Vaccination in Hajj: An Overview of the Recent Findings

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ABSTRACT

Background: About two million people annually travel to Kingdom of Saudi Arabia to perform Hajj. The pilgrims may be at risk of exposure to communicable diseases in this mass gathering and their vaccination against contagious diseases can prevent many morbidities and mortalities. The aim of our study was to review the papers which evaluated effectiveness and compliance of the vaccines applied in Hajj.

Methods: We used PubMed and Scopus to search international medical databases. The key words were as follows: Hajj, Haj, vaccine, vaccination, and immunization. The time interval of the search was from the beginning of 2010 to May 23, 2016. One hundred and thirty papers were extracted, and their contents were subsequently reviewed after title and abstract screenings. The original articles were included in the study and non-English articles were excluded from the study.

Results: Considering the extracted papers, almost all pilgrims were vaccinated against meningococcal diseases. Using of influenza and pneumococcal vaccine rates were different among the pilgrims. The other vaccines have been taking according to specific conditions.

Conclusions: The findings regarding influenza vaccine effectiveness are contradictory. A few studies confirmed the flu vaccine effectiveness while some others rejected its usefulness. Meningococcal immunization is an effective preventive tool with high compliance for Hajj pilgrims. Further investigations are recommended for the other vaccines.

Keywords: Communicable diseases, preventive medicine, travel medicine, vaccination

INTRODUCTION

About two million people annually travel to Kingdom of Saudi Arabia (KSA) to perform Hajj.¹² The pilgrims are exposed to various infectious agents in this mass gathering. Considering previous research, the prevalent infectious disorders among the pilgrims are respiratory, gastrointestinal, and liver diseases.

Common infectious respiratory diseases are the common cold, influenza, exudative pharyngitis, bronchitis, sinobronchitis, sinusitis, pneumonia (viral, classic, and atypical bacteria and mycobacterial), and superimposed infections on asthma.³⁴ The common infectious gastrointestinal and liver diseases are gastroenteritis, food poisoning, and hepatitis.⁴

Furthermore, the responsible infectious pathogens are reported as follows:

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Respiratory pathogens
Rhinoviruses,\textsuperscript{[5‑7]} coronaviruses (E229 – SARS – MERS),\textsuperscript{[6]} adenoviruses, both seasonal and pandemic influenza\textsuperscript{[7]} including, influenza A (H3N2) and B,\textsuperscript{[8]} influenza H1N1, parainfluenza viruses, respiratory syncytial viruses, herpes simplex virus,\textsuperscript{[8,9]} meningococcal diseases\textsuperscript{[10]} and meningococcal carrier state,\textsuperscript{[11]} emerging hypervirulent strains, i.e., Streptococcus spp.,\textsuperscript{[16]} Haemophilus influenzae,\textsuperscript{[1,11]} Bordetella pertussis,\textsuperscript{[12]} Chlamydia pneumoniae, Legionella pneumophila, Mycoplasma pneumonia,\textsuperscript{[9,10]} and respiratory tuberculosis.\textsuperscript{[13]}

Gastrointestinal and liver pathogens
Food poisoning agents,\textsuperscript{[14]} Vibrio cholerae,\textsuperscript{[15]} Hepatitis A, E, B, and C.\textsuperscript{[16]}

The other pathogens
Brucella,\textsuperscript{[17]} arboviruses,\textsuperscript{[6]} phlebovirus (the cause of rift valley fever),\textsuperscript{[18]} hemorrhagic viruses (Ebola),\textsuperscript{[19]} and Enterobacillus\textsuperscript{[3]} [Table 1].

Based on the above findings, the greatest risk of infections is related to respiratory and gastrointestinal systems, and some effective vaccines against infections of these two systems are available now.

There are different ideas among Hajj researchers about which vaccines should adminster to Hajj pilgrims before their departure to KSA. Hence, the aim of our study was to review the papers which evaluated effectiveness and compliance of the vaccines applied in the Hajj published through the recent years.

METHODS

We used PubMed and Scopus to search international medical databases. The keywords were as follows: Hajj, Haj, vaccine, vaccination, and immunization. The time interval of the search was from the beginning of 2010 to May 23, 2016. The main reason for choosing this period was reviewing only new findings. After removing duplicated records, one hundred and thirty papers were selected, and their contents were subsequently reviewed through title and abstract screenings. The flow diagram of our search steps was presented in Figure 1. All original articles which had evaluated effectiveness or compliance of the vaccines administered in the Hajj were included in the study and non-English articles were excluded from the study. Considering our objectives to discuss the common vaccines which administered to pilgrims and since there is other under review vaccines which most Hajj researchers do not agree with their usages, we excluded the papers of the vaccines which were evaluated only in one paper.

Two review authors extracted data independently from each study regarding authors, type of vaccine, published year, journal, type of study, location of study, pilgrims’

\begin{table}[h]
\centering
\small
\begin{tabular}{|l|l|l|l|}
\hline
\textbf{Category} & \textbf{Pathogen/s} & \textbf{Author/s} & \textbf{Number of reference} \\
\hline
\textbf{Respiratory system} & Rhinoviruses & Alborzi & [5] \\
 & Coronaviruses (E229 – SARS – MERS) & Al-Tawfiq & [6] \\
 & Influenza A (H3N2) & Razavi & [3] \\
 & Influenza B & & \\
 & Influenza H1N1 & Alborzi, Balkhy, Ashshi & [5,8,9] \\
 & Parainfluenza viruses & & \\
 & Respiratory syncytial viruses & & \\
 & Herpes simplex virus & & \\
 & Meningococcal carrier state & Karsany & [11] \\
 & Streptococcus spp. & Razavi & [3] \\
 & Haemophilus influenzae & & \\
 & Bordetella pertussis & Wilder-Smith & [12] \\
 & Chlamydia pneumoniae & Razavi & [3] \\
 & Legionella pneumophila & & \\
 & Mycoplasma pneumoniae & & \\
 & Respiratory tuberculosis & Wilder-Smith & [13] \\
\hline
\textbf{Gastrointestinal and liver pathogens} & Food poisoning agents & Al-Mazrou & [14] \\
 & Vibrio cholerae & Gautret & [15] \\
 & Hepatitis A, E, B, C & Rafiq & [16] \\
 & Enterobacillus & Razavi & [3] \\
\hline
\textbf{The other pathogens} & Brucella & Memish & [17] \\
 & Arboviruses & Al-Tawfiq & [6] \\
 & Phlebovirus (the cause of Rift Valley fever) & Fagbo & [18] \\
 & Hemorrhagic viruses (Ebola) & Al-Tawfiq & [19] \\
\hline
\end{tabular}
\caption{Hajj common infectious pathogens reported by the researchers}
\end{table}
nationality, and a number of participants [Tables 2 and 3]. In the next step, the highlighted points were synthesized according to the objectives of our research. No further assessment was performed regarding the quality of the reviewed manuscripts, and the credit of journals was considered sufficient.

**RESULTS**

Eleven articles on pneumococcal, meningococcal, and influenza vaccines met our criteria. The studies investigated the effectiveness or compliance of different vaccines in the Hajj. Two papers explained both topics.

**Influenza vaccine**

**Effectiveness**

Hasan *et al.* compared the influenza vaccine effectiveness between two groups of vaccinated and nonvaccinated Malaysian Hajj pilgrims. They scored the number of symptoms from 1 to 5. The average score was 0.95 (standard deviation [SD] = 0.9) in the intervention group and 0.88 (SD = 0.69) in the control group (\(P = 0.781\)). In another study, Emamian *et al.* assessed the effects of influenza vaccination on respiratory tract infections excluding the common cold. Twenty-four patients (75%) in the case group and 48 participants (76.2%) in the control group were vaccinated (\(P = 0.898\)). Moreover, Deris *et al.* assessed the effectiveness of the influenza vaccine on acute respiratory symptoms of Malaysian pilgrims but found no effect of the vaccine on respiratory symptoms. Furthermore, Memish *et al.* studied pilgrims from different countries based on their history of pandemic influenza A vaccination and respiratory infections. The frequency of respiratory infections was higher among people who did not vaccinate compared to those who vaccinated (\(P = 0.009\)) [Table 2].

**Compliance**

Barasheed *et al.* estimated the influenza vaccination rate among Australian pilgrims in 2 consecutive years. In 2011, of 431 Australians participated in the survey, 65% mentioned receiving the influenza vaccine. In 2012, of 535 Australians, 89% declared receiving the vaccine. In another Malaysian study, Deris *et al.* calculated the influenza vaccine uptake among Malaysian pilgrims. They found that 72.8% of the pilgrims received influenza

![Figure 1: The flow diagram of our search steps](http://www.ijpvmjournal.net/content/7/1/129)
As well as, Alqahtani et al. in one study carried out on 356 Australian Hajj pilgrims have shown that vaccination rate against influenza before traveling was 80%.\(^{[29]}\)

Memish et al. also investigated the H1N1 vaccine compliance among 519 arriving and 2699 departing pilgrims. Thirty percent of the pilgrims reported that they had vaccinated against pandemic influenza A before departure to the KSA \(^{[23]}\).

### Meningococcal vaccine

**Effectiveness**

Memish et al. conducted another study to analyze invasive meningococcal disease (IMD) surveillance data in KSA from 1995 to 2011. They compared the related data before and after the new policy about using polysaccharide quadrivalent ACWY vaccine for pilgrims. They evaluated the changes between the preepidemic and postepidemic periods. The results showed that the mean annual IMD rate decreased from 0.20 (SD = 0.1–0.06) cases/100,000 (P = 0.02). Moreover, the mean number of Hajj-related diseases changed from 13 (SD = 9.3) to 2 (SD = 2.3) cases/year (P = 0.02).\(^{[24]}\)

Ceyhan et al. performed a study on Turkish Hajjis to assess acquisition of meningococcal carriage in pilgrims who had received polysaccharide quadrivalent ACWY vaccine before their departure to the KSA. They showed that 13% of the 472 participants were meningococcal carriers before Hajj and 27% were meningococcal carriers after Hajj. All of the pilgrims were infected by serogroup W135 \(^{[25]}\).

### Table 3: The characteristics of the papers which evaluated the vaccine compliance in Hajj

| First author | Reference number | Type of vaccine | Published year | Journal | Type of study | Location of study | Pilgrims nationality | Number of participants |
|--------------|------------------|-----------------|----------------|---------|---------------|-------------------|----------------------|-----------------------|
| Memish       | [26]             | Influenza, meningococcal, and pneumococcal | 2014 | The Journal of Infectious Diseases | Cohort | KSA | Various | 3210 pre-Hajj and 2025 post-Hajj pilgrims |
| Memish       | [27]             | Meningococcal   | 2014 | International Journal of Infectious Diseases | Case series | KSA | Various | 861 |
| Barasheed    | [28]             | Influenza       | 2014 | Journal of Travel Medicine | Cross-sectional | Australia | Australian | 431 in 2011 and 535 in 2012 |
| Deris        | [22]             | Influenza       | 2010 | Journal of Travel Medicine | Cross-sectional | Malaysia | Malaysian | 387 |
| Memish       | [23]             | Influenza A     | 2012 | Journal of Travel Medicine | Cross-sectional | KSA | Various 63% Middle Eastern and 37% Asian or African | 519 arriving pilgrims and 2699 departing pilgrims |
| Alqahtani    | [29]             | Influenza       | 2016 | Int J Infect Dis Infectious Disorders – Drug Targets | Cross-sectional | Australia | Australian | 365 |
| Tashani      | [30]             | Pneumococcal   | 2014 | Infectious Disorders – Drug Targets | Cross-sectional | Australia | Australian | 158, 513 and 219 in the years of 2011, 2012 and 2013 respectively |

KSA=Kingdom of Saudi Arabia

carriers before traveling.\(^{[22]}\) As well as, Alqahtani et al. in one study carried out on 356 Australian Hajj pilgrims have shown that vaccination rate against influenza before traveling was 80%.\(^{[29]}\)

Memish et al. also investigated the H1N1 vaccine compliance among 519 arriving and 2699 departing pilgrims. Thirty percent of the pilgrims reported that they had vaccinated against pandemic influenza A before departure to the KSA \(^{[23]}\).

### Pneumococcal vaccine

**Compliance**

Memish et al. evaluated the pilgrim’s immunological profile at the time of their entrance to the KSA. Serum samples of 796 out of 861 pilgrims were collected. A total of 98.2% of the pilgrims were vaccinated by the meningococcal quadrivalent in the last 3 years \(^{[26]}\).

**DISCUSSION**

An important question is whether vaccination against influenza prevents respiratory infections. The findings in various studies are confirmed,\(^{[31]}\) and the efficacy of this
vaccine in the prevention of respiratory diseases in the Hajj is not confirmed in some other studies.\[32\]

Alqahtani et al. reported that the uptake of seasonal influenza vaccine in different studies ranged from 0.7% to 100% with the highest coverage rate in the elderly pilgrims and those with preexisting comorbidities.\[29\] In a study by Razavi et al. on 32,370 Iranian pilgrims, a total of 3465 pilgrims (10.7%) were vaccinated against influenza before departure. The incidence of ILI was about 56% among vaccinated pilgrims against influenza and 72% among those not vaccinated (P < 0.001), with odds ratio = 0.50; thus, the efficacy of the influenza vaccine in this study was 50%.\[41\]

Alfelali et al. in one study carried out on 33,213 pilgrims have shown that overall combined data from studies suggest that over the last decade with increasing of influenza vaccination, the influenza-like illness frequency decreased among Hajj pilgrims (RR = 0.2, P < 0.01).\[13\]

Ziyaeeyan et al.\[14\] in one study conducted on 305 Iranian pilgrims have shown some cases of H1N1 pdm09 among the pilgrims after returning to their original country. Most of the cases had the history of vaccination against seasonal influenza.

The effectiveness of the meningococcal vaccine is satisfactory now. Hence, the Ministry of Health of the KSA has considered it as one of the components of the mandatory immunization programs for all pilgrims entering the KSA for the Hajj. The pilgrims’ compliance is high for meningococcal vaccination.\[22\] Surveillance of meningococcal carriage state in Hajj is recommended.\[10\]

In another study, Madani et al. conducted a study on 392 health-care workers in the Hajj services and assessed their compliance with the meningococcal, influenza, and hepatitis B vaccination. They showed that the vaccination coverage level against meningococcal, influenza, and hepatitis B was suboptimal, very low, and suboptimal, respectively.\[15\] This study confirms our previous idea regarding the compliance of influenza and meningococcal vaccines among Hajj pilgrims.

Likewise, Read et al. showed that the quadrivalent glycoconjugate meningococcal vaccination decreased the pharyngeal meningococcal carrier state among university students in the UK. Therefore, they suggested that it might affect the transmission when widely used.\[106\]

Dbaibo et al., in one study, examined a single-dose vaccine of MenACWY-TT (a kind of meningococcal vaccine conjugated to tetanus toxoid) in 400 healthy adult travelers without the history of tetanus and meningococcal appropriate vaccination. After using a single dose of MenACWY-TT in adults 56 years of age and older, they concluded that this combined vaccine was immunogenic. The vaccine response rate was ≥76%.\[31\]

There are studies that show that the use of pneumococcal vaccine to prevent pneumococcal diseases, especially in high-risk patients is efficient.\[14\] Dabiran et al. suggested that the high-risk groups in Hajj including patients with chronic obstructive pulmonary disease, asthma, chronic bronchitis, emphysema, cardiac diseases, cancers, and those who have been splenectomy should receive pneumovax-23 vaccine.\[18\]

Al-Tawfiq et al. have also stated that the pneumococcal vaccine uptake is 5% in Hajj.\[40\] According to a report by Ridda, 90% of pneumococcal serotypes will be covered by the 23-valent pneumococcal polysaccharide vaccine. Therefore, we can use the pneumococcal vaccine in the Hajj, at least for high-risk groups.\[41\] On the basis of Alqahtani et al. study, the rate of pneumococcal vaccines uptake was low.\[42\]

This author, in another study, has stated that the rate of pneumococcal vaccination among Australian Hajj Pilgrims was 30%.\[29\] The Saudi Thoracic Society recommended that all children smaller than 5 years old, people elder than 50 years old, and adults who have specific risk factors and are elder than 6 years old should be vaccinated against pneumococcal infections.\[39\]

We presented a summary table of the vaccines which are currently mandatory or recommended by the Saudi authorities in Table 4.

**Other vaccines**

**Tetanus, diphtheria, and pertussis vaccine**

Gautret et al., in a cross-sectional survey study which was conducted on 580 pilgrims, reported that the total vaccination rates for tetanus, diphtheria, and poliomyelitis (TdP) were 18.9%, 14.7%, and 15.0%, respectively, which is not an appropriate status.\[43\]

Furthermore, in another study, Gautret and Wilder-Smith recommended using a booster dose of tetanus and diphtheria vaccine for travelers.\[44\] On the basis of Alqahtani et al. study, the rate of diphtheria vaccines uptake was low.\[42\] This author, in another study, has stated that the rate of pertussis vaccine use among Australian Hajj Pilgrims was 30%.\[29\]

In addition, Wilder-Smith et al. performed a prospective seroepidemiological study on 358 adult pilgrims and reported that 1.4% of the pilgrims acquired pertussis. Moreover, they recommended that acellular pertussis vaccine should be administered for the pilgrims before the Hajj.\[42\]

**Poliomyelitis vaccine**

As poliomyelitis currently occurs in a few countries, the travelers of such countries should be vaccinated against it.\[44\]

**Tetanus, diphtheria, and poliomyelitis vaccine**

Gautret et al., in one cross-sectional study conducted on 580 pilgrims, evaluated social determinants of the
Tdp vaccination coverage. They concluded that pilgrims with lower socioeconomic status and linguistic, cultural, and religious characteristics had a low level vaccination against TdP. Inequities of national preventive services were pointed by the authors.

Yellow fever, typhoid, cholera, and rabies vaccines
In a prospective study, Pavli et al. assessed pretravel vaccination in a total of 2494 travelers in Greece. In this study, 615 (24.7%), 28 (1.1%), 12 (0.5%), 1629 (65.3%), and 666 (26.7%) travelers were vaccinated for typhoid fever, cholera, rabies, yellow fever, and meningococcal infections, respectively. The study showed the necessity of revising the recommendations for people who travel to developing countries.[45]

Gautret et al., in a cohort study conducted on 461 Hajj pilgrims to Mecca, reported that the rate of vaccination was low and 87% of travelers did not have an appropriate vaccination for pertussis and hepatitis A, 75% for diphtheria and poliomyelitis, 70% for tetanus, and 67% for influenza.[46]

Currently, polio has been eradicated in most countries except Pakistan, Afghanistan, and Nigeria.[47] Therefore, to participate in the Hajj rituals, polio vaccination against poliomyelitis is also recommended.[49]

Shaving the hair by the male pilgrims, Estehlagh, is one of the rituals in the Hajj. In this situation, the pilgrims will shave their hair. This practice is a mental training for forsaking the interests that may drive a man away from spirituality.

During shaving the hair with contaminated blades, the pilgrims may be exposed to some diseases such as hepatitis. Therefore, shaving hygiene and vaccination against diseases such as hepatitis should also be considered.

In an endemic area for rabies where the people are attacked by suspicious animals, they must be vaccinated against the disease on days 0, 3, 7, 14, and 28.[49]

In this situation, vaccination should be continued during the journey. Therefore, health managers should be prepared to manage these cases, and the principles should not be forgotten.

Moreover, Al-Tawfiq et al. strongly recommended vaccination against yellow fever and poliomyelitis for the pilgrims of high-risk countries and against meningococcal infections for all pilgrims.[49]

Table 4: The vaccines which are currently mandatory or recommended based on the countries (released by the Ministry of Health of Kingdom of Saudi Arabia)

| Vaccine                  | Mandatory                                                                      | Recommended                                      |
|--------------------------|--------------------------------------------------------------------------------|--------------------------------------------------|
| Yellow fever             | Angola, Benin, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Cote d’Ivoire, Democratic Republic of the Congo, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Mali, Mauritania, Niger, Rwanda, Senegal, Sierra Leone, The Republic of South Sudan, Sudan, Togo, Uganda, Argentina, Bolivarian Republic of Venezuela, Brazil, Colombia, Ecuador, French Guiana, Guyana, Panama, Paraguay, Peru, Plurinational State of Bolivia, Suriname, and Trinidad and Tobago. All means of transportations come from these countries, all ships. | Other countries                                    |
| Meningococcal vaccine    | All countries                                                                  | -                                                |
|                          | All citizens and residents of Medina and Mecca Hajj workers and any individual working in contact with pilgrims in the KSA |                                                  |
| Poliomyelitis             | Afghanistan, Nigeria, Pakistan, Cameroon, Chad, Ethiopia, Kenya, Niger, Somalia, Syria Equatorial Guinea, Yemen, and Iraq | Others particularly India and Indonesia            |
| Seasonal influenza        | -                                                                              | Groups particularly India and Indonesia (e.g., international pilgrims, pregnant women, children over 5, elderly, preexisting health condition such as asthma, chronic heart and lung disease, HIV/AIDS infection, internal pilgrims, all health-care workers) |}
| Diphtheria                | -                                                                              | All                                              |
| Tetanus                  | -                                                                              | All                                              |
| Pertussis                | -                                                                              | All                                              |
| Polio                    | -                                                                              | All                                              |
| Measles                  | -                                                                              | All                                              |
| Mumps                    | -                                                                              | All                                              |
CONCLUSIONS

Meningococcal immunization is an effective preventive tool with high compliance among pilgrims. The findings regarding influenza vaccine effectiveness are contradictory. Hence, further investigations are recommended through original research particularly large cohorts in different populations.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

Received: 03 Mar 16 Accepted: 16 Nov 16
Published: 15 Dec 16

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