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Full Length Research Paper

Potential risk of *Streptococcus pneumoniae* in Nasopharyngeal Carriage during Umrah and Hajj Seasons in Makkah, Saudi Arabia

Ayman K. Johargy[1], Aiman M. Momenah[1], Sami S. Ashgar[1], Hani S. Faidah[1], Hamdi M. El-Said[1]*, Atif Asghar[2], Ameen Alherabi[2], Ashraf E. Sorour[1], Ibrahim S. Alayed[3], Baraa T. Melibari[3], Rayan A. Monshi[3] and Omar M. Alsaati[3]

[1]Medical Microbiology Department, Faculty of Medicine, Umm Al-Qura University, Makkah, Saudi Arabia
[2]Custodian of the Two Holy Mosques Institute of the Hajj Research ,Umm Al-Qura University, Makkah, Saudi Arabia
[3]Faculty of Medicine, Umm Al-Qura University, Makkah, Saudi Arabia

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Hajj and Umrah poses many health challenges and lead to a higher risk of acquiring and disseminating infectious diseases, as a result of mass gatherings and shared accommodation and air pollution. Nasal colonization by *Streptococcus pneumoniae* is a major contributing factor for pneumococcal disease that still one of the major causes of morbidity and mortality worldwide. The aim of this study was to the detection and evaluate of *S. pneumoniae* in the nasopharyngeal carriage and the antibiotic susceptibility patterns of *S. pneumoniae* isolates in different ethnic groups, during Umrah and Hajj Season. A total of 3184 nasal swab were collected from 979/613 Umrah visitors/Pilgrims, swab from each one upon arrival and swab before leaving Saudi Arabia, during the period from March to November 2009 G. Samples were cultured for the presence of *S. pneumonia* by stander laboratory procedures in the Microbiology research laboratory, Faculty of Medicine, Umm Al-Qura University. The carriage rate of *S. pneumoniae* was 0% before performing Umrah and 6.41% after performing Umrah and 80% from isolates after Umrah were sensitive to Cefotaxime, Ceftriaxone, Rifampicin and Meropenem antibiotics. The carriage rate of *S. pneumoniae* was 0.7% before performing Hajj and1% after performing Hajj and 75% from isolates before Hajj and 66.7% after Hajj were sensitive to the previous antibiotics. This study revealed that ethnic groups carries *S. pneumoniae* were more after performing Hajj and Umrah than before Hajj and Umrah. Thus, we recommend to repeat this study after few years to evaluate the carriage rate of *S. pneumoniae* in Umrah visitors and Pilgrims and adding controls from Saudi nationals to any upcoming study in order to compare the carriage rate of *S. pneumoniae* in Umrah visitors, Pilgrims and Saudi nationals, for designing control strategies for these infectious diseases during Umrah and Hajj seasons.

Keywords: *Streptococcus pneumoniae*, nasopharyngeal carriage, Hajj and Umrah, ethnic groups, Saudi Arabia.

INTRODUCTION

Hajj is the greatest ritual gathering of Muslims from around the world. It takes place in holy Makah. The congregation of so many people from different parts of the world in unavoidably overcrowded conditions within a confined area for a defined period of time presents many public health challenges and health risks are greatly increased with potential for both local and international consequences. One of the main health problems correlated with crowding is respiratory tract and

*Corresponding Author E-mail: hamdimustafa1@gmail.com; Mobile: 00966551941735

meningitis infections due to its ease of transmission by air droplets (Memish et al., 2014; Al-Tawfiq and Memish, 2012). These infections can be transmitted from infected people and more significantly from asymptomatic carriers due to absence of symptoms (Qureshi et al., 2000; Wilder-Smith and Memish, 2003). The human nasopharynx and nares are densely colonized by a broad variety of micro organisms including commensal bacteria as well as potentially pathogenic bacteria (PPB) such as *Streptococcus pneumoniae*. Studies have shown that colonization with PPB is a major contributing factor for respiratory and extra-respiratory infections including pneumonia and meningitis in PPB carriers as well as their closed contacts (Johargy et al., 2011; Cardozo et al., 2006; Kadioglu et al., 2008; Peacock et al., 2001). The reported rates of PPB colonization acquisition and carriage vary extensively between different studies and geographical sites (Musher, 2005; Tenover and Gaynes, 2000; Ruoff et al., 2003; Melles et al., 2007; Fontanals et al., 2000). These differences have been related to genetic background variables and socio-economic conditions including housing, access to health care, poor hygiene, and overcrowded living conditions (Gili Regev et al., 2004; Garcia–Rodriguez and Martinez, 2002). *S. pneumoniae* (the pneumococcus) is a Gram-positive aerobic commensal bacterium which forms part of the normal flora in the nasophary (Hosseini et al., 2015). The pneumococcus can evade the immune system through a combination of surface expressed and secreted virulence factors to cause mucosal diseases such as otitis media, sinusitis and pneumonia, as well as systemic diseases such as bacteremia and meningitis (Anh et al., 2007; Bogaert, 2004). These diseases, collectively termed pneumococcal disease, can be classified as invasive or non-invasive disease. Otitis media, sinusitis and non-bacteremic pneumococcal pneumonia are examples of non-invasive disease which are confined to the mucosal surface, whereas bacteremic pneumonia, bacteremia and meningitis are examples of invasive disease. Bacteremic pneumococcal pneumonia, defined as having pneumonia and a positive blood culture (Jover, 2008). Invasive pneumococcal disease is thought to progress from colonization to bacteremia, with or without pneumonia, only a minority of cases developing meningitis. Pneumonia accounts for 19% of all under 5 year old deaths worldwide, which makes it the most deadly infectious illness for this age group (Wardlaw, 2006). The pneumococcus is the leading cause of pneumonia in children and it has been reported to cause over 50% of severe pneumonia cases in Africa (Adetifa et al., 2012; Weinberger et al., 2013). Pneumococcal disease is most prevalent in the young and the elderly. Pneumococcal pneumonia is treatable using antibiotic therapy. However, where treatment is delayed or unavailable mortality is high (Al-Tawfiq and Memish, 2015; Turner, 2008). Previously, the developing world had focused on treating pneumococcal disease rather than preventing it, but with the current increase in antibiotic resistance, it is widely accepted that prevention is the key to minimizing the disease burden (King, 1996). Vaccination offers the most efficient and cost-effective method of preventing this disease. However, there are more than 90 pneumococcal serotypes which make development of a vaccine to provide universal protection a big challenge. There are two formulations of pneumococcal vaccines that have been licensed thus far: polysaccharide vaccines (Pups) and protein conjugate vaccines (PCVs). The 23-valent pneumococcal polysaccharide vaccine, which contains purified capsular polysaccharide antigens from 23 serotypes, offers some protection against invasive pneumococcal disease in adults but is not effective in either children less than 2 years of age or immune compromised adults (Cutts, 2005; Ansaldi et al., 2012). PCVs, which contain purified capsular polysaccharides conjugated to a carrier protein, offer protection against both pneumonia and invasive disease in children and immune compromised adults (Qazi, 2007; Samir et al., 2014). The availability of a vaccine against some *S. pneumoniae* serotypes has risen the concern of increasing colonization rate by other strains that are not part of the vaccines currently available, which may explains the continuous appearance of clinical cases in some areas. This information is important particularly in the crowding seasons due to gathering of millions of people in a confined area, which means an increasing chance of colonization and infection with those serotypes not included in the currently available vaccines. An example of this importance is what happened in the pilgrimages of 2000 and 2001 which were associated with an increased number of *Neisseria meningitidis* sero group W135 infections in pilgrims and their close contacts (Ashgar et al., 2013). Many infections with this previously uncommon strain were subsequently reported from several countries in Europe, Africa and the Middle East with a high mortality rate resulting in the requirement of vaccination with quadrivalent polysaccharide vaccine (PS) before entering Saudi Arabia (Memish, 2002; Benkouiten et al., 2014). Although PS vaccination prevents the disease, it cannot prevent the carriage. The aim of the present study was to evaluate the potentially pathogenic bacteria in, Umrah visitors, pilgrims and carriers during Umrah and Hajj seasons in order to determine: the Colonization of potentially pathogenic bacteria in different ethnic groups, to find out any significant correlation between carriage rate and ethnic group and the risk of transmission of highly virulent PPB circulating to other countries during the season by their returning Umrah visitors and Pilgrims.

MATERIAL AND METHODS

Study design

This study was performed on 979 Umrah visitors from different nationalities including; 129 Turkish, 127 Indonesian, 102 Pakistani, 99 Syrian, 98 Nigerian, 79 Egyptian, 77 Iranian, 71 Indian, 56 British, 56 Iraqi, 39 Malaysian, 27 Libyan, 14 Swedish, 4 American and 1 Jordanian, during the period from March to end of August 2009 G and also in 613 Pilgrims from different nationalities including; 161 Indian, 102 Nigerian, 95 Indonesian, 90 Libyan, 68 Syrian, 46 British, 35 Turkish, 11 Australian, 3 Swedish and 2 Iranian during the period from October to end of November 2009 G in the Microbiology research Laboratory, Faculty of Medicine , Umm al-Qura university.

Samples collection

Around 3184 nasopharyngeal swabs were collected from 979/613 Umrah visitors/Pilgrims, swab from each Umrah visitor/Pilgrim at arrival to Saudi Arabia and swab before Leaving the country. The swabs were collected at arrival of the Umrah visitors/Pilgrims to King Abdul-Aziz International Airport (KAAIA), and data forms including; nationality, age, sex, smoking, coughing, sore throat, antibiotic usage, date of collection, contacts numbers for the group's leaders, were recorded for each visitors/Pilgrims. While, the remaining swabs were then collected before departure from KAAIA from the same visitors/Pilgrims. All Samples were collected on Amies transport swabs media and transported to the Microbiology research laboratory without any delay.

Laboratory procedures

All samples were cultured for the presence of *S. pneumoniae* in the Microbiology research laboratory, under complete aseptic conditions and incubated at 37C^{o} and 5% CO2. *S. pneumoniae* was isolated from blood agar and chocolate agar plates after an overnight incubation and identified according to stander laboratory procedures, by colony morphology, alpha-hemolysis, Gramstain, optchin sensitivity disc and bile solubility test. The susceptibility tests were performed according to the Clinical and Laboratory Standards Institute (CLSI) (Wayne, 2014).

RESULTS AND DISCUSSION

Overall prevalence of *S.pneumoniae* isolated from Umrah visitors during the Umrah season

Out of 1958 nasopharyngeal swabs were collected from 979 Umrah Visitors selected in this study, 129 were of Turkish nationality. The carriage rate of the potentially pathogenic bacteria among the 129 Turkish Umrah Visitors were 0 (0%) positive for *S. pneumoniae* before performing Umrah and 1 (0.8%) were positive after performing Umrah and this difference was not statistically significant (p-value = 1.0). 126 were of Indonesian nationality. The carriage rate of the potentially pathogenic bacteria among the 126 Indonesian Umrah Visitors were, 0 (0%) positive for *S.pneumoniae* before performing Umrah and 1 (0.8%) were positive after performing Umrah and this difference was not statistically significant (p-value = 1.0).102 were of Pakistani nationality. The carriage rate of the potentially pathogenic bacteria among the 102 Pakistani Umrah Visitors were 0 (0%) no *S. pneumoniae* was isolated from Pakistani Umrah Visitors before or after performing Umrah. 99 were of Syrian nationality. The carriage rate of the potentially pathogenic bacteria among the 99 Syrian Umrah Visitors were0 (0%) no *S. pneumoniae* was isolated from Syrian Umrah Visitors before or after performing Umrah.98 were of Nigerian nationality. The carriage rate of the potentially pathogenic bacteria among the 98 Nigerian Umrah Visitors were 0 (0%) no *S. pneumoniae* was isolated from Nigerian Umrah Visitors before or after performing Umrah. 79 were of Egyptian nationality. The carriage rate of the potentially pathogenic bacteria among the 79 Egyptian Umrah Visitors were0 (0%) positive for *S. pneumoniae* before performing Umrah and 1 (1.3%) were positive after performing Umrah and this difference was not statistically significant (p-value = 1.0). 77 were of Iranian nationality. The carriage rate of the potentially pathogenic bacteria among the 77 Iranian Umrah Visitors were 0 (0%) no *S. pneumoniae* was isolated from Iranian Umrah Visitors before or after performing Umrah.71 were of Indian nationality. The carriage rate of the potentially pathogenic bacteria among the 71 Indian Umrah Visitors were 0 (0%) no *S. pneumoniae* was isolated from Indian Umrah Visitors before or after performing Umrah. 56 were of British nationality. The carriage rate of the potentially pathogenic bacteria among the 56 British Umrah Visitors were 0 (0%) were positive for *S. pneumoniae* before performing Umrah and 2 (3.5%) were positive after performing Umrah and this difference was not statistically significant (p-value = 0.5).56 were of Iraqi nationality. The carriage rate of the potentially pathogenic bacteria among the 56 Iraqi Umrah Visitors were 0 (0%) no *S. pneumoniae* was isolated from Iraqi Umrah Visitors before or after performing Umrah. 39 were of Malaysian nationality. The carriage rate of the potentially pathogenic bacteria among the 39 Malaysian Umrah Visitors were 0 (0%) no *S. pneumoniae* was isolated from Malaysian Umrah Visitors before or after performing Umrah. 27 were of Libyan nationality. The carriage rate of the potentially pathogenic bacteria among the 27 Libyan Umrah Visitors were 0 (0%) no *S. pneumoniae* was isolated from Libyan Umrah Visitors before or after performing Umrah. 14 were of Swedish

Table 1. Overall prevalence of *Streptococcus pneumoniae* isolated from different nationalities of the Umrah visitors during the Umrah season

Nationality	Number of Umrah visitors tested	Before Umrah				After Umrah				P-value of difference between positive Umrah visitors before performing Umrah and positive Umrah visitors after performing Umrah
		+ Umrah visitors		- Umrah visitors		+ Umrah visitors		- Umrah visitors		
		No.	%	No.	%	No.	%	No.	%	
Turkish	129	0	0	129	100.00	1	0.78	128	99.22	P=1.0 Not Significant
Indonesian	127	0	0	127	100.00	1	0.79	126	99.21	P=1.0 Not Significant
Pakistani	102	0	0	102	100.00	0	0	102	100.00	-
Syrian	99	0	0	99	100.00	0	0	99	100.00	-
Nigerian	98	0	0	98	100.00	0	0	98	100.00	-
Egyptian	79	0	0	79	100.00	1	1.27	78	98.73	P = 1.0 Not Significant
Iranian	77	0	0	77	100.00	0	0	77	100.00	-
Indian	71	0	0	71	100.00	0	0	71	100.00	-
British	56	0	0	56	100.00	2	3.57	54	96.43	P = 0.5 Not Significant
Iraqian	56	0	0	56	100.00	0	0	56	100.00	-
Malaysian	39	0	0	39	100.00	0	0	39	100.00	-
Libyan	27	0	0	27	100.00	0	0	27	100.00	-
Sweden	14	0	0	14	100.00	0	0	14	100.00	-
American	4	0	0	4	100.00	0	0	4	100.00	-
Jordanian	1	0	0	1	100.00	0	0	1	100.00	-
Total	**979**	**0**	**0**	**979**	**100.00**	**5**	**6.41**	**974**	**93.59**	**P=0.0622 Not Quite Significant**

nationality. The carriage rate of the potentially pathogenic bacteria among the 14 Swedish Umrah Visitors were 0 (0%) no *S. pneumoniae* was isolated from Swedish Umrah Visitors before or after performing Umrah. 4 were of American nationality. The carriage rate of the potentially pathogenic bacteria among the 4 American Umrah Visitors were 0 (0%) no *S. pneumoniae* was isolated from American Umrah Visitors before or after performing Umrah.1 was of Jordanian nationality. No potentially pathogenic bacteria were isolated from the Jordanian Umrah Visitor before or after performing Umrah. Table1. Summarize the prevalence of the potentially pathogenic bacteria isolated from Umrah visitors during the Umrah season. (Table 1) .

In this study 5 *Streptococcus pneumoniae* isolates were isolated. These isolates were distributed as the following according to different nationalities: 1 isolate was isolated from Turkish Umrah visitors, 0 before Umrah and 1 after Umrah, 1 isolate were isolated from Indonesian Umrah visitors, 0 before Umrah and 1 after Umrah, 1 isolate was isolated from Egyptian Umrah visitors, 0 before Umrah and 1 after Umrah, and 2 isolates were isolated from British Umrah visitors, 0 before Umrah and 2 after Umrah.

Out of the 979 Umrah visitors tested in this study for the presence of the potentially pathogenic bacteria, *Streptococcus pneumoniae* was isolated from 0 (0%) Umrah visitors before performing Umrah and 5 (6.41%) Umrah visitors after performing Umrah. The difference in the prevalence of positive *Streptococcus pneumoniae* from the Umrah visitors before and after performing Umrah was statistically not quite significant (p-value = 0.06).

Overall prevalence of *Streptococcus pneumoniae* isolated from Pilgrims during the Hajj season

In this study 1226 samples (2 samples from each pilgrim, one at arrival to Saudi Arabia and one before leaving the country) were collected from 613 pilgrims from different nationalities including; 161 Indian, 102 Nigerian, 95 Indonesian, 90 Libyan, 68 Syrian, 46 British, 35 Turkish, 11 Australian, 3 Swedish and 2 Iranian. The carriage rate of the potentially pathogenic bacteria among the 161 Indian pilgrims were 1 (0.6%) positive for *Streptococcus pneumoniae* before performing Hajj and 3 (1.9%) were positive after performing Hajj and this difference was not statistically significant (p-value = 0.6). The carriage rate of the potentially pathogenic bacteria among the 102 Nigerian pilgrims were 1 (1%) positive for *Streptococcus pneumoniae* before performing Hajj and 1 (1%) were positive after performing Hajj and this difference was not statistically significant (p-value = 1.0). The carriage rate of the potentially pathogenic bacteria among the 95 Indonesian pilgrims were 1 (1.1%) were positive for *Streptococcus pneumoniae* before performing Hajj and 0

Table 2. Overall prevalence of *Streptococcus pneumoniae* isolated from different nationalities of the Pilgrims during the Hajj season

Nationality	Number of Pilgrims tested	Before Hajj		After Hajj		P-value of difference between positive pilgrims before performing Hajj and positive pilgrims after performing Hajj
		+ Pilgrims	- Pilgrims	+ Pilgrims	- Pilgrims	
Indian	161	1 (0.6%)	160 (99.4%)	3 (1.9%)	158 (98.1%)	0.6 not significant
Nigerian	102	1 (1%)	101 (99%)	1 (1%)	101 (99%)	1.0 not significant
Indonesian	95	1 (1.1%)	94 (98.9%)	0 (0%)	95 (100%)	1.0 not significant
Libyan	90	1 (1.1%)	89 (98.9%)	1 (1.1%)	89 (98.9%)	1.0 not significant
Syrian	68	0 (0%)	68 (100%)	0 (0%)	68 (100%)	-
British	46	0 (0%)	46 (100%)	0 (0%)	46 (100%)	-
Turkish	35	0 (0%)	35 (100%)	0 (0%)	35 (100%)	-
Australian	11	0 (0%)	11 (100%)	1 (9.1%)	10 (90.9%)	1.0 not significant
Swedish	3	0 (0%)	3 (100%)	0 (0%)	3 (100%)	-
Iranian	2	0 (0%)	2 (100%)	0 (0%)	2 (100%)	-
Total	**613**	**4 (0.7%)**	**609 (99.3%)**	**6 (1%)**	**607 (99%)**	**0.8 not significant.**

(0%) were positive after performing Hajj and this difference was not statistically significant (p-value = 1.0). The carriage rate of the potentially pathogenic bacteria among the 90 Libyan pilgrims were 1 (1.1%) were positive for *Streptococcus pneumoniae* before performing Hajj and 1 (1.1%) were positive after performing Hajj and this difference was not statistically significant (p-value = 1.0). The carriage rate of the potentially pathogenic bacteria among the 68 Syrian pilgrims were no *Streptococcus pneumoniae* was isolated from Syrian pilgrims before or after performing Hajj. The carriage rate of the potentially pathogenic bacteria among the 46 British pilgrims were no *Streptococcus pneumonia* was isolated from British pilgrimsbefore or after performing Hajj. The carriage rate of the potentially pathogenic bacteria among the 35 Turkish pilgrims were no *Streptococcus pneumoniae* was isolated from Turkish pilgrimsbefore or after performing Hajj. The carriage rate of the potentially pathogenic bacteria among the 11 Australian pilgrims were 0 (0%) were positive for *Streptococcus pneumoniae* before performing Hajj and 1 (9.1%) were positive after performing Hajj and this difference was not statistically significant (p-value = 1.0). The carriage rate of the potentially pathogenic bacteria among the 3 Swedish pilgrims were no *Streptococcus pneumonia* was isolated from Swedish pilgrimsbefore or after performing Hajj. The carriage rate of the potentially pathogenic bacteria among the 2 Iranian pilgrims were no *Streptococcus pneumonia* was isolated from Iranian pilgrimsbefore or after performing Hajj. Out of the 613 pilgrims tested in this study for the presence of the potentially pathogenic bacteria *Streptococcus pneumoniae* was isolated from 4 (0.7%) pilgrims before performing Hajj and 6 (1%) pilgrims after performing Hajj.

The difference in the prevalence of positive *Streptococcus pneumoniae* from the pilgrims before and after performing Hajj was not statistically significant (p-value = 0.8). (Table 2).

Antibiotics susceptibility testing of *S.pneumoniae* isolated from Umrah Visitors during the Umrah season

The following antibiotics were used for antimicrobial susceptibility testing: benzylpenicillin, cefoxitin, clindamycin, erythromycin, fosfomycin, gentamycin, clindamycin, lefofloxacin, linezoid, moxifloxacin, mupirocin, oxacillin, rifampicin, teicoplanin, tetracycline, tigecyclin, tobramycin, trimetho-prim/sulfamethoxazole, vancomycin, ceftriaxone, meropenem, ciprofloxacin, levofloxacine, azithromycine, augmentine and ceftazidime. For the 5 *Streptococcus pneumoniae* isolates isolated from Umrah Visitors in this study, (80%) isolates after Umrah were sensitive to Cefotaxime, Ceftriaxone, Rifampicin and Meropenem antibiotics. While, in the other side, (80%) isolates after Umrah were resistant to Erythromycin and Trimethoprim-sulfamethoxazole antibiotics. (Table 3).

Antibiotics susceptibility testing of *Streptococcus pneumoniae* isolated from Pilgrims during the Hajj season

For the 10 *Streptococcus pneumoniae* isolates isolated from pilgrims in this study, (75%) isolates before Hajj and (66.7%) isolates after Hajj were sensitive to Cefotaxime, Ceftriaxone Ciprofloxacin, Levofloxacin, Rifampicin, Meropenem and Augmentin antibiotics. (Table 4).

Table 3. Antimicrobial Susceptibility of *S.pneumoniae* isolated from Umrah visitors during the Umrah season

ANTIBIOTICS	Before Umrah Total (0)				After Umrah Total (5)			
	Susceptible	%	Non-susceptible	%	Susceptible	%	Non-susceptible	%
Azithromycine	0	0.00	0	0.00	3	60.00	2	40.00
Cefotaxime	0	0.00	0	0.00	4	80.00	1	20.00
Ceftriaxone	0	0.00	0	0.00	4	80.00	1	20.00
Ciprofloxacin	0	0.00	0	0.00	3	60.00	2	40.00
Levofloxacin	0	0.00	0	0.00	3	60.00	2	40.00
Erythromycin	0	0.00	0	0.00	1	20.00	4	80.00
Rifampicin	0	0.00	0	0.00	4	80.00	1	20.00
Clindamycin	0	0.00	0	0.00	2	40.00	3	60.00
Meropenem	0	0.00	0	0.00	4	80.00	1	20.00
Augmentin	0	0.00	0	0.00	3	60.00	2	40.00
Chloramphenicol	0	0.00	0	0.00	2	40.00	3	60.00
Trimethoprim-sulfamethoxazole	0	0.00	0	0.00	1	20.00	4	80.00

Table 4. Antimicrobial Susceptibility of *Streptococcus pneumoniae* isolated from Pilgrims during the Hajj season

ANTIBIOTICS	*Streptococcus pneumoniae* isolates Before Hajj Total (4)		*Streptococcus pneumoniae* isolates Before Hajj Total (6)	
	Susceptible No. (%)	Non-susceptible No. (%)	Susceptible No.(%)	Non-susceptible No. (%)
Azithromycine	3 (75%)	1 (25%)	2 (33.3%)	4 (66.7%)
Cefotaxime	3 (75%)	1 (25%)	4 (66.7%)	2 (33.3%)
Ceftriaxone	3 (75%)	1 (25%)	4 (66.7%)	2 (33.3%)
Ciprofloxacin	3 (75%)	1 (25%)	4 (66.7%)	2 (33.3%)
Levofloxacin	3 (75%)	1 (25%)	4 (66.7%)	2 (33.3%)
Erythromycin	3 (75%)	1 (25%)	2 (33.3%)	4 (66.7%)
Rifampicin	3 (75%)	1 (25%)	4 (66.7%)	2 (33.3%)
Clindamycin	3 (75%)	1 (25%)	2 (33.3%)	4 (66.7%)
Meropenem	3 (75%)	1 (25%)	4 (66.7%)	2 (33.3%)
Augmentin	3 (75%)	1 (25%)	4 (66.7%)	2 (33.3%)
Chloramphenicol	1 (25%)	3 (75%)	2 (33.3%)	4 (66.7%)
Trimethoprim-sulfamethoxazole	3 (75%)	1 (25%)	2 (33.3%)	4 (66.7%)

CONCLUSION AND RECOMMENDATIONS

The carriage rate of *S. pneumoniae* among the Umrah visitors was more after Umrah than before Umrah and the carriage rate of *S. pneumoniae* among the pilgrims was more after Hajj than before Hajj. The Indonesian and Libyan pilgrims were the most ethnic groups carries *S. pneumoniae* before performing Hajj, while the Australian pilgrims were the most ethnic group carries *S. pneumoniae* after performing Hajj. The most effective antibiotics against *S. pneumoniae* isolated from Umrah visitors and pilgrims were Cefotaxime, Ceftriaxone, Rifampicin and Meropenem. Thus we recommend to repeat this study after few years to evaluate the carriage rate of *S. pneumoniae* in Umrah visitors and Pilgrims and if there is any changes in the rate either increasing or decreasing. Adding controls from Saudi nationals to any upcoming study to compare the carriage rate of *S. pneumoniae* in Umrah visitors, Pilgrims and Saudi nationals.

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CONFLICT OF INTEREST

Authors have declared that no conflict of interests exists.

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