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## Exploring barriers to and facilitators of preventive measures against infectious diseases among Australian Hajj pilgrims: cross-sectional studies before and after Hajj



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### SUMMARY

**Objective:** For reasons that have yet to be elucidated, the uptake of preventive measures against infectious diseases by Hajj pilgrims is variable. The aim of this study was to identify the preventive advice and interventions received by Australian pilgrims before Hajj, and the barriers to and facilitators of their use during Hajj.

**Methods:** Two cross-sectional surveys of Australians pilgrims aged  $\geq 18$  years were undertaken, one before and one after the Hajj 2014.

**Results:** Of 356 pilgrims who completed the survey (response rate 94%), 80% had the influenza vaccine, 30% the pneumococcal vaccine, and 30% the pertussis vaccine. Concern about contracting disease at Hajj was the most cited reason for vaccination (73.4%), and not being aware of vaccine availability was the main reason for non-receipt (56%). Those who obtained pre-travel advice were twice as likely to be vaccinated as those who did not seek advice. Of 150 pilgrims surveyed upon return, 94% reported practicing hand hygiene during Hajj, citing ease of use (67%) and belief in its effectiveness (62.4%) as the main reasons for compliance; university education was a significant predictor of hand hygiene adherence. Fifty-three percent used facemasks, with breathing discomfort (76%) and a feeling of suffocation (40%) being the main obstacles to compliance.

**Conclusion:** This study indicates that there are significant opportunities to improve awareness among Australian Hajj pilgrims about the importance of using preventive health measures.

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## 1. Introduction

The transmission of infectious diseases is high at mass gatherings such as the annual Hajj pilgrimage in Makkah, Saudi Arabia.<sup>1</sup> Hajj is the largest annual mass gathering on the planet, with around two to three million people attending from over 180 countries. Intense congestion, shared accommodation, air

pollution, and compromised hygiene all contribute to the transmission of infections at Hajj, most notably acute respiratory infections (ARIs).<sup>1,2</sup>

Hajj presents a public health challenge for Saudi Arabia, as the authorities need to cater for an increasing number of pilgrims and respond to emerging infections such as the Middle East respiratory syndrome coronavirus (MERS-CoV).<sup>3,4</sup> It is also challenging for the countries sending pilgrims, since these pilgrims can import epidemic diseases to their home countries upon return. In an effort to reduce the risk of infectious diseases at Hajj, an array of preventive measures have been recommended by the Saudi

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**Table 1**  
Health recommendations for travellers to Saudi Arabia for Hajj 2014<sup>5</sup>

Health hazard	Vaccine	Countries required	Other preventive measures
<i>Air-borne diseases</i>			
Meningococcal disease	Quadrivalent meningococcal vaccine (ACYW135)	Compulsory for all pilgrims	Not applicable
Influenza	Seasonal influenza	Recommended for all, in particular at-risk pilgrims	Not applicable
MERS-CoV and other respiratory infections	Not available	Recommended for all	People aged $\geq 65$ years, those with chronic diseases, pregnant women, and children aged $< 12$ years recommended to postpone Hajj 2014 Hand washing with water or disinfectant Cough etiquette Avoiding hand contact with eyes, nose, and mouth Avoiding contact with ill persons Facemask use Maintenance of good personal hygiene and food hygiene People at risk of severe diseases due to MERS-CoV are asked to avoid close contact with animals when visiting farms Complying with hygiene measures while dealing with animals Avoiding contact with sick animals
Diphtheria	Diphtheria	Remaining up to date	Not applicable
Pertussis	Pertussis	Remaining up to date	Not applicable
Measles	Measles	Remaining up to date	Not applicable
Mumps	Mumps	Remaining up to date	Not applicable
<i>Food- and water-borne diseases</i>			
Poliomyelitis	OPV or IPV	Compulsory for pilgrims from endemic countries Other pilgrims should remain up to date	Not applicable
<i>Soil-borne diseases</i>			
Tetanus	Tetanus	Remaining up to date	Not applicable
<i>Vector-borne diseases</i>			
Yellow fever	Yellow fever	Compulsory for pilgrims from endemic countries and those transiting through endemic countries	Not applicable
<i>Health education</i>			
Health authorities in countries of origin are required to provide health information to pilgrims on infectious disease symptoms, modes of transmission, and measures for prevention			

MERS-CoV, Middle East respiratory syndrome coronavirus; OPV, oral poliovirus vaccine; IPV, inactivated poliovirus vaccine.

Arabian Ministry of Health (MoH), which include vaccination and hygiene measures (Table 1).<sup>5</sup> However, studies have demonstrated that vaccine uptake and compliance with hygiene and protective measures are highly variable among pilgrims,<sup>6,7</sup> and the reasons behind this variability remain unclear.

To date few studies have assessed the knowledge, attitudes, and beliefs in relation to preventive measures among Hajj pilgrims. A recent qualitative study of Australian pilgrims found that considerable misconceptions about preventive measures and the risk of respiratory infections prevail among Hajj pilgrims.<sup>8</sup> A French study demonstrated that less than half of pilgrims were aware of social distancing and facemask use as precautions against respiratory infections,<sup>9</sup> but no study has explored the barriers to and facilitators of the uptake of preventive measures. To address these questions, two cross-sectional surveys were conducted among Australian pilgrims, one before and one after the Hajj 2014, to identify what preventive advice and interventions pilgrims received before travel, and what factors influenced their compliance with these measures while they were there.

## 2. Materials and methods

### 2.1. Study design

Two cross-sectional self-administered questionnaires were distributed among Australian Hajj pilgrims aged  $\geq 18$  years in 2014. The first survey was conducted on a group of departing

pilgrims approximately 1 month before Hajj (pre-Hajj study). The second survey was conducted on a second, separate group of pilgrims immediately after their return to Australia (post-Hajj study).

#### 2.1.1. Pre-Hajj survey

The pre-Hajj survey collected data on socio-demographic characteristics, Hajj itinerary details, and the receipt of pre-travel advice, including vaccinations. The questionnaire also assessed the pilgrims' knowledge of and attitudes towards preventive measures, and their risk perception of diseases occurring at Hajj, including influenza, pneumonia, and blood-borne diseases.

#### 2.1.2. Post-Hajj survey

The post-Hajj questionnaire assessed the actual compliance with infection control measures (such as the use of facemasks, hand disinfectants, and handkerchiefs) during Hajj, and the barriers to and facilitators of the use of those preventive measures while at Hajj. The surveys were primarily in English, with Arabic translations available for those who preferred to complete the survey in Arabic.

### 2.2. Participant recruitment

Muslims residing in the Greater Sydney area, New South Wales (NSW) were the target population for the study. NSW has the largest Muslim population (50%) of any state in Australia with the

majority living in Greater Sydney.<sup>10</sup> Australian Hajj pilgrims aged 18 years and over who were planning to attend the Hajj 2014 were eligible for recruitment.

Potential participants were approached through Hajj tour operators. The list of accredited Hajj travel agents in Australia, including their location/address, was obtained from the Saudi Arabian Embassy in Canberra, Australia. The selection of participants was based on the number of Hajj visas allocated for a given travel agent: travel agents with the highest quota of Hajj visas were approached first, and the travel agents who dealt with diverse ethnic groups, including Arabs, Africans, Indians, and Malays, were prioritized to ensure a diverse sample.

For the pre-Hajj survey, departing pilgrims were approached at weekly pre-Hajj seminars run by travel agents between August 1 and mid-September 2014. All pilgrims attending the seminars were invited to take part in the study.

For the post-Hajj survey, a second group of pilgrims (separate to the first) were approached in person at community gatherings and events within weeks of returning home from Hajj (between mid-October and the end of December 2014). The study was promoted using a number of methods, including the distribution of brochures at mosques and community centres and by word of mouth.

### 2.3. Sample size

A consecutive sampling plan was used to ensure a sample that was representative of pilgrims residing in NSW. Assuming that at least 70% of respondents will have a general knowledge of infection control measures, and considering an error margin of 5% to be acceptable for this anonymous survey, a sample of 323 was considered to be sufficient for this study; assuming a non-completion rate of the survey of 15–20%, a total of 380 participants were targeted. The sample size of this study represents approximately 10% of Australian pilgrims to Hajj 2014 (which is approximately 3500). Previous works studying the uptake of vaccinations among Australian Hajj pilgrims showed that a convenience sample of 10% of the target population is sufficient.

### 2.4. Data analysis

The data collected were entered into an Excel spreadsheet. The statistical analysis was performed using IBM SPSS Statistics version 19.0 (IBM Corp., Armonk, NY, USA). Pearson correlation coefficients and Chi-square tests were used to assess variables and determine associations and correlations. Univariate factors with *p*-values of <0.25 were entered into multivariable regression analyses. Two-tailed *p*-values of ≤0.05 were considered statistically significant in the multivariable models.

### 2.5. Ethics approval

This study was reviewed and approved by the Human Research Ethics Committee (HREC) at The University of Sydney (Project No. 2014/599).

## 3. Results

### 3.1. Pre-Hajj study

#### 3.1.1. Demographics

A total of 380 respondents agreed to participate in the study, of whom 356 (94%) completed the survey questionnaires. Their demographic details are presented in Table 2. Eighty-two percent of pilgrims (291/356) were attending Hajj for the first time, and the median duration of their stay in Saudi Arabia was 27 (range 7–40) days.

**Table 2**

Pre- and post-Hajj surveys: differences in participant demographic characteristics

Factors	Pre-Hajj group n (%)	Post-Hajj group n (%)	<i>p</i> -Value <sup>a</sup>
Age, years			
Median (range)	39 (18–79)	41 (18–72)	0.50
Mean (SD)	40.6 (± 13.2)	40.6 (± 10.7)	
Sex			
Male	213 (60)	71 (47)	0.01*
Female	143 (40)	79 (53)	
Country of birth <sup>b</sup>			
Australia	102 (32)	34 (23)	<0.01*
Lebanon	73 (23)	22 (15)	
Indonesia	41 (13)	50 (35)	
Pakistan	33 (11)	8 (5)	
Bangladesh	24 (7)	6 (4)	
Other	44 (14)	27 (18)	
Not answered <sup>c</sup>	39 (11)	3 (2)	
Years in Australia			
≤10 years	48 (22)	36 (31)	0.08
>10 years	167 (78)	80 (69)	
Employed			
Yes	230 (65)	98 (65)	0.87
No	126 (35)	52 (34)	
Presence of comorbidities			
Yes	76 (22)	24 (16)	0.16
No	280 (78)	126 (84)	
Highest education level <sup>b</sup>			
None	31 (9)	5 (3)	<0.01*
School certificate	55 (15)	12 (3)	
High school certificate	66 (19)	24 (16)	
Certificate/diploma	75 (21)	32 (21)	
University degree	89 (25)	48 (32)	
Higher university degree	40 (11)	29 (19)	
Number of times attending Hajj			
First time	291 (82)	118 (79)	0.42
>1 time	65 (18)	32 (21)	

<sup>a</sup> Asterisks indicate a significant difference.

<sup>b</sup> By Chi-square for trend.

<sup>c</sup> Excluded from the total number.

### 3.1.2. Vaccine uptake and associated factors

All respondents reported receiving meningococcal vaccine; the majority (83%, 297/356) also received one or more other recommended vaccines (Table 3). Factors influencing vaccine uptake are listed in Table 3. Being aged >40 years was significantly associated with the uptake of recommended vaccines (odds ratio

**Table 3**

Pre-Hajj study: uptake of recommended vaccines<sup>a</sup>

Vaccine status (≥1 vaccine)	
Yes	297 (84)
No	50 (14)
Not sure	9 (2)
Vaccine name	
Seasonal influenza vaccine	283 (80)
Pneumococcal vaccine	107 (30)
Pertussis (whooping cough) vaccine	107 (30)
Hepatitis A vaccine	59 (17)
Hepatitis B vaccine	61 (17)
MMR (measles, mumps and rubella) vaccine	36 (10)
Typhoid vaccine	45 (13)
Polio vaccine	28 (8)
Reasons for vaccination <sup>b</sup>	
I don't want to get sick	218 (73)
My Hajj tour group leader recommended getting the vaccine(s)	190 (64)
My doctor advised me to get the vaccine(s)	158 (53)
The vaccine is effective in protecting me against diseases	135 (45)
Reasons for not being vaccinated <sup>b</sup>	
I didn't know about them	28 (56)
I don't think I will get a disease at Hajj, I'm under 'Allah's' protection	16 (32)
I don't need them because I don't have any chronic disease	15 (30)
I don't worry about getting sick	13 (26)

<sup>a</sup> Results are presented as the number and percentage (%).

<sup>b</sup> Some pilgrims cited more than one reason.

(OR) 2.5, 95% confidence interval (CI) 1.2–4.9,  $p = 0.01$ ), as was having a university education (OR 3.4, 95% CI 1.7–6.7,  $p = 0.01$ ).

### 3.1.3. Pre-travel advice seeking and associated factors

Approximately two thirds (236/356) obtained 'professional travel health advice' from one or more sources before Hajj, including 57% (182/236) from general practitioners (GPs), 24% (55/236) from a specialist travel clinic, 12% (27/236) from a specific Hajj website (e.g., MoH website<sup>11</sup>), and 11% (25/236) from the 'Smartraveller' website.<sup>12</sup> Of those who received professional pre-travel advice, 81% (191/236) reported a positive experience with the advice, while the rest described a negative experience.

One third (120/356) did not seek any 'professional travel health advice' before Hajj. Reasons for not seeking pre-travel advice included not recognizing the need to seek such advice (47%, 56/120), preference for other sources, i.e., friends, family members, and travel agents (32%, 39/120), reliance on previous experience/knowledge (14%, 17/120), and previous negative experience of seeking pre-travel advice (7%, 8/120). Being within the age band of 34 to 49 years was the only factor associated with receiving professional pre-travel advice (OR 2.5, 95% CI 1.5–4,  $p = 0.01$ ).

Additional pre-travel health advice sources were also reported, including Hajj travel leaders (66%, 235/356), family members and friends who had previous experience of performing Hajj (45%, 161/356), and 'general websites' on the Internet (17%, 59/356). Forty-six percent (164/356) were aware of the annual Hajj health recommendations issued by the Saudi MoH.

Additionally, pilgrims who sought pre-travel advice from GPs (OR 1.9, 95% CI 1–3.5,  $p = 0.03$ ) or tour group leaders (OR 2.1, 95% CI 1.1–3.8,  $p = 0.01$ ) before travelling to Hajj were twice as likely to be vaccinated as those who did not.

### 3.1.4. Risk perception of diseases

Pilgrims were reportedly concerned about food poisoning (61%, 217/356), diarrhoea (59%, 210/356), influenza (58%, 206/356), blood-borne diseases (49%, 173/356), skin diseases (45%, 160/356), and pneumonia (33%, 117/356). However, there was no association between the level of concern about influenza, pneumonia, and blood-borne diseases and the uptake of the influenza, pneumococcal, and hepatitis B vaccines, respectively (all  $p$ -values  $>0.2$ ).

## 3.2. Post-Hajj study

### 3.2.1. Demographics

A total of 150 returned pilgrims were surveyed. Their demographic characteristics are presented in Table 2. A large proportion of pilgrims (79%, 118/150) had performed Hajj for the first time. They had stayed for a median duration of 25 (range 7–35) days.

### 3.2.2. Participants' perceptions of the effectiveness of preventive measures

The majority of participants, 71% (107/150), believed hand washing (with water only) to be the most effective measure to protect oneself from respiratory infections, while the uses of alcoholic hand rubs (37%, 56/150) and facemasks (35%, 52/150) were considered to be less effective. Only beliefs about the effectiveness of facemasks and hand washing with water and soap were significantly associated with their actual use ( $p < 0.01$ ) (Table 4).

### 3.2.3. Compliance with preventive measures and associated factors

Half of the pilgrims (53%, 80/150) used facemasks to protect themselves from infectious diseases during Hajj at least three times a day. Participants described three major reasons for facemask use: protection from disease (76%, 61/80), protection

**Table 4**

Post-Hajj study: association between participants' beliefs about the effectiveness of preventive measures and compliance with preventive measures

Pilgrims' perception of effectiveness	Compliance n (%)	Non-compliance n (%)	p-Value <sup>a</sup>
Facemask			
Very effective	39 (75)	14 (27)	<0.01*
A little to somewhat effective	37 (48)	40 (52)	
Not effective at all	4 (19)	16 (76)	
Hand washing with water only			
Very effective	64 (60)	43 (40)	0.02*
A little to somewhat effective	18 (46)	21 (54)	
Not effective at all	0	4 (100)	
Use of soap-based hand disinfectant			
Very effective	70 (80)	17 (20)	0.02*
A little to somewhat effective	37 (70)	16 (30)	
Not effective at all	3 (30)	7 (70)	
Alcoholic hand disinfectant			
Very effective	23 (41)	33 (59)	0.06
A little to somewhat effective	17 (28)	44 (72)	
Not effective at all	6 (18)	27 (82)	
Avoiding contact with ill people			
Very effective	19 (26)	54 (74)	0.18
A little to somewhat effective	16 (24)	51 (76)	
Not effective at all	0	10 (100)	

<sup>a</sup> By Chi-square for trend; asterisks indicate a significant difference.

from air pollution (58%, 46/80), and belief that facemasks are effective in preventing ARIs (41%, 33/80). Less than half (47%, 70/150) did not use a facemask. The reasons for non-compliance were breathing discomfort (76%, 53/70), feeling of suffocation (40%, 28/70), and thinking it was not necessary (31%, 22/70). In addition, none of the demographic characteristics were associated with facemask compliance (all  $p$ -values  $>0.25$ ) and therefore these were not entered into multivariable regression analyses.

A subgroup of women ( $n = 76$ ) answered questions on their use of the niqab (traditional face veil); of those who responded, 49% (37/76) used only facemasks, 34% (26/76) used only the niqab, and 20% (15/76) used both a facemask and the niqab. Of those who used the niqab (either alone or with a facemask), 51% (21/41) reported that they did so because it is 'airy' and easier to breathe and 39% (16/41) felt that it was comfortable to use.

### 3.2.4. Hand hygiene

Almost all (94%, 141/150) practised some kind of hand hygiene during Hajj. This included hand washing with soap (73%, 110/150), hand washing with water only (55%, 82/150), and alcoholic hand disinfectant (31%, 46/150). Reasons influencing the pilgrims' decision to use these methods included belief in the effectiveness of hand hygiene in preventing infectious diseases (67%, 94/141) and convenience and ease of use (62.4%, 88/141). Additionally, those with a university education were more likely to use hand hygiene measures than those without (OR 7.9, 95% CI 1.4–42.9,  $p = 0.01$ ).

### 3.2.5. Other measures

Respondents reported using other preventive measures including disposable handkerchiefs (53%, 79/150), avoiding dense crowding (29%, 43/150), avoiding contact with symptomatic people (39%, 58/150), and practicing hand washing after touching the ill (30%, 45/150).

## 4. Discussion

This appears to be the first in-depth quantitative study comparing the health knowledge attitudes, beliefs, and practices of departing and returning Hajj pilgrims regarding preventive measures against infectious diseases. This study found that

receiving pre-travel advice from GPs and tour group leaders was the main facilitator of compliance with preventive measures. Not recognizing the need to receive pre-travel advice was identified as an important barrier. This survey found the influenza vaccine coverage rate among Australian Hajj pilgrims in 2014 to be high (80%). This is consistent with figures reported since 2012,<sup>13,14</sup> and much higher compared to recent data from some other countries such as Turkey where the vaccination rate was only 7.1% during the Hajj 2015,<sup>14</sup> and France where the vaccination rate for 2014 was zero due to vaccine non-availability,<sup>15</sup> and compares well with the overall vaccination rates among international pilgrims over recent decades, which range between 0.7% and 100%.<sup>6,16</sup>

Influenza vaccine aside, the uptake of other recommended vaccines was low. For instance, the uptake of pneumococcal vaccine was only 30%. Previous Australian and international surveys have reported coverage rates ranging from 2.5% to 36%.<sup>6,17</sup> This is concerning because pneumonia is the leading cause of hospital admission and an important cause of mortality at Hajj.<sup>18–20</sup> Furthermore, surveys have shown that many pilgrims were not aware that pneumonia is transmissible<sup>21</sup> and preventable by vaccination.<sup>22</sup> There is currently no formal guidance from the Saudi MoH on the use of pneumococcal vaccine for Hajj pilgrims, which may partly explain this apparent lack of awareness (Table 1).<sup>23</sup>

The uptake of pertussis vaccine was 30%, compared with 10.6% among French Hajj pilgrims in 2005.<sup>24</sup> Additionally, the coverage for hepatitis A and B vaccines were each 17%, which is higher than the 11.5% uptake for hepatitis A reported among French pilgrims in 2005,<sup>24</sup> and the 6% each for hepatitis A and B among Saudi pilgrims in 2010.<sup>25</sup> While a large proportion of Hajj pilgrims are from countries with intermediate to high hepatitis B virus (HBV) prevalence, the risk of contracting HBV at Hajj is not well studied.<sup>26,27</sup> It is known that a significant proportion of pilgrims engage in high-risk behaviours; for example it was found that about 43% of male pilgrims shaved their heads with reused razors,<sup>28</sup> or had their heads shaved by non-professional (unlicensed) barbers.<sup>25</sup> Other studies have also reported high-risk behaviours that increase the risk of hepatitis A, including buying and eating food from street vendors.<sup>29</sup> Despite this, hepatitis A and B vaccines are not listed in the Saudi MoH recommendations for Hajj pilgrims (Table 1).<sup>23</sup>

In this study, polio vaccine uptake was 8%, which is low compared with the uptake among French pilgrims in 2006 (15%),<sup>30</sup> and the uptake among pilgrims from other non-endemic countries in 2013 (43%).<sup>31</sup> Typhoid vaccine coverage was 13% in this study, which compares well with the uptake rate of 9% among international pilgrims in 2002.<sup>32</sup> The present study appears to report MMR (measles, mumps, and rubella) vaccine uptake (10%) for the first time.

The participants cited several reasons for not receiving the recommended vaccines, the most common being that they were unaware that the vaccines were recommended. These results are consistent with the findings of Memish et al., who reported a lack of knowledge to be a significant factor for poor uptake of the seasonal influenza vaccine among pilgrims.<sup>33</sup> Conversely, previous Australian studies have reported reliance on natural immunity as the main reason for not being vaccinated against influenza in 2011, while low risk perception of contracting influenza was the main reason in 2012.<sup>13</sup>

A unique finding of this study is that pilgrims who received pre-travel advice from GPs and Hajj tour group leaders were twice as likely to be vaccinated as those who did not receive such advice. Barasheed et al. found that receiving advice from Hajj group leaders was the main motivator for the uptake of influenza vaccine among Australian Hajj pilgrims in 2012.<sup>13</sup>

This survey also revealed that older pilgrims (aged >40 years) were more likely to take up the recommended vaccines. Similarly,

Gautret et al. demonstrated that influenza vaccine coverage increased with age in French pilgrims.<sup>24</sup> This could be due to the fact that older people are more aware of their health, or it could be due to an increasing number of pre-existing illnesses as people age. Another study among French pilgrims found that 'at risk' pilgrims were significantly more likely to be advised to receive pneumococcal vaccine than those who were not 'at risk'.<sup>22</sup> This may explain why vaccine uptake has been found to increase with age in some studies.<sup>24,34</sup>

Although respiratory infections are the most common diseases during Hajj,<sup>1</sup> the participants in this study were more concerned about food-borne illness than ARIs. Limited knowledge and perception of diseases among pilgrims has been found in other studies; an Australian study found that 42% of pilgrims in 2014 were not aware that pneumonia can be transmissible.<sup>21</sup> Similarly, French pilgrims in 2014 did not perceive pneumonia as a severe condition, and were not aware of the existence of a vaccine against it.<sup>22</sup>

No association was found between the disease risk perception for influenza, pneumonia, and hepatitis B and the uptake of the respective vaccines. This contradicts other data, which demonstrated that an increased risk perception of pandemic influenza A (H1N1) was significantly associated with influenza vaccine uptake among US pilgrims in 2009.<sup>35</sup>

Almost all of the participants in the present study used some kind of hand hygiene; this was higher compared with French pilgrims in 2013 (50%).<sup>36</sup> More than half of the pilgrims used facemasks in this study, similar to French pilgrims in 2013.<sup>36</sup> Nevertheless, previous studies have reported that only half of the participants were aware of the availability of non-pharmaceutical preventive measures against respiratory infections.<sup>9,33</sup>

Belief that hand hygiene is easy to use and effective in preventing infections were the main reasons for uptake among the present sample. Conversely, facemasks were less accepted. Among non-users, discomfort and difficulty in breathing were barriers to their use. Those who used facemasks believed that they were effective in preventing infectious diseases. Similar quantitative findings have been reported among members of the general Singaporean community,<sup>37</sup> but not previously among Hajj pilgrims. Another important factor identified as a driver for the use of facemasks was protection from air pollution. A recent study found that the air pollution level in Makkah during the Hajj consistently exceeds internationally acceptable standards,<sup>38</sup> and therefore this perception is probably justified and could inform health promotion policy.

Thirty-four percent of female pilgrims in the present sample preferred to use a traditional face cover (niqab) to a facemask during Hajj. In contrast, other studies found that higher proportions (over 70%) of Saudi women preferred the niqab over facemasks at Hajj 2002 and 2003.<sup>39,40</sup> In the exploration of why some women prefer using the niqab, it was found that comfort and breathability were contributing factors.

In this study, two thirds of pilgrims sought pre-travel advice from health professionals; this is similar to the results of a survey that found that 65% of Arab pilgrims received health advice before departing to Hajj.<sup>41</sup> GPs were the most cited sources, followed by specialist travel clinics. This result is supported by a study that found GPs to be the most trusted sources of health advice among Australian pilgrims in 2014.<sup>21</sup> Interestingly, only 12% of the present sample sought advice from the Saudi MoH website. This is different to the findings of a study that showed the Saudi MoH to be the main source of health information among pilgrims from Arab countries (69%).<sup>41</sup> This difference may be due to language barriers.

Not recognizing the need to seek pre-travel health advice and the preference for other information sources (i.e., friends, family members, and travel agents) were the main barriers to seeking

professional pre-travel advice. These results support the findings of a recent Australian study, which also demonstrated a high level of confidence in advice from non-health professional sources such as family, friends, and travel agents.<sup>8</sup> The present study identified that being aged between 34 and 49 years was the only factor significantly associated with seeking pre-travel health advice. Therefore, enhancing awareness among other groups of Hajj pilgrims, especially elderly adults and those with pre-existing illnesses, about the importance of seeking professional pre-travel advice could be an important strategy to improve the uptake of preventive measures. Moreover, providing GPs with culturally appropriate health information on Hajj and the preventive measures recommended by the Saudi MoH could also facilitate uptake.<sup>42</sup>

This study has some limitations. Two different groups were surveyed and the groups showed significant differences in demographic characteristics, particularly in sex, education level, and country of birth. Also, the sample size of the post-Hajj group was smaller than intended. These could limit the generalizability of the findings of one group to the other. These limitations are being addressed by a second, larger cohort study among Australian pilgrims during Hajj 2015, and a qualitative study among GPs and tour group leaders is underway. Despite these limitations this study has uniquely identified the barriers to and facilitators of the uptake of preventive measures among Australian Hajj pilgrims, providing important preliminary data upon which to build.

This study shows that there are significant opportunities to improve awareness among Hajj pilgrims about the importance of using preventive health measures and indicates the need for better communication of official health information from the Saudi MoH to a broader international audience.

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