system integrates the knowledge based on a written asthma action plan to support individual adult asthma patients in making an objective decision on their individual asthma control status. The information that is available in the written action plan is applied and structured to assist adult asthma patients in this decision-making after they have provided the system with a group of symptoms. It would enable the system to generate a conclusion about their current asthma control status. The structured information is coded into a prototype that enables the adult asthma patient who's using this health application to generate a conclusion and a summary of the patient's asthma control within a period of time. The web-based health asthma application is built using the Personal Home Page (PHP) language. The flowchart of the application is shown in Figure 1.
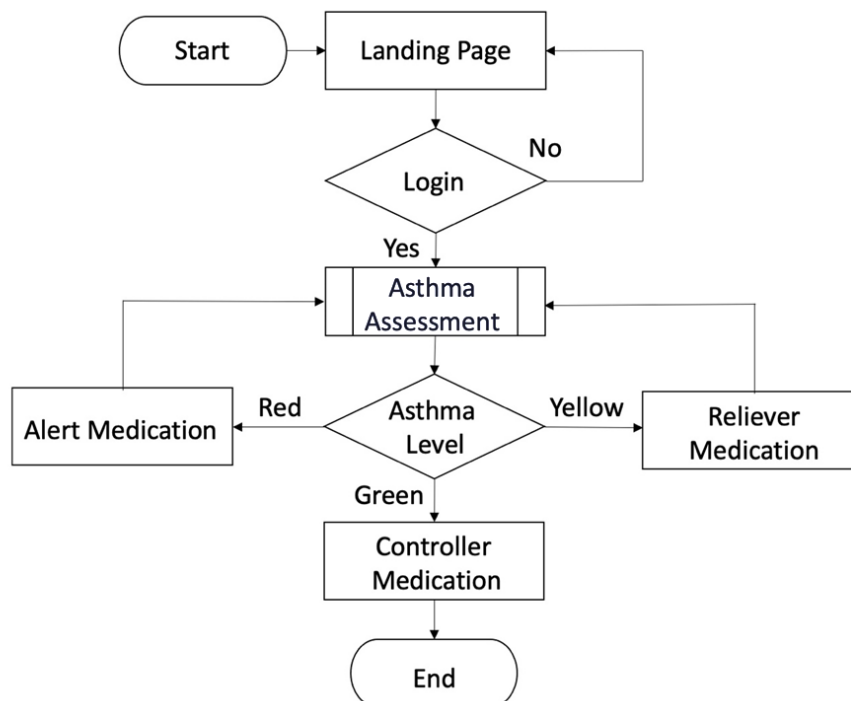
Figure 1: The flowchart of the prototype health application.

On the landing page, there is a login button. Users must enter a username and password. For those who have not registered, they must register before login. The next page is the asthma assessment. Users are required to answer all the questions. The questions were derived from the paper-based written asthma action plan (Figure 2). Upon submission of the assessment, the asthma level will be given based on the colour coding and its explanation. The green indicates the user is doing well; the yellow notifies the user is getting worse. The red, is an alert notification that the user must get immediate medication.

Figure 2: The written asthma action plan (2).

The completed web-based asthma heath application will be given to adult asthma patients for their usage. A link will be given to the respondents in our study. The web-based health application will be able to give a conclusion on their asthma control, whether it is good control, partially controlled, or poorly controlled. After respondents have been able to receive the conclusion of their asthma control, they will be given the usability questionnaire for them to determine whether the web-based health application is feasible and reliable for them. The web-based health application will also be given to the healthcare professionals for usage, and they also get their response on the usability of the web-based health application.

RESULTS AND DISCUSSION

A knowledge-based system (KBS) applies intelligent reasoning to a domain that aims to solve a problem that requires considerable time, effort and expertise. To achieve this, a KBS typically requires significant domain knowledge and an intelligent reasoning module (16, 17). KBS can save money by leveraging experts, allowing users to function at a higher level, and promoting consistency. One may consider the KBS as a productive tool, having knowledge of more than one expert for a long period of time. In fact, a KBS is a computer-based system that uses and generates knowledge from data, information and knowledge (16). The development of KBS is a success with this prototype. After the completion of the system, researchers tested the system, and it was found to be stable. The data is said to be stable as the PHP uses a calculation algorithm to conclude the asthma control status based on the symptoms data entered into the system. Multiple data of different varieties of symptoms have been tested, giving the correct outcome of asthma control status for each individual patient. Data collection is sustained using a paid web hosting site. All the data that are being

stored are only accessible to researchers in this project. The usage of a unique password ensures confidentiality of the data for future use of this newly developed prototype. This prototype is part of a larger study aimed at testing the usability of a digital health application for adult asthma patients.

Berners-Lee and Hendler and Berners-Lee et al. (18, 19) have envisioned the semantic web as a platform friendly to both humans and machines, where natural language text conveys knowledge to humans, and corresponding ontologies provide a form of easily accessible knowledge to machines. This structure potentially provides an abundant ontology that can be exploited in the development of KBSs.

Currently, multiple strategies or healthcare measures have been developed and implemented to combat chronic disease management especially with asthma management. However, there is still a need for improvement in the health of adult asthma patients. This newly developed web-based health application is hoped to achieve better health outcomes. The additional benefit of this prototype is that it can give a general overview of the understanding of asthma disease by embedding in the system the medical-based knowledge of patients. The information that is provided in the health application includes asthma symptoms in a diagrammatic form, effective asthma treatment options, risk factors and potential triggers for asthma, and different forms of diagnostic strategies for asthma. All the general knowledge for the usage of asthma patients will be evidence-based information from the updated local clinical practice guidelines and other recognised references that will be updated from time to time. Common Knowledge Acquisition and Documentation Structuring (KADS) is the result of a major European project, which focused on developing a complete KBS development methodology, encompassing project management, organisation analysis, and knowledge and software engineering followed in this prototype (20).

This prototype will not only benefit the individual asthma patient health empowerment, but it will also provide more objective data for patient's follow-up. Using this health application, its mobility enables the data to be shared with any doctors attending these patients during their follow-up. It is hoped that consultation time will be reduced through the application of this health prototype during their daily clinical practice.

CONCLUSION

The study presents the health application prototype among adult asthma patients. Currently, despite multiple strategies or healthcare measures that have been implemented, it is hoped with this newly developed web-based health application, the optimisation of adult asthma control will be achieved. This will further ease the burden of the healthcare workers in Malaysia.

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ETHICAL APPROVAL

This study was approved by the ethical committee of UPNM (JKEP: 01/2023) and UKM (UKM. FPR.SPI 800-1/3/23).

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