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Pilot use of a novel smartphone application to track traveller health behaviour and collect infectious disease data during a mass gathering: Hajj pilgrimage 2014

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Abstract This study examines the feasibility of using a smartphone application (app) to conduct surveys among travellers during the Hajj pilgrimage, where the use of apps has not been evaluated for infectious disease surveillance. A longitudinal study was conducted among pilgrims at the Hajj 2014 using an iPhone app with separate questionnaires for three study phases covering before, during, and after Hajj. Forty-eight pilgrims from 13 countries downloaded the app. Respondents were aged between 21 and 61 (median 36) years and 58.5% (24/41) were male. Of these, 85% (41/48) completed the first phase, 52% (25/41) completed both the second and third phases, and 25 of these reported meningococcal vaccination, with 36% (9/25) receiving other vaccines. All (25) reported hand hygiene use and 64% (16/25) wore a facemask at some point during the pilgrimage. Four (6%) reported close contact with camels. Respiratory symptoms commenced from the 4th day of Hajj, with sore

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throat (20%) and cough (12%) being the most common. Three participants (12%) reported respiratory symptoms after returning home. Conducting a prospective survey using a smartphone app to collect data on travel-associated infections and traveller compliance to prevention is feasible at mass gatherings and can provide useful data associated with health-related behaviour.

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1. Introduction

The annual Hajj pilgrimage to Mecca, Saudi Arabia, is a striking example of intensely crowded human activity where 2–3 million pilgrims assemble from over 180 countries. Incidence of acute respiratory tract infections (ARI) is high [1,2]. Moreover, emergence of Middle East respiratory syndrome coronavirus (MERS-CoV) in Saudi Arabia and other countries poses a new public health challenge [3]. In order to reduce the risk of ARI among Hajj pilgrims, the Saudi Arabian health authority recommends a range of infection control measures [4], however, compliance to these measures is highly variable [5–8]. Several studies have addressed pilgrim knowledge, attitude, and practice (KAP) towards preventive measures and infectious diseases, finding that their understanding about the potential severity of respiratory infection and the need for protective measures was inadequate [8–13]. Gautret et al. [9] found that <50% of French pilgrims were aware of social distancing, available treatment options, and facemask use as precautionary measures against the spread of respiratory infections. Other studies assessed pilgrim knowledge of emerging infections, such as MERS-CoV and Ebola, and found that 60% of pilgrims were not aware of MERS-CoV circulation in Arabia and about 40% had no accurate knowledge of Ebola transmission. However, longitudinal studies examining these questions before, during, and after travel are lacking.

Conducting longitudinal studies among travellers during mass gatherings involves many challenges, including requirements of a large sample size and high response rate, as well as continuous follow up throughout the course of travel with real-time data capturing. Conducting such studies using conventional “pen and paper”-based methods requires significant time and resources.

Smartphones are increasingly becoming an integral part of modern life, making it possible to conduct prospective surveys among Hajj pilgrims through their use. Several studies have demonstrated their usefulness in conveying health messages in a variety of contexts and audiences, with

high response and retention rates and fewer data-entry errors during descriptive studies and randomised controlled trials [14,15]. Thus, smartphones may provide better platforms to conduct prospective surveys among Hajj pilgrims than conventional “pen and paper”-based methods [14–18]. Additional advantages include constant internet connection, location-detection services, and user proximity making it an ideal tool for collecting infectious disease data during mass gatherings. Data concerning smartphone usefulness in infectious disease research at mass gatherings are very limited [19]. Therefore, we conducted a pilot study using a smartphone app to examine its feasibility to track not only Hajj pilgrim KAP regarding preventive measures, but also symptom onset and participation in high-risk activities before, during, and after Hajj 2014.

2. Methods

2.1. Study design

A prospective cohort study was conducted among Hajj pilgrims at three time points, including before, during, and after Hajj 2014 (between September 5th and October 30th). This involved using three sets of questionnaires in English, including a pre-Hajj questionnaire composed of 23 questions, seven identical pages of Hajj questionnaires (containing five questions per questionnaire) each to be completed daily over a week during the peak Hajj period, and a post-Hajj questionnaire composed of six questions. We developed an iPhone application (app) called ‘Hajj Health Diary’, utilising the ‘Health Monitor’ app template [20] and released it in the Apple app store on September 5, 2014. Users started by registering their device in our online secure research database and were assigned a unique identifier for their device. This method was used successfully in previous studies [15,16,21]. The app determined user location through the smartphone location service and recorded it in our research database each time the participant used it.

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