



## 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.<sup>[1,2]</sup> 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.<sup>[3,4]</sup> The common infectious gastrointestinal and liver diseases are gastroenteritis, food poisoning, and hepatitis.<sup>[4]</sup>

Furthermore, the responsible infectious pathogens are reported as follows:

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## Respiratory pathogens

Rhinoviruses,<sup>[3-5]</sup> coronaviruses (E229 – SARS – MERS),<sup>[6]</sup> adenoviruses, both seasonal and pandemic influenza<sup>[7]</sup> including, influenza A (H3N2) and B,<sup>[3]</sup> influenza H1N1, parainfluenza viruses, respiratory syncytial viruses, herpes simplex virus,<sup>[5,8,9]</sup> meningococcal diseases<sup>[10]</sup> and meningococcal carrier state,<sup>[11]</sup> emerging hypervirulent strains, i.e., *Streptococcus* spp.,<sup>[10]</sup> *Haemophilus influenzae*,<sup>[3]</sup> *Bordetella pertussis*,<sup>[12]</sup> *Chlamydomphila pneumoniae*, *Legionella pneumophila*, *Mycoplasma pneumoniae*,<sup>[3]</sup> and respiratory tuberculosis.<sup>[13]</sup>

## Gastrointestinal and liver pathogens

Food poisoning agents,<sup>[14]</sup> *Vibrio cholerae*,<sup>[15]</sup> Hepatitis A, E, B, and C.<sup>[16]</sup>

## The other pathogens

*Brucella*,<sup>[17]</sup> arboviruses,<sup>[6]</sup> phlebovirus (the cause of rift valley fever),<sup>[18]</sup> hemorrhagic viruses (Ebola),<sup>[19]</sup> and *Enterobacillus*<sup>[3]</sup> [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 administer 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'

**Table 1: Hajj common infectious pathogens reported by the researchers**

Category	Pathogen/s	Author/s	Number of reference
Respiratory system	Rhinoviruses	Alborzi	[5]
	Coronaviruses (E229 – SARS – MERS)	Al-Tawfiq	[6]
	Influenza A (H3N2)	Razavi	[3]
	Influenza B		
	Influenza H1N1	Alborzi,	[5,8,9]
	Parainfluenza viruses	Balkhy,	
	Respiratory syncytial viruses	Ashshi	
	Herpes simplex virus		
	Meningococcal carrier state	Karsany	[11]
	<i>Streptococcus</i> spp.	Razavi	[3]
	<i>Haemophilus influenzae</i>		
	<i>Bordetella pertussis</i>	Wilder-Smith	[12]
	<i>Chlamydomphila pneumoniae</i>	Razavi	[3]
	<i>Legionella pneumophila</i>		
	<i>Mycoplasma pneumoniae</i>		
Gastrointestinal and liver pathogens	Respiratory tuberculosis	Wilder-Smith	[13]
	Food poisoning agents	Al-Mazrou	[14]
	<i>Vibrio cholerae</i>	Gautret	[15]
	Hepatitis A, E, B, C	Rafiq	[16]
	<i>Enterobacillus</i>	Razavi	[3]
The other pathogens	<i>Brucella</i>	Memish	[17]
	Arboviruses	Al-Tawfiq	[6]
	Phlebovirus (the cause of Rift Valley fever)	Fagbo	[18]
	Hemorrhagic viruses (Ebola)	Al-Tawfiq	[19]

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

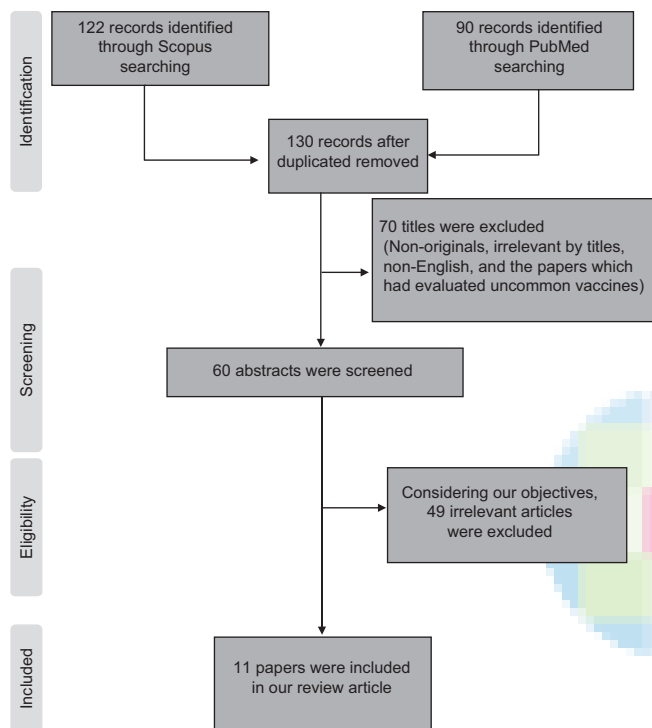


Figure 1: The flow diagram of our search steps

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 ( $P = 0.781$ ).<sup>[20]</sup> 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 ( $P = 0.898$ ).<sup>[21]</sup> 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.<sup>[22]</sup> 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].<sup>[23]</sup>

#### 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.<sup>[28]</sup>

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

Table 2: The characteristics of the papers which evaluated the vaccine effectiveness in Hajj

First author	Reference number	Type of vaccine	Published year	Journal	Type of study	Location of study	Pilgrims nationality	Number of participants
Hasan	[20]	Influenza	2014	J Immigrant Minority Health	Cohort	Malaysia	Malaysian	65 in the vaccinated group and 41 in the control group
Emamian	[21]	Influenza	2012	Int J Prev Med	Nested case-control	KSA	Iranian	338
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	A total of 519 arriving pilgrims and 2699 departing pilgrims were examined
Memish	[24]	Meningococcal	2013	Euro Surveillance	Case series	KSA	Saudi citizens, residents, foreign pilgrims, and illegal immigrants	265 in preepidemic and 184 in postepidemic periods
Ceyhan	[25]	Meningococcal	2013	Clinical and Vaccine Immunology	Cohort	Turkey	Turkish	472 before the Hajj and 296 after the Hajj

**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 India: 17.1% Indonesia: 12.9% Pakistan: 11.9% Turkey: 10.7% and others	3210 pre-Hajj and 2025 post-Hajj pilgrims
Memish	[27]	Meningococcal	2014	International Journal of Infectious Diseases	Case series	KSA	Various Indonesia: 18.62% Pakistan: 14.17% India: 13.36% and Turkey: 12.01%	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	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

vaccine before traveling.<sup>[22]</sup> 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%.<sup>[29]</sup>

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 [Table 3].<sup>[23]</sup>

### 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 (SD = 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 ( $P = 0.02$ ).<sup>[24]</sup>

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 [Table 2].<sup>[25]</sup>

#### 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 [Table 3].<sup>[26]</sup>

### Pneumococcal vaccine

#### Compliance

Tashani *et al.* assessed a group of Australian pilgrims over 3 consecutive years with the aim of the evaluation of the pneumococcal vaccine uptake. The frequencies were as follows: 28.5% (2011), 28.7% (2012), and 14.2% (2013), respectively.<sup>[30]</sup>

In addition, Memish *et al.* evaluated nasopharyngeal samples of 5235 pilgrims from different countries. Only 4.2% of the pilgrims were vaccinated against pneumococcal diseases [Table 3].<sup>[27]</sup>

## DISCUSSION

An important question is whether vaccination against influenza prevents respiratory infections. The findings in various studies are confirmed,<sup>[31]</sup> and the efficacy of this

vaccine in the prevention of respiratory diseases in the Hajj is not confirmed in some other studies.<sup>[32]</sup>

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.<sup>[29]</sup> 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%.<sup>[31]</sup>

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,  $P < 0.01$ ).<sup>[33]</sup>

Ziyaeyan *et al.*<sup>[34]</sup> 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.<sup>[27]</sup> Surveillance of meningococcal carriage state in Hajj is recommended.<sup>[10]</sup>

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.<sup>[35]</sup> 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.<sup>[36]</sup>

Dbaiibo *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  $\geq 76\%$ .<sup>[37]</sup>

There are studies that show that the use of pneumococcal vaccine to prevent pneumococcal diseases, especially in high-risk patients is efficient.<sup>[38,39]</sup> 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.<sup>[38]</sup>

Al-Tawfiq *et al.* have also stated that the pneumococcal vaccine uptake is 5% in Hajj.<sup>[40]</sup> 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.<sup>[41]</sup> On the basis of Alqahtani *et al.* study, the rate of pneumococcal vaccines uptake was low.<sup>[42]</sup>

This author, in another study, has stated that the rate of pneumococcal vaccination among Australian Hajj Pilgrims was 30%.<sup>[29]</sup> 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.<sup>[39]</sup>

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.<sup>[43]</sup>

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

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.<sup>[12]</sup>

#### *Poliomyelitis vaccine*

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

#### *Tetanus, diphtheria, and poliomyelitis vaccine*

Gautret *et al.*, in one cross-sectional study conducted on 580 pilgrims, evaluated social determinants of the

**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 Haj 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	-	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

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.<sup>[43]</sup>

**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.<sup>[45]</sup>

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.<sup>[46]</sup>

Currently, polio has been eradicated in most countries except Pakistan, Afghanistan, and Nigeria.<sup>[47]</sup> Therefore,

to participate in the Hajj rituals, polio vaccination against poliomyelitis is also recommended.<sup>[48]</sup>

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.<sup>[49]</sup>

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.<sup>[19]</sup>

## 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.

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## Conflicts of interest

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