



RESEARCH ARTICLE

MOBILE HEALTH APPLICATIONS: AN EMERGING TREND IN THE HEALTH CARE DELIVERY TO MASS GATHERING

Aljohani Abdulaziz^{1,*}, Ayesha Abbasi² and Yousef Almohamadi³.

¹Department of Family Medicine, Security Forces Specialized Polyclinic, Madinah, Saudi Arabia

²Department of Internal Medicine, Security Forces Specialized Polyclinic, Madinah, Saudi Arabia

³Department of Pediatric, Security Forces Specialized Polyclinic, Madinah, Saudi Arabia

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ABSTRACT

Background: In this era of digital innovation, mobile health (mHealth) has emerged as a novel concept in the health care industry. Mobile Health is defined as using mobile communications for health interventions and information, and involves the use of portable devices that are capable of creating, storing, retrieving, and transmitting data to improve the safety, quality of care, and health of end users. However, the efficacy of these apps in improving healthcare delivery to Muslim pilgrims arriving in Saudi Arabia each year is yet to be determined. **Objectives:** The purpose of our study was to assess whether the use of mobile health apps improves pilgrims experience, and to compare the patient experience between users and nonusers. **Methods:** The Outpatient Experience Questionnaire was the basis of our survey, which included 5 dimensions (physical environment and convenience, physician-patient communication, health information, short-term outcome, and general satisfaction), 25 items, and Pilgrims demographic characteristics (gender, age, education, marital status, nationality, living place, self-rated health status) with good reliability and validity. **Results:** A sample of 1346 pilgrims was randomly selected from Holy Mosque, Alansar Hospital and King Fahd Hospital in Madinah, Saudi Arabia. The inclusion criteria were age 18years or above, consenting to participation, completing hospital visit, and offering their own experience accurately and independently in the questionnaire. Data entry and management were performed using Epidata 3.1, and analysed using SPSS Version 20.0, 2011. The mHealth app users were more likely to be young ($p=0.02$), married ($p=0.03$), and better educated ($p=0.014$) than non-users. The app users also gave higher scores in the dimensions of Physical Environment and Convenience ($P=0.005$), Physician- Patient Communication ($P=0.004$), Provision of Health Information ($P=0.001$), Short term Outcome ($P=0.001$), and Overall Patient Satisfaction ($P=0.001$). **Recommendation:** Based on these results, we recommend the development of a novel, user friendly mobile health application, specifically tailored to the felt need of the pilgrim community.

INTRODUCTION

In the 21st century, the use of mobile phones and other wireless technology in health care is a burgeoning field within public health. mHealth is defined as using mobile communications for health interventions and information and involves the use of portable devices that are capable of creating, storing, retrieving, and transmitting data in real time to improve the safety, quality of care, and health of end users (Abts, 2019). Improving the health and well-being of pilgrims has remained a common goal throughout the health services in the kingdom. According to Britannica, Hajj is the pilgrimage to the holy city of Mecca in Saudi Arabia, which every adult, affording Muslim must make at least once in his or her life.

Every year, millions of pilgrims of diverse ethnic, cultural and socioeconomic backgrounds arrive in the kingdom of Saudi Arabia to perform Hajj. During their stay, about 300,000 pilgrims access health care facilities. These pilgrims need health service during their holy rituals, and a quick way to provide health counseling. The use of IT-based innovations, such as health applications, in the delivery, management and planning of healthcare services can greatly facilitate this process for the pilgrims as well as the health care providers. Furthermore, the mobile health apps can provide information to pilgrims such as hospital guidance, health care consultancy, visiting appointment and registration, and medical result checking. The global penetration of mobile phones in developed as well as developing countries allows for the adoption and implementation of mobile health. According to R2G, a market analyst company focusing on digital healthcare, there are now 325,000 mobile health apps from 84,000 app publishers on the market (Ahmed, 2014) the vast majority of

*Corresponding author: Aljohani Abdulaziz,

Department of Family Medicine, Security Forces Specialized Polyclinic, Madinah, Saudi Arabia.

which are free (Akter, 2010). These applications aim to improve patient experience, defined as the overall satisfaction a patient gets during the course of receiving care or treatment (Consulting, 2009). There are many benefits of mHealth interventions compared to delivering an in-person public health intervention, including cost-effective dissemination, real-time data collection and feedback, lowered patient load, and flexibility for tailoring (Dehling, 2015). They can also mitigate the cost of health care delivery and reduce the unnecessary crowding of health care facilities. The utilization of these mobile health applications can improve patient care and collect patient data for further research. They can also impart health education and promote health seeking behavior among the pilgrims. Mobile applications can also play a crucial role in emergency response and disaster management, an example of which is the merger between Vodafone Group Foundation and United Nations Foundation (6). Moreover, these applications can also serve as an instant emergency aid. For instance, these can provide written, auditory and illustrative instructions to a user in case of a personal emergency such as choking, bleeding, bone fracturing, difficult breathing and heart attack before specialized staff arrives for rescue (Hu, 2016). This can reduce the morbidity and mortality from the emergency. Those mobile health apps have allowed for more efficient responses to patient demands, and reduced the amount of time a patient spends in long queues trying to access care in hospital settings. Thus, mobile health apps play a pivotal role in improving the efficiency and quality of health care delivery (Kontos, 2014). Despite this surge in the use of mobile health apps, evidence to evaluate their effectiveness in improving health care delivery to pilgrims is lacking. According to Wikieducator, "Felt need" is defined as a community's assessment of the current situation, determining what is lacking and realizing the potential for change. It is our goal to assess the need for the development of an interactive mobile health application, specifically tailored to the needs of the pilgrims as assessed by this study.

Objectives: Saudi Arabia is visited by millions of pilgrims every year to perform Hajj, the holy pilgrimage ordained upon all adult, affording Muslims once in their lives. These pilgrims need health service during their holy rituals, and a quick way to provide health counseling. The mobile health apps can provide information to pilgrims such as hospital guidance, health care consultancy, visiting appointment and registration, and medical result checking. Despite this surge in the use of mobile health apps, evidence to evaluate their effectiveness in improving health care delivery is lacking. Therefore, the purpose of our study was to examine whether the use of mobile health apps improves pilgrims experience, and to compare the patient experience between users and nonusers as well as the characteristics associated with the users of these apps.

METHODS

Questionnaire Design: The Outpatient Experience Questionnaire was the basis of our survey, which included 5 dimensions (physical environment and convenience, physician-patient communication, health information, short-term outcome, and general satisfaction), 25 items, and Pilgrims demographic characteristics (gender, age, education, marital status, nationality, living place, self-rated health status) with good reliability and validity (9). The ethical approval was obtained from Institutional Review Board (IRB), and the questionnaire was validated by the Global Center for Mass

Gatherings Medicine (GCMGM), Ministry of Health, KSA. In the questionnaire, we added another question in the characteristics section, "Did you use mobile health apps during this visit?" to divide the users and nonusers. The mobile health apps included a number of apps including Mymedicnow, a Dubai based app, and a free app launched by Saudi government in March 2018, which provides audio, visual and written communication between health care providers and app users.

Sample and Procedure: The survey was carried out in August 2019. A sample of 1346 respondents were selected by convenience sampling from places of pilgrims gathering next to the Holy Mosque in Madinah, Saudi Arabia, and two comprehensive public hospitals (Alansar Hospital and King Fahd Hospital) in Madinah, Saudi Arabia. The selected hospitals are where pilgrims receive advanced treatment services. We adopted the following inclusion criteria for respondents: aged ≥ 18 years; pilgrims; completed the hospital visit; gave consent to be a participant in the study; and offered their personal experience about the visit accurately and independently. Trained interviewers selected respondents by convenience sampling who met the inclusion criteria and conducted the face-to-face interviews. Refusal to answer any question resulted in the deletion of questionnaire for that respondent. The interviewers reviewed each questionnaire to ensure that no errors or omissions were made. Every participant provided a score based on their experience. The scores represented the pilgrim's evaluation of the health services provided by app as well as the extent to which patient experience could be improved.

Study Measures: In multiple linear regressions, the dependent variable was the total patient experience score. The Outpatient Experience Questionnaire was used to calculate patient experience score. A 5-point Likert scale was inserted to record pilgrim responses, with 5 representing the best experience and 1 representing the worst. For example, "What do you think of adequate time in application for consultation?" (coded as 1=very short, 5=very long). Each dimension score was calculated by summing all item scores in the dimension and then dividing that sum by the number of items in that dimension. The total patient experience score was the total questionnaire score, which was calculated by summing the scores of the 25 items in the questionnaire and then dividing that sum by the total number of items. The total patient experience score ranged from 1 to 5. To determine possible areas for improvement, we normalized each respondent item's score to 0-100 by using the following formula: Normalized score = $100 \times (\text{Respondent's selected response value} - \text{Minimum response value on scale}) / (\text{Maximum response value} - \text{Minimum response value})$ (Agency). We determined that the distance between a patient experience score and 100 is the gap that must be improved. The independent variables included the 7 demographic characteristics and whether mobile health apps were used (coded as 1=yes, 0=no)

Statistical Analysis: Epidata 3.1 ("The EpiData Association" Odense, Denmark) was used for data entry and management. Double-entry data input was used to ensure accuracy. A chi-square test was utilized to compare the different categorical characteristics between mobile health app users and nonusers. A *t* test was used to test the mean difference in patient experience scores between mobile health app users and nonusers.

Multiple linear regression was conducted to determine whether the use of mobile health apps during hajj visit was associated with good pilgrim's experience. The statistical significance for all tests was determined using a cutoff of $P < 0.05$ (in a 2-tailed test). All analyses were conducted using SPSS Version 20.0, 2011.

RESULTS

Pilgrims Characteristics of Mobile Health Application Users and Nonusers: Pilgrims characteristics of Mobile Health Application users and nonusers are shown in Table 1. Our study assessed several demographic variables such as gender, age, nationality, education status, marital status, living place, and the self-rated health status of the pilgrim participants. A total of 1346 respondents, including males ($n=705$) and females ($n=641$) were selected by convenience sampling. The users and non-users differed in age ($p=0.02$), education status ($p=0.014$) and marital status ($p=0.03$). Compared with app non users, mobile health app users were younger, married, and better educated. With regard to gender (p value= 0.42), there was no significant difference between users and non-users, although a greater percentage of females (33.7%) were users as compared to males (23.6%). About 23.6% males were app users, and 76.3% were non-users, whereas among the females, 33.7% were users, and 66.3% non-users. The respondents were divided into three age groups: ≤ 44 , 45-64 and ≥ 65 years, with the majority of users (72.1%) and non-users (73.9%) falling in the 45-64 year age group. Nationality did not play a significant role in determining user versus non user experience ($p=0.38$). Understandably, the educational status of the participants was a highly significant variable (p value= 0.014), with university graduates comprising 43.6% users versus only 22.2% non-users. There was no significant difference in the response of participants inhabiting rural and urban areas ($p=0.51$), signifying that pilgrims from rural and urban areas were equally cognizant about the potential benefits and utility of mobile health applications. The last demographic variable was the self-rated health status of each participant. Finally, the self-rated health status was also a significant predictor of user versus non user of mobile health app ($p=0.032$). More users regarded their health status to be poor (33.7%) as compared to users (28.1%). The users also favored the option of several languages in the mobile health applications as compared to the non-users ($p=0.009$).

Differences in pilgrims Experience between Mobile Health Application Users and Nonusers: Patient experience scores of mobile health app users and nonusers are shown in Table 2. The t test results showed that there was a significant difference in total patient experience scores, the 5 dimensions and the 25 items between the 2 groups. In total patient experience scores, mobile health app users gave significantly higher scores than nonusers ($t=3.919$, $P=0.001$). In the dimension of Physical environment and convenience, users gave considerably higher scores than nonusers ($t=2.805$, $p=0.005$), although there is insignificant difference between the 2 groups in items concerning whether the information in the app is well organized, and the extent to which contents of the menus and the toolbars match user needs. As far as the physician-patient communication is concerned, there was a significant difference between the experience scores of app users and non-users ($t=2.930$, $p=0.004$), including effective response to patient queries, clear explanation of health information,

protection of personal privacy, and respecting patient opinions. However, careful listening to patient problems ($t=0.594$, $p=0.55$), and courteous attitude toward patients ($t=1.474$, $p=0.14$) were not significant between the 2 groups. The dimension of health information was highly significant between the user and non-user groups ($t=3.556$, $p=0.001$), with the users giving higher overall scores regarding the provision of educational materials, effective management of health, provision of self-assessment tools, improved access to health care services, and overall usefulness of the mobile health app for the wellbeing of pilgrims. The next dimension assessed was the short-term outcomes of using mobile health application, with a significant difference in the scores of app users and non-users ($t=4.703$, $p=0.001$). Finally, the overall satisfaction of app users was significantly higher than non-users ($t=3.896$, $p=0.001$).

DISCUSSION

Digital innovation is an integral component of improving health care delivery. In the past few years, healthcare has been revolutionized by technological breakthroughs. Mobile health (mHealth) applications are one such example. mHealth is defined as utilizing mobile communications for health interventions and information and involves the use of portable devices that are capable of creating, storing, retrieving, and transmitting data in real time to improve the safety, quality of care, and health of end users (Abts, 2019). It is a rapidly growing industry that facilitates the management of healthcare by both patients and healthcare providers (Misra, 2015). There are many advantages to mHealth interventions compared to delivering an in-person public health intervention, including cost-effective dissemination, real-time data collection and feedback, lowered patient load, and flexibility for tailoring. Today, almost 90% population has consistent access to mobile devices, and therefore, mobile health applications can cater to a huge population. There are about 325,000 mobile health applications, the majority of which are free (Akter, 2010). According to the available data, these health apps focus on fitness(36%), lifestyle and stress(17%), diet and nutrition(12%), specific diseases(9%), women's health and pregnancy(7%), medication reminders and information(6%), healthcare providers and insurance(2%), and other topics(11%) (Nielsen, 2018).

However, despite the widespread use of mobile health apps, there has been no previous research that evaluates their effectiveness in improving health care delivery to pilgrims. Every year, millions of pilgrims of diverse ethnic, cultural and socioeconomic backgrounds arrive in the Kingdom of Saudi Arabia to perform the Muslim pilgrimage, Hajj. These pilgrims require an efficient health care delivery system to meet their needs. Since the development of mobile health applications is a time consuming and costly process, the need for developing a mobile health application specifically tailored to the requirements of the pilgrims must be assessed first. Our study evaluated the difference in the patient experience between users and non-users of mobile health applications during pilgrimage. We found that the users of mobile health application had a superior patient experience as compared to the non-users ($p=0.001$). This is in accordance with the results reported in a study conducted in China, where the usage of mobile health app during a hospital visit was a significant predictor of patient experience scores ($p=0.002$) (Penchansky, 1981).

Table 1. Difference in respondents' characteristics of mobile health app users and nonusers

Characteristic	App users, No. (%)	Nonusers, No. (%)	Chi-square (df)	P value
Gender			0.1	0.42
Male	167 (23.6)	538 (76.3)		
Female	216 (33.7)	425 (66.3)		
Age			12.2	0.02
≤44	63 (16.4)	136 (14.1)		
45 – 64	276 (72.1)	712 (73.9)		
≥65	44 (11.5)	115 (12)		
Nationality:			0.12	0.38
• Indian	13 (3.4)	193 (20.0)		
• Egyptian	67 (17.5)	109 (11.3)		
• Pakistani	73 (19.1)	234 (24.3)		
• Indonesian	24 (6.3)	122 (12.8)		
• Malaysian	17 (4.4)	38 (3.9)		
• Bengali	28 (7.3)	24 (2.5)		
• Morocco	31 (8.1)	77 (8.0)		
• Turkish	40 (10.4)	53 (5.5)		
• Others	90 (23.5)	113 (11.7)		
Education status:			6.4	0.014
Elementary and below	41 (10.7)	176 (18.3)		
Middle school	103 (26.9)	224 (23.3)		
High school	72 (18.8)	349 (36.2)		
University or above	167 (43.6)	214 (22.2)		
Marital status:			7.2	0.03
Single	31 (8.1)	162 (16.8)		
Married	352 (91.9)	801 (83.2)		
Living place:			0.23	0.51
Urban areas	312 (81.5)	581 (60.3)		
Rural areas	71 (18.5)	382 (36.7)		
Self-rated health status:			5.8	0.032
Poor	129 (33.7)	271 (28.1)		
Fair	96 (25.1)	327 (34.0)		
Good	118 (30.8)	217 (22.5)		
Very good	40 (10.4)	148 (15.4)		

Table 2. Pilgrims experience scores of mobile health app users and nonusers

Dimension/item	App users scores	Nonusers scores	t test	P value
1.Physical environment and convenience	3.92	3.16	2.805	0.005
•The application should be easy to use	3.35	3.16	1.91	0.04
•Easy registration procedure	3.97	3.67	2.63	0.007
•The information in the app well organized	4.08	4.02	0.24	0.81
•Navigating through the menus and toolbars is easy to do	3.83	2.98	1.86	0.03
•Existence of several languages in the application	4.29	3.17	2.38	0.009
•The contents of the menus and the toolbars match my needs	4.06	3.98	0.37	0.43
•Adequate time in application for consultation	3.77	2.81	2.48	0.004
•Using the app even when the Internet connection is poor	4.12	2.96	2.53	0.02
2.Physician-patient communication	3.83	3.52	2.930	0.004
•Existence doctors who can respond to patients queries	4.20	3.96	3.079	0.002
•Clear explanation for health information	4.02	3.85	1.804	0.07
•Careful listening to patient problem	3.28	3.21	0.594	0.55
•Courtesy and respect attitude	3.95	3.82	1.474	0.14
•Involve in decision making	3.49	3.28	1.987	0.048
•Protect personal privacy	3.95	2.94	1.768	0.03
•Respect opinions	3.76	3.40	3.812	0.001
3.Health information	4.26	3.61	3.556	0.001
•The app provide educational materials	4.13	3.86	2.894	0.004
•The app helped me manage my health effectively	4.03	3.74	2.624	0.009
•The app provide performing self-assessment tools	3.74	3.51	1.949	0.05
•The app improved my access to health care services	3.93	3.42	3.615	0.001
•The app would be useful for my health and well-being	3.70	3.37	3.020	0.003
•Maintain confidentiality of information in the application	3.96	3.61	3.034	0.002
4.Short-term outcome	4.03	3.63	4.703	0.001
The app handle health problems after using	3.90	3.53	4.533	0.002
The app makes health care more convenient	4.16	3.43	3.390	0.001
The app reduce/prevent from health problems	4.07	3.67	4.117	0.001
The app help you make a change that benefited your health	3.72	3.35	3.614	0.021
5.Overall satisfaction	3.88	3.43	3.896	0.001
Total pilgrims experience scores	3.97	3.49	3.919	0.001

The mobile health app users gave higher scores to all five dimensions, including physical environment and convenience, physician-patient communication, health information, short time outcome, and overall patient satisfaction. The mobile application users were more likely to be young, married, and better educated as compared to the non-users. However, gender, nationality, and living place (rural versus urban) did not create a significant difference between user and non-user health experience. Similar findings were reported in another study in which the main adult users of health apps were individuals who were younger (adults between 18-44 years old vs. 45+ years old), had higher education (some college or college graduate vs. high school or less), and reported good health (Sekhon, 2017). The participants in our study stressed that the registration process would become easier and more streamlined by using health applications. It would decrease the time spent in long queues, and in fact, mitigate the need to visit a health care facility in the vast majority of cases. When inquired about the importance of availability of several languages in the health application, the majority of pilgrims considered it as crucial to ensure effective communication and health care delivery to the diverse pilgrims ($p=0.009$)

Mobile health applications provide a reliable platform where patients can interact with physicians, before, during and after their medical appointment with the physician (Lu *et al.*, 2018) This ensures adequate time to impart health information, address queries, and involve patients in decision making to ensure superior health outcome. Similar results were reported in a study by National Health Service, UK (Tate, 2013). In our study, the users were confident that mobile health applications take adequate measures to protect patient privacy ($p=0.03$) and maintain the confidentiality of patient data ($p=0.002$). This is in contrast to the findings of a study in which the majority of apps (95.63% of apps) were found to pose at least some potential damage through information security and privacy infringements (Wartella, 2015). Regarding health information, the majority of pilgrims strongly agreed that mobile health applications should provide educational materials to the pilgrims, in order to create health awareness and promote healthy behaviours. ($p=0.01$)

Recommendations

It is critical to enhance the acceptability of mobile health apps in order to bring about the desired health impact across the spectrum (16) of pilgrim population. Acceptability is a dynamic concept that reflects the extent to which people delivering or receiving a healthcare intervention consider it to be appropriate, based on anticipated or experienced cognitive and emotional responses to the interventions. Acceptability can be enhanced by increasing the ease of use, providing accurate health information, ensuring rapid response by physicians, protecting patient privacy, and prioritizing patient safety and well-being. The elderly and less educated pilgrim groups should be targeted with the aim of improving the use of mobile health apps in these groups. There should be an efficient emergency response mode in the app, which should guide the users in case of emergencies before the arrival of a specialized rescue team. Apps should also employ high risk alerts to relay sensitive information that, if missed, could cause harm to a patient, e.g. low blood glucose in a diabetic patient (Xu, 2015) Lastly, the application must be developed in accordance with the international guidelines for mobile health applications. Xcertia, an mHealth collaborative and guidelines body founded

by the American Medical Association (AMA), American Heart Association (AHA), DHX Group, and Healthcare Information and Management Systems Society (HIMSS), sets forward five core principles in this regard: privacy, security, content, usability, and operability (Zapata, 2015)

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