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ORIGINAL PAPER

Impact of a Health Education Intervention on the Incidence of Influenza-Like Illnesses (ILI) During Hajj via Smartphone Application

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Abstract

This study was aimed at demonstrating the impact of a health education intervention on reducing the incidence of influenza-like illnesses symptoms among Malaysian Hajj pilgrims. This study utilizes a quasi-experimental study in the evaluation of the impact of the intervention. Participants were recruited during Hajj orientation courses organized by private Hajj companies. Participants from two companies were assigned to an intervention group and control group, respectively. The intervention group received a smartphone-based health education intervention guided by the Health Belief Model (HBM), while the control group received a regular Hajj guide intervention smartphone application before departure to Hajj. Data on the incidence of influenza-like illnesses (ILI) were collected from participants from two Hajj companies before and after returning from Hajj. Data analysis was conducted using SPSS with descriptive analysis, and analytical tests were conducted at 5% significance level. A total of 102 pilgrims completed the study in both intervention and control groups. The incidence of ILI and Non-ILI symptoms were statistically significant when the intervention and control groups ($p = 0.049$) were compared. In conclusion, health education has an impact on reducing the incidence of ILI and non-ILI among Hajj pilgrims.

Keywords Influenza-like illnesses · Smartphone · Hajj · Incidence · Malaysia

Abbreviations

ILI Influenza-like illness
HBM Health Belief Model

Introduction

Annually, the Hajj pilgrimage to Makkah in Saudi Arabia attracts an estimated 10 million Muslim faithful worldwide. This pilgrimage is usually associated with a regular occurrence of influenza and ILI among pilgrims. Hajj can equally pose a risk for many respiratory tract infections (RTIs) and

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outbreaks of communicable diseases [1]. A possible high morbidity and mortality rate are commonly associated with pilgrims challenged by severe medical conditions or other high-risk populations due to ILI during Hajj [2]. A greater proportion of pilgrims (90%) suffered from at least a specified respiratory symptom, and the risk of influenza and ILI due to viruses increases several folds during Hajj [3]. However, more severe respiratory illnesses such as pneumonia are the primary cause of hospitalization during the Hajj [4, 5].

The transmission of influenza and ILI viruses during the Hajj could spread worldwide [6]. Respiratory illnesses were reported among returning Malaysian Hajj pilgrims even though they practice some preventive measures [7]. Also, a study among South African pilgrims reported circulating influenza strains in 9.4% of their returning pilgrims [8]. However, the emergence of coronavirus disease 2019 (COVID-19) from Wuhan, China, in 2019 and its subsequent declaration as a Public Health Emergency of International Concern in March 2020 garnered lots of attention, particularly for mass gatherings in addition to already existing concerns regarding respiratory tract infections generally [9]. This resulted in an international spread, causing a global pandemic that caused significant disruption of international travel leading to postponement and cancellations of Hajj and other major mass gatherings [10].

The Saudi Health ministry usually undertakes the planning and design of programs to create awareness among pilgrims (e.g., compliance with face mask use, cough etiquette, vaccination, and hand hygiene) to reduce the incidence of severe Hajj-related illness [11, 12]. All these preventive strategies must be done concurrently to decrease influenza and ILI effectively [7]. This scheme of the seasonal layout plan is coordinated by international organizations such as the European Centre for Disease Prevention and Control (ECDC), the World Health Organization (WHO), and the United States Centre for Disease Control and Prevention (CDC), which issued guidelines for control of respiratory diseases during Hajj [12].

Several studies have regarded smartphones and cyber-based technologies as suitable and feasible means to deliver intervention modules. Smartphone phone-based application delivery has been used broadly and successfully to sustain portable and widespread interventions [13]. The capacity to digitally distribute material grants multiple benefits to health care researchers and end-users: prominently, personalization of resources, enhanced scalability, and affordable costs. Hence it is hypothesized that a health educational module proffers evidence-based data concerning risk factors associated with respiratory infection prevention strategies has an added advantage of decreasing the uncertainty for other health situations with a distinct improvement in general well-being [14]. Similarly, right from the onset of the COVID-19 pandemic, some smartphone based-application that provide essential and credible information promptly to the public has been addressed by some apps developed for COVID-19 [15, 16]. Such applications provide details about the coronavirus, disease, good hygiene practices, and guidelines, like social distancing and the importance of wearing face masks [17].

Some studies have been conducted on educational interventions for ILI prevention among Hajj pilgrims from different countries [18–21]. However, none of the health educational interventions was based on any health behaviour theory to boost compliance with these preventive practices and increase their levels of knowledge towards influenza-like illnesses, prevention attitudes, and practices towards prevention strategies. Similarly, Malaysian pilgrims have low compliance with preventive measures [7, 22]. Therefore, this study aims to develop and evaluate the effectiveness of health education modules for influenza and ILIs prevention among Hajj pilgrims from Malaysia.

Methods

Study Design and Sampling

A quasi-experimental study design was employed to assess the impact of a smartphone-based health education intervention on reducing the incidence of ILI. The incidence, symptoms' duration, and ILI episodes were assessed using a validated questionnaire [23]. Data from the participants were collected in July and September 2019 as a pre and post-intervention survey, respectively. Out of the eight Hajj and Umrah companies approached for enrollment in the study, only two companies agreed to participate. Private Hajj companies were chosen in this study because they organize Hajj and Umrah orientation regularly, usually with many attendees. Therefore, one company was purposively selected for implementing the intervention, and the other was selected for the control intervention. A sample size of 60 participants per group would achieve a significant difference in the studied outcome between the intervention and control group using a two-sided test with alpha = 0.05 and power = 0.8. The intervention phase was guided by the Transparent Reporting of Evaluation with Non-randomized Designs (TREND) statement (Fig. 1).

Study Participants and Location

The study participants were pilgrims who attended a workshop for enlightening and educating Hajj pilgrims organized by private Hajj companies in Kuala Lumpur and Kelantan during the recruitment period. Pilgrims were drawn to participate in the study upon meeting the inclusion and

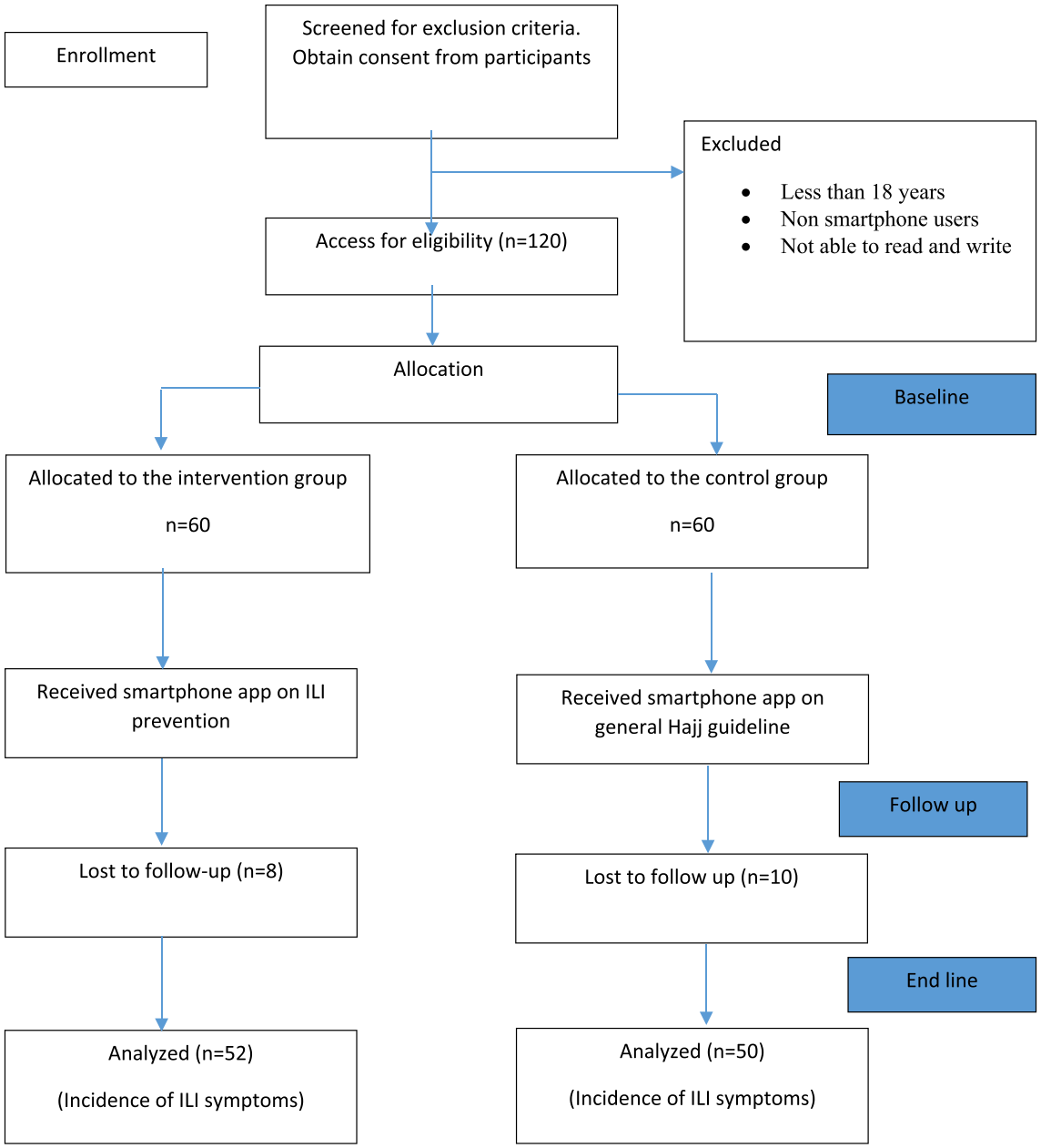

Fig. 1 Flow diagram of the study

exclusion criteria. Kelantan state has a high proportion of Malay ethnic group that are predominantly Muslims. Pilgrims who participated in the Hajj enlightenment workshop that are 18 years and above, able to read and write, and willing to participate in the study were included. Exclusion criteria included pilgrims participating in lesser Hajj, health care workers, and those that cannot read and write.

Pilgrims were classified as those that are 'at high risk' and therefore are strongly advised to have influenza vaccine and pneumococcal vaccine. In addition, pilgrims aged 50 years and above with comorbidities such as hypertension, lung or kidney diseases based on Malaysian Clinical Practical Guidelines (2019) are categorized as high-risk individuals [24]. On the other hand, pilgrims less than 50 years of age were categorized as 'low-risk pilgrims.' During the enrolment stage, participants that met the inclusion criteria were required to fill out the informed consent form.

Health Education Intervention Module

The intervention module used in this study is the smartphone application known as the Hajj health educational module

Table 1 Sections of the health educational module

No	Section	Aim
1	Pre Hajj	• To register the biodata and medical record of the user • To educate pilgrims about influenza and ILI prevention • To increase the perception of threats for the pilgrims by targeting the perceived susceptibility to the diseases and the perceived severity of any possible threat that can be transmitted during Hajj • To enhance the preventive practices and behaviour of the pilgrims by teaching the recommended practices associated with the Hajj pilgrimage • To educate the pilgrims on cues to actions of the pilgrims regarding prevention of influenza and ILIs
2	During Hajj	• Use of face mask, good hand hygiene, cough etiquette, supplements, and other health recommendations and guidelines (Dos and Don'ts) • To motivate the pilgrims to take positive actions by targeting the perceived benefits and perceived barriers of the pilgrims towards influenza and ILIs
3	After Hajj	• Proper action to take in the event of any infection and proper medication • Report any complications to the nearest medical center
4	Formative assessment	• Through formative assessment practices, pilgrims will think at deeper levels, problem-solve effectively, ask good questions, and take ownership of their learning • Using formative assessment practices on an ongoing basis helps teachers gather evidence of learning to ensure each pilgrim's instruction effectiveness • Gathering evidence of learning using formative assessment practices gives teachers the information they need to tailor instruction based on students' readiness to learn

(Hajj-HEM) [25]. This application was developed to guide Hajj pilgrims in preventing influenza-like illnesses**.** The participants were notified that the application is used only for research purposes and is only available to the participants that consented to participate. The Hajj-HEM underwent a series of development processes involving a panel of experts consisting of a virologist, educationist, epidemiologist, computer scientist, and medical statistician. The development was guided by the theory health belief model (HBM). This theory has a broad spectrum of applicability in intervention studies and is a guide in dealing with many health-related issues and adherence to treatment regimens. Applying the model to developing persuasive educational messages for healthy behaviour is widely supported. The Hajj-HEM was designed to contain five main activities divided into four sections (before Hajj, during Hajj, after Hajj, and formative assessment). The HBM was utilized to increase the pilgrims' desire to make changes in improving lifestyles during Hajj. The first domain contains the "Perceived susceptibility of pilgrims towards ILIs"; pilgrims were educated regarding their understanding of the causative agents and risk factors of ILIs that occur due to Hajj pilgrimage. Secondly, the "perceived severity of ILIs" can be explained as the individual's beliefs regarding the complications of ILIs. Thirdly, the "perceived benefit for the prevention of ILIs"; pilgrims were educated on improving and adopting healthy behaviours to prevent the occurrence of ILIs. Finally, the "perceived barriers for the prevention of ILIs"; pilgrims were taught of the disadvantages or potential barriers they had to overcome in trying to change their behaviours. Finally, in "Cues to action for the prevention of ILIs,"; we employed a novel interactive smartphone application to create awareness and elicit behavioural change.

To secure the application, the Hajj HEM has a component for registering the users. Users can access the formative assessment section and evaluate their understanding via interactive questions and answers to ensure compliance and a friendly interface with the application. The application was designed to function without an internet connection to allow easy usage. The finalized Hajj HEM application was launched on the play store and restricted to only the study participants. The application was designed to record the number of downloads and track their usage. Copyright and patent of the application are in process. The summary of the HBM content of the module is shown in Table 1.

Module Validation and Pre-testing

The content validity of the health education module was assessed in collaboration with experts in respiratory diseases and public health and epidemiology, including the researcher's supervisors and other lecturers in the department of microbiology and community medicine, as well as those in the area of educational studies, for proper scrutiny. Information technology (IT) experts also validated the application. To ensure the validity of the module, 20 pilgrims who did not participate in the study were asked to evaluate the application in terms of presentation, clarity of meaning, language, usability, and the flow of contents.

Intervention Group

The intervention delivery of the health education module was organized in collaboration with the private Hajj companies based on the agreement and general consent of the participants. The health education intervention on influenza and ILI prevention was delivered to the participants one to two weeks before departure for the Hajj pilgrimage. The intervention was delivered through a self-download of the newly developed application known as the "Hajj HEM" through the google play store with the help of the research assistant for the study. The control group received the regular Hajj guide application (M-Hajj DSS and M-Umrah application) developed by Mohamed et al. [26]. The module delivery was closely monitored and supervised by the researcher while giving necessary feedback to the research assistants to ensure that the module was downloaded correctly. Users' privacy was respected in line with Malaysia's Personal Data Protection Act (PDPA).

Control Group

The control group's participants received the regular Hajj guide application (M-Hajj DSS and M-Umrah application) developed by Mohamed et al. Similarly, research assistants implemented the intervention module in the control group.

Statistical Analyses

The data were examined and cleaned before the final analysis to ensure all values were entered appropriately and within the correct range. The data were all initially entered in SPSS 24.0. data analyses were performed with IBM Statistical Package for Social Sciences (SPSS) version 24. All data were checked for missing values. Frequency and percentage were used to summarize categorical variables such as race, occupation, educational qualification, previous vaccination history, previous Hajj and Umrah experience, and presence of comorbidities. Mean and standard deviation were used as the central tendency and dispersion measures to summarize continuous variables such as age. Pearson Chi-square test was done to get a baseline comparison of the groups by their sociodemographic characteristics, history of vaccination, and presence of ILI symptoms before departure. Fisher's Exact test was conducted for variables that equal to or more than 20% of the cells had an expected frequency of less than five observations.

Results

Baseline Sociodemographic Characterization

Table 2 shows the detailed baseline sociodemographic characteristics of participants. The two groups show similar characteristics during the recruitment. The comparison between the intervention and control groups showed no statistical difference. The response rate during the post-intervention was 83.87% and 83.33% for the intervention and control arms of the study, respectively. The mean (SD) ages of the participants in the intervention and control groups are 48.88 (11.75) and 44.84, respectively. Most of the pilgrims are females in both groups.

Comparison of Sociodemographic Characteristics and Incidence of ILI Between Intervention and Control Groups

This section shows the association of the sociodemographic characteristics with the incidence of respiratory tract infection symptoms in both intervention and control groups. The result of the Chi-square analysis shows no significant difference among the variables, as shown in Table 3.

Effect of Intervention on the Incidence of ILI Among the Intervention and Control Groups

A chi-square test was conducted to determine the overall effect of health education intervention in preventing respiratory tract infection symptoms among the intervention and control groups before and after Hajj. No statistical difference ($p = 0.515$) was found at the pre-intervention stage, where only 1 participant (2.0%) reported symptoms of respiratory traction infections in the control group and 2 participants (3.8%) reported the symptoms in the intervention group. However, after returning from Hajj, there was a significant difference in the occurrence of RTI symptoms where 13 participants (26.0%) in the control group and 5 participants (9.6%) in the intervention group ($p = 0.038$), as shown in Table 4.

Effect of Intervention on Compliance with Face Mask Use in Reducing the Incidence of ILI Symptoms

The compliance of facemask usage is based on the recommendation in the health education module using the chi-square test, as shown in Table 5. Acceptable practices such as the use of N95 surgical mask, use of disposal mask, disposal of mask after each use, and the use of face mask in crowded areas showed a statistically significant result between the control group showed a significant difference among all the variables

Table 2 Comparison of baseline sociodemographic characteristics between intervention and control groups

Sociodemographic factor	Intervention Frequency (%) (n = 52)	Control Frequency (%) (n = 50)	p-value
Age (years)			
Mean (SD)	48.88 (11.75)	44.84 (13.57)	0.110[a]
Gender			
Male	16 (30.8)	14 (28.0)	0.465[c]
Female	36 (69.2)	36 (72.0)	
Marital status			
Married	46 (82.7)	35 (70.0)	0.083[b]
Single	6 (11.5)	14 (28.0)	
Divorced/widowed	3 (5.8)	1 (2.0)	
Occupation			
Civil servant	24 (46.2)	27 (54.0)	0.692[b]
Self-employed	5 (9.6)	4 (8.0)	
Private	5 (9.6)	5 (10.0)	
Pensioner	13 (25.0)	7 (14.0)	
Housewife	4 (7.7)	4 (8.0)	
Student	1 (1.9)	3 (6.0)	
Highest level of education			
PhD	4 (7.7)	0 (0)	
Master's degree	3 (5.8)	4 (8.0)	
Bachelor's degree	16 (30.8)	21 (42.0)	
Diploma	11 (21.2)	6 (12.0)	
Secondary school	18 (34.6)	19 (38.0)	
Previous Hajj experience			
Yes	16 (30.8)	9 (18.0)	0.102[c]
No	36 (69.2)	41 (82.0)	
Previous Umrah experience			
Yes	16 (30.8)	11 (22.0)	
No	36 (69.2)	39 (78.0)	
Influenza vaccination history			
Yes	15 (28.8)	13 (26.0)	0.460[c]
No	37 (71.2)	37 (74.0)	
Pneumococcal vaccination history			
Yes	12 (23.1)	13 (26.0)	0.455[c]
No	40 (76.9)	37 (74.0)	
Presence of influenza-like illnesses symptoms before departure			
Yes	2 (3.8)	1 (2.0)	1.000[a]
No	50 (96.2)	49 (98.0)	
Presence of common cold symptoms before departure			
Yes	2 (3.8)	1 (2.0)	1.000[a]
No	50 (96.2)	49 (98.0)	

[a]t-test

[b]Pearson Chi-square

[c]Fisher's exact test

Table 3 Comparison of sociodemographic characteristics and incidence of ILI symptoms during Hajj among the intervention and control groups

Variables	Intervention (n = 52)				Control (n = 50)			
	Yes, n (%)	No, n (%)	χ^2	p-value	Yes, n (%)	No, n (%)	χ^2	p-value
Age group								
At risk	3 (60.0)	22 (46.8)	0.315	0.662[a]	8 (66.7)	15 (39.5)	2.715	0.183[a]
Not at risk	2 (40.0)	25 (53.2)			4 (33.3)	23 (60.5)		
Gender								
Male	3 (60.0)	13 (27.7)	2.219	0.163[a]	6 (50.0)	8 (21.1)	3.791	0.071[a]
Female	2 (40.0)	34 (72.3)			6 (50.0)	30 (78.9)		
Marital status								
Married	38 (80.9)	5 (100)	1.158	0.561[b]	10 (83.3)	25 (65.8)	1.441	0.486[b]
Single	6 (12.8)	0 (0)			2 (16.7)	12 (31.6)		
Divorced/widowed	3 (6.4)	0 (0)			0 (0)	1 (2.6)		
Occupation								
Civil servant	2 (40.0)	22 (46.8)	2.228	0.817[b]	7 (58.3)	20 (52.6)	1.588	0.903[b]
Self-employed	1 (20.0)	4 (8.5)			1 (8.3)	3 (7.9)		
Private	0 (0)	5 (10.6)			1 (8.3)	4 (10.5)		
Pensioner	2 (40.0)	11 (23.4)			2 (16.7)	5 (13.2)		
Housewife	0 (0)	4 (8.5)			0 (0)	4 (20.5)		
Student	0 (0)	1 (2.1)			1 (8.3)	2 (5.3)		
Highest level of education								
PhD	0 (0)	4 (8.5)	5.241	0.263[b]			1.881	0.598[b]
Master's degree	0 (0)	3 (6.4)			0 (0)	4 (10.5)		
Bachelor's degree	1 (20.0)	15 (31.9)			6 (50.0)	15 (39.5)		
Diploma	3 (60.0)	8 (17.0)			2 (16.7)	4 (10.5)		
Secondary school	1 (20.0)	17 (36.2)			4 (33.3)	15 (39.5)		
Previous Hajj experience								
Yes	1 (20.0)	15 (31.9)	0.301	1.000[a]	2 (16.7)	7 (18.4)		
No	4 (80.0)	32 (68.1)			10 (83.3)	31 (81.6)	0.019	1.000[a]
Previous Umrah experience								
Yes	0 (0)	16 (34.0)	2.459	0.308[a]	1 (8.3)	10 (26.3)	1.719	0.257[a]
No	5 (100)	31 (66.0)			11 (91.7)	28 (73.7)		
Influenza vaccination history								
Yes	2 (40.0)	13 (27.7)	0.335	0.619[a]	5 (41.7)	8 (21.1)	2.014	0.256[a]
No	3 (60.0)	34 (72.3)			7 (58.3)	30 (78.9)		
Pneumococcal vaccination history								
Yes	2 (40.0)	10 (21.3)	0.892	0.325[a]	5 (41.7)	8 (21.1)	0.156	0.256[a]
No	3 (60.0)	37 (78.7)			7 (58.3)	30 (78.9)		
Chronic lung disease								
Yes	0 (0)	1 (2.1)	0.108	1.000	1 (8.3)	0 (0)	3.231	0.240[a]
No	5 (100)	46 (97.9)			11 (91.7)	38 (100)		
Neuromuscular disease								
Yes	0 (0)	1 (2.1)	0.108	1.000[a]	2 (16.7)	3 (7.9)	0.780	0.582[a]
No	5 (100)	46 (97.9)			10 (83.3)	35 (92.1)		
Allergic rhinitis								
Yes	1 (20.0)	4 (8.5)	0.686	0.410[a]	2 (16.7)	0 (0)	6.597	0.054[a]
No	4 (80.0)	43 (91.5)			10 (83.3)	38 (100)		
Diabetes								
Yes	1 (20.0)	6 (12.8)	0.203	0.530[a]	2 (16.7)	2 (5.3)	1.611	0.240[a]
No	4 (80.0)	41 (87.2)			10 (83.3)	36 (94.7)		
Hypertension								

Table 3 (continued)

Variables	Intervention (n = 52)				Control (n = 50)			
	Yes, n (%)	No, n (%)	χ^2	p-value	Yes, n (%)	No, n (%)	χ^2	p-value
Yes	0 (0)	10 (21.3)	1.317	0.569[a]	3 (25.0)	11 (28.9)	0.070	1.000[a]
No	5 (100)	37 (78.7)			9 (75.0)	27 (71.1)		
Heart disease								
Yes	0 (0)	1 (0)	0.108	1.000[a]	–	–	–	–
No	5 (100)	46 (97.9)			12 (100)	38 (100)		
Presence of influenza-like illnesses symptoms before departure								
Yes	–	–	–	–	–	–	–	–
No	5 (100)	47 (100)			12 (100)	38 (100)		
Presence of common cold symptoms before departure								
Yes	0 (0)	1 (2.6)	0.322	1.000[a]	0 (0)	1 (2.6)	0.322	1.000[a]
No	12 (100)	37 (97.4)			12 (100)	37 (97.4)		

[a]t-test

[b]Pearson Chi-square

[c]Fisher's exact test

analysed. Compliance with face mask use among the intervention and control groups during Hajj showed a significant outcome, with the intervention group having better compliance than the control group.

Discussion

To date, there is no study done in Malaysia to determine the effectiveness of Hajj HEM in reducing the incidence of influenza and ILI during Hajj. Therefore, this study demonstrates the impact of a smartphone application for health education intervention in preventing influenza-like illnesses among Malaysian Hajj pilgrims. The Hajj-HEM was developed to raise the awareness of Hajj pilgrims for the prevention of influenza and ILIs during Hajj. The intervention will enhance ILI prevention knowledge related to the control and prevention of infections and as a component of an effective strategy aimed at reducing influenza and ILIs during Hajj using the novel and interactive smartphone application. Assigning one participant to the intervention and another to control is not accidental; hence comparing the two participants' outcomes is a logical strategy. This proffers the possibility that either one would participate in the intervention or control. Without this assumption, it is impossible to infer that all the selection bias has been removed from the estimated treatment effect.

Smartphone app as the medium of delivery was considered for the intervention due to the wide acceptance spanning over 75.9% adopting its usage across all age groups in Malaysia. Similarly, access to the internet covered about 24.5 million users in Malaysia, with over 89.4% accessed through smartphones [27]. The remarkable proliferation and potential application of smartphone technologies in health promotion studies have unfolded modern frontiers in health educational intervention to advance individual health behaviours as well as optimized prevention and control of diseases. Health is of great benefit in the impact of health promotion behaviours [28, 29]. The choice of smartphones demonstrates a vital opportunity to change health behaviours worldwide, especially in emerging economies [30]. The smartphone intervention guided by the Health Belief Model (HMB) utilized in developing the smartphone application displayed remarkable achievement in reducing the incidence of influenza-like illnesses. The impact of the health education module was statistically significant among the intervention group and the control group from pre-test to post-test.

In this study, the incidence of influenza and ILI symptoms of 9.6% and 26.0% was statistically significant (p = 0.038) among the pilgrims in the intervention and control groups, respectively. Out of these figures, 4 and 2 pilgrims fulfilled the criteria for ILI in the two groups of the study. For other non-ILI symptoms, only one pilgrim from the intervention group and seven pilgrims from the control group reported other non-ILI symptoms. However, two participants reported both ILI and non-ILI symptoms in the control group, and none reported both symptoms in the intervention group. These results revealed a lower incidence rate when compared with previous studies conducted among Malaysian pilgrims. A study by Hashim et al. [7] reported that the incidence of ILI symptoms among Malaysian hajj pilgrims for the 2013 season was 93.4%, with a subset of 78.2% fulfilling

Table 4 Comparison of ILI incidence among the intervention and control groups after Hajj/Umrah

Variables	Intervention (n = 52)	Control (n = 50)	p-value
Presence of ILI symptoms after Hajj			
Yes	5 (9.6)	13 (26.0)	0.038[a]
No	47 (90.4)	37 (74.0	
Symptoms of:			
ILI	4 (7.7)	2 (4.0)	0.049[b]
Common cold	1 (1.9)	7 (14.0)	
Both ILI and common cold	0 (0)	2 (4.0)	
ILI occurred after how many days:			0.190[b]
None	47 (90.0)	39 (78.0)	
1–7 days	1 (1.9)	4 (8.0)	
> 1 week	4 (7.7)	7 (14.0)	
Episodes of ILI			0.385[a]
Yes	5 (9.6)	8 (16.0)	
No	47 (90.4)	42 (84.0)	
Duration of ILI			
1 day	1 (1.9)	1 (2.0)	0.793[a]
2–3 days	1 (1.9)	2 (4.0)	
4–5 days	1 (1.9)	0 (0)	
6–7 days	1 (1.9)	1 (2.0)	
> 1 week	0 (0)	1 (2.0)	
Common cold occurred after how many days			
< 2 days	0 (0)	(0)	0.103[a]
3–5 days	1 (1.9)	2 (4.0)	
6–7 days	0 (0)	4 (8.0)	
> 1 week	1 (1.9)	3 (6.0)	
Duration of common cold			
1 day		1 (2.0)	
2–3 days	0	2 (4.0)	0.306[a]
4–5 days	0	2 (4.0)	
6–7 days	1 (1.9)	2 (4.0)	
> 1 week	1 (1.9)	1 (2.0)	
Admitted to hospital for ILI infection			
Yes	0	0	
No	52	50	

[a]t-test

[b]Pearson Chi-square

[c]Fisher's exact test

the criteria for ILI. The low acquisition of the symptoms may be due to the increase in the knowledge of the prevention of ILI, which was recorded in both the intervention and control groups. However, the uptake of influenza and pneumococcal vaccines could protect against the infection. The use of other preventive measures also showed improvement during the pre and post-test across both groups. However, in this study, it was shown that respiratory symptoms started after one week of stay in the Holy land and continued after that. This is possible because the incubation period of most generally circulating respiratory aetiological agents is within one week [31].

The symptoms of ILI during Hajj were challenging because the information was collected retrospectively from pilgrims on arrival from Hajj. Information about having a headache, experiencing fatigue, or myalgia during Hajj season, whereby pilgrims must complete the Hajj ritual in a very close and dense environment, is almost inevitable. Due to the variation in conceptualizing the definition of influenza and ILIs among Hajj pilgrims, particularly in the

Table 5 Compliance with face mask use among the intervention and control groups during Hajj

Variables	RTI incidence		p-value
	Intervention (n = 52)	Control (n = 50)	
Use of 1 ply face mask			< 0.001[a]
Always	13 (25.0)	1 (2.0)	
Occasional	35 (67.3)	31 (62.0)	
Never	4 (7.7)	18 (36.0)	
Use N95 surgical mask			0.005[a]
Always	11 (21.2)	1 (2.0)	
Occasional	22 (42.3)	20 (40.0)	
Never	19 (36.5)	29 (58.0)	
The use of niqab			0.235[a]
Always	7 (13.5)	2 (4.0)	
Occasional	13 (25.0)	15 (30.0)	
Never	32 (61.5)	33 (66.0)	
The use of disposable mask			0.024[a]
Always	18 (34.6)	6 (12.0)	
Occasional	18 (34.6)	21 (42.0)	
Never	16 (30.8)	23 (46.0)	
Use of non-disposable face mask			0.096[a]
Always	17 (32.7)	8 (16.0)	
Occasional	17 (32.7)	16 (32.0)	
Never	18 (34.6)	26 (52.0)	
Dispose mask after each use			0.004[a]
Always	23 (44.2)	8 (16.0)	
Occasional	5 (9.6)	13 (26.0)	
Never	24 (46.2)	29 (58.0)	
Mask use in Masjid			0.051[a]
Always	23 (44.2)	11 (22.0)	
Occasional	19 (36.5)	28 (56.0)	
Never	10 (19.2)	11 (22.0)	
Mask use when outside the hotel			0.066[a]
Always	19 (36.5)	10 (20.0)	
Occasional	25 (48.1)	24 (48.0)	
Never	8 (15.4)	16 (32.0)	
Use of mask in crowded areas			0.026[a]
Always	17 (32.7)	7 (14.0)	
Occasional	15 (28.8)	26 (52.0)	
Never	20 (38.5)	17 (34.0)	

[a]t-test

[b]Pearson Chi-square

[c]Fisher's exact test

era of pandemic influenza, the recommendation by Rashid et al. [32] is convenient for pilgrims or any mass gathering. Therefore, it was adopted in this study. For the pilgrims to be considered as having an "acute respiratory infection," the aetiological agent must be identified when the pilgrim is admitted to a health center during Hajj. A pilgrim with the triad of 'cough, sore throat, and subjective fever' can be considered to have ILI.

The massive crowd during the Muslim pilgrimage is a crucial determinant of the development of risk of respiratory symptoms. Pilgrims generally are subjected to spread or acquire respiratory infections based on the epidemiological pattern of the circulating pathogens. Based on influenza and ILI symptoms, a pilgrim with at least one vital symptom of either fever, headache, or myalgia in addition to at least one of the local symptoms was considered symptomatic of influenza-like illnesses [33]. The symptoms of

the infection before the intervention were not statistically significant among the intervention and control groups. The present study revealed a positive effect of the intervention on the incidence of ILI symptoms among the participants. A significant reduction in the proportion of respondents in the intervention group compared to the control group is a clear indication of the health education module's effectiveness in reducing the incidence of ILI symptoms.

The intervention group showed high compliance with the use of face masks. The correct and regular use of the face mask is essential in reducing the incidence of ILIs. Adherence to use in all places during the pilgrimage is also essential. This finding is supported by a study by Benkouiten et al. [34], which revealed that masks were conceivably effective at restricting respiratory virus infection by close contact with infected individuals when used by healthy individuals. Overall, the general compliance was reflected in the change in practice score among the intervention group, although not significant with those of the control group.

Despite the impact of the intervention, this study has some limitations. The comparatively short period of enrolment of participants (3–4 weeks) might have possible minor effects on the findings of this study [35]. The control group may have been exposed to other sources of information during the study period, and the researcher could not control this. However, this study was based on participants' self-reported information, which may lead to recall and information bias. The chance of recall bias is also a factor to consider in this study because the respondents were asked to fill the questionnaires retrospectively post-intervention. Therefore, based on the experiences being described, there may be a risk of recall bias.

Conclusion

In conclusion, the present study revealed the positive impact of a smartphone-based health intervention on the incidence of influenza and influenza-like illness symptoms among the selected Hajj companies. This module will also be important, particularly with the present COVID-19 pandemic, in which the module addressed the preventive practices applicable in COVID-19 prevention guidelines.

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Author Contributions MDG designed the research, developed the questionnaire, collected the data, and performed the statistical analysis; NNN, HH, WNA, and AAB participated in the design, the development of the questionnaire, and the data collection and data analysis and critically reviewed the work and this report; and NWA, ZZD, and HH participated in the design and critically reviewed the statistical analysis and the work of this report. All authors read and approved the final manuscript.

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Data Availability The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Competing interests The authors declare that they have no competing interest.

Ethics Approval This study was performed in compliance with the Declaration of Helsinki and approved by the Human Research Ethics Committee of Universiti Sains Malaysia [ref no: USM/JEPeM/17020146] and the Human Research Ethics Committee (UHREC) of Universiti Sultan Zainal Abidin (UniSZA). Furthermore, each participant was provided with a fact sheet about the research, and informed consent was obtained before the conduct of the research. The study was registered with the Australian New Zealand Clinical Trials Registry (ANZCTR) with registration number ACTRN12619000217101. The pilgrims who agreed to participate were ensured of information concealment, including confidentiality throughout the intervention.

Consent for Publication Not applicable.

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