

Assessment of Prevalence Group A Streptococci (GAS) Associated with Upper Respiratory Tract Infection among Hajj and Umrah Pilgrims

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Abstract

Background: Respiratory tract infection (RTI) is a prevalent infection across the world and is a major health concern linked to the crowding that occurs during the Hajj season. **Objectives:** To identify how prevalent *Streptococcus pyogenes* is among Umrah visitors and pilgrims by comparing its presence before and after the visitors perform Umrah and hajj. **Methods:** A cross-sectional study was carried out on Umrah visitors/pilgrims, for which their throat swabs were taken for assessing the upper respiratory tract infection's carriage rate, particularly of Group A streptococci (GAS), after they arrived in Saudi Arabia for the Hajj and Umrah rituals and before their leaving. After collecting the swabs, they were inoculated on Columbia agar using 5% sheep blood and then incubated at 37°C. VITEK 2 systems were used to identify the isolates. **Results:** Of the 979/613 Umrah visitors/pilgrims involved, before performing Umrah, their *Streptococcus pyogenes* percentage was 0.2% and it increased to 0.7 after performing Umrah. Further, the *Streptococcus pyogenes* percentage before and after performing Hajj was 0.3% and 1.1%, respectively. No statistical significance was found in the difference between the positive *Streptococcus pyogenes* found before and after performing Hajj and Umrah among Umrah visitors/pilgrims (p-value = 0.2). All bacterial isolates were found to be sensitive to Cefotaxime and Ceftriaxone antibiotics (100%). **Conclusion:** The *Streptococcus pyogenes* high resistance to antibiotics combined with the lack of a vaccine poses a serious risk concerning the resulting infection spread and emphasizes the necessity of ensuring greater global surveillance of such epidemics.

Keywords

Respiratory Tract Infection, Pilgrims, Streptococcus Pyogenes

1. Introduction

One of the most well-known gatherings on a global scale, Hajj is attended by approximately more than two million people every year in a generally confined space. The combination of the large number of people from more than 80 countries attending this event with the limited area for them to gather leads to unavoidable overcrowding that can cause numerous infectious diseases to spread during their time in Saudi Arabia [1]. A major health concern linked to crowding is respiratory tract and meningitis infections, which spread easily because of transmission through air droplets [2] [3] [4] [5] [6]. One of the most common infections, respiratory tract infection (RTI) causes an upward of 450 million infections and 4 million deaths every year [7]. RTI is transmitted through respiratory droplets and its risk is increased when there is overcrowding. Individuals can contract this disease from clear symptomatic patients as well as asymptomatic carriers with potentially pathogenic organisms (PPO) including *Staphylococcus aureus*, *Streptococcus pyogenes*, *Streptococcus pneumoniae*, *Neisseria meningitidis*, *Moraxella catarrhalis* and *Haemophilus influenzae*, *Pseudomonas aeruginosa*, influenza A and B viruses, parainfluenza 1 - 3 viruses, adenovirus, rhinovirus, and RSV [8] [9].

This raises an important issue for the Kingdom of Saudi Arabia (KSA) since it is the country hosting the Islamic religious occasions of Hajj and Umrah. RTI is a severe problem in the KSA because more than 10 million pilgrims visit the country every year for pilgrimage, which also burdens the country's healthcare sector [10]. *Streptococcus pyogenes* or Group A streptococci (GAS) is a common bacterial cause of pharyngitis, which involves mild fever, severe sore throat, tonsillar exudates, and enlarged tonsils. There is a greater risk of this infection spreading when there is a large crowd sharing a common environment, thereby resulting in epidemic diseases because of personal contact with infected individuals or even healthy carriers. Pharyngitis is a severe problem because it also involves complications that may arise because of inaccurate diagnosis [11]. Despite the improved economic conditions of developed countries reducing the incidence of diseases in the last 100 years, as evidenced in the living conditions, the pathogenic strains underwent genetic changes that further increased the infection rates. Hence, several epidemiological studies have indicated that these diseases may re-emerge in developed countries [12].

The incidence of these infectious diseases will also increase in less developed or poor countries because of the low standard of living resulting from the country's inadequate economic progress [13]. The present study thus aims to identify the *Streptococcus pyogenes* prevalence as well as antibiotic resistance patterns in Umrah visitors and pilgrims of varied ethnic groups both before and after performing their Hajj and Umrah.

2. Materials and Methods

2.1. Collection of Specimens

For this study, approximately 1958/1226 random samples of throat swab from

979/613 Umrah visitors/pilgrims after they arrived in Saudi, followed by samples before they left the country between April 2010 - March 2011. The first set of throat swabs was gathered upon the Umrah visitors/pilgrims' arrival at King Abdul-Aziz International Airport (KAAIA) along with data forms that included their age, nationality, sex, and other information concerning their coughing, smoking, sore throat, antibiotic usage, and date of sample collection. Samples were collected using Amies Transport Medium to ensure the survival of pathogens in the collected swabs and were then immediately sent to the Microbiology research laboratory at the College of Medicine, Umm Al Qura University.

2.2. Cultivation and Identification of Bacteria

All throat swabs were inoculated on Columbia agar using 5% sheep blood and incubated at 37°C; overnight incubation. In the second day a small beta-hemolytic colony, *Streptococcus pyogenes* was isolated from Columbia blood agar, and examined macroscopically based on the characteristic appearance and microscopically, identified as Gram-positive cocci in chains by Gram stain. A catalase test was also performed where catalase-negative. Further, for distinguishing between *S. pyogenes* (bacitracin sensitive) and other non-group A beta-haemolytic streptococci (bacitracin resistant), more subcultures of beta-haemolytic colonies were carried out on Columbia blood agar using additive bacitracin disc (0.04 IU). VITEK 2 systems compact 15 bioMerieux identification, and susceptibility testing (GP ID Cards) were applied to confirm and identify all isolates.

2.3. Antibiotic Susceptibility Test

All isolated strains from throat swabs were subculture on blood agar for antibiotic susceptibility using AST-STO1 card of VITEK II instrument (bioMerieux). Two sterile tubes contain 3 ml saline aqueous 0.45% Na CL, P1-I 7.0 in each tube. In one of these tubes, five colonies were transferred from culture using a sterile stick and mixed to produce a homogenous organism suspension, and the bacterial suspension was adjusted to be equivalent to a McFarland 0.50 using a calibrated VITEK 2 Densicheck. A volume of 280 µl of the bacterial suspension was transferred from the first tube to the second tube. All inoculated cards were placed in the instrument within 30 mm of inoculation. Data were analysed using software version VT2-R4.0l. The results were available within 8 - 12 hours.

The antibiotic sensitivity test (AST) measured the minimum inhibitor concentrations (MIC) of the following antibiotics against GAS: azithromycin, cefotaxime, ceftriaxone, ciprofloxacin, levofloxacin, erythromycin, vancomycin, augmentin, clindamycin, penicillin, and amoxicillin.

3. Results

3.1. *Streptococcus pyogenes* Prevalence among Umrah

The overall prevalence of *Streptococcus pyogenes* isolated from 979 Umrah visitors during the Umrah season from different nationalities included 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.

From the 979 visitors that this study tested, *Streptococcus pyogenes* were isolated from 0.2% and 0.7% of Umrah visitors before and after performing Umrah, respectively. These isolates were distributed based on their nationalities: One isolate was isolated from Turkish Umrah visitors, 0 before Umrah, and one after Umrah. One isolate was isolated from Syrian Umrah visitors, one before Umrah, and 0 after Umrah. Two isolates were isolated from Indian Umrah visitors, 0 before Umrah, and 2 after Umrah. One isolate was isolated from British Umrah visitors, 0 before Umrah and 1 after Umrah.

Three isolates were isolated from Iraqi Umrah visitors, 1 before Umrah and 2 after Umrah. One isolate was isolated from Malaysian Umrah visitors, 0 before Umrah and 1 after Umrah. No statistical significance was found for the difference in the positive *Streptococcus pyogenes*' prevalence in Umrah visitors before and after performing Umrah (p-value = 0.2) (Table 1).

Table 1. Rates of infection with *Streptococcus pyogenes* among Umrah visitors during the Umrah season.

Nationality	Number of Umrah visitors	Before Umrah				After Umrah				P
		+ 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	1.0
Indonesian	127	0	0	127	100.00	0	0	127	100.00	-
Pakistani	102	0	0	102	100.00	0	0	102	100.00	-
Syrian	99	1	1.01	98	98.99	0	0	99	100.00	1.0
Nigerian	98	0	0	98	100.00	0	0	98	100.00	-
Egyptian	79	0	0	79	100.00	0	0	79	100.00	-
Iranian	77	0	0	77	100.00	0	0	77	100.00	-
Indian	71	0	0	71	100.00	2	2.82	69	97.18	0.5
British	56	0	0	56	100.00	1	1.79	55	98.21	1.0
Iraqian	56	1	1.79	55	98.21	2	3.57	54	96.43	1.0
Malaysian	39	0	0	39	100.00	1	2.56	38	97.44	1.0
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	2	0.20	977	99.80	7	0.72	972	99.28	P = 0.2

P-value of difference between positive Umrah visitors before performing Umrah and positive Umrah visitors after performing Umrah, $P < 0.05$ is significant.

3.2 Antibiotics Susceptibility Testing of *Streptococcus pyogenes*

The study isolated nine *Streptococcus pyogenes* isolates from Umrah visitors and found them sensitive to Ceftriaxone, Cefotaxime, and Vancomycin antibiotics (Table 2).

Distribution of *Streptococcus pyogenes* Prevalence among Pilgrims during the Hajj Season According to Different Nationalities

This study tested the prevalence of *Streptococcus pyogenes* in 613 pilgrims from different nationalities such as 161 Indian, 102 Nigerian, 95 Indonesian, 90 Libyan, 68 Syrian, 46 British, 35 Turkish, 11 Australian, 3 Swedish, and 2 Iranian. The study isolated *Streptococcus pyogenes* from 0.3% and 1.1% of pilgrims before and after performing Hajj, respectively. These isolates were distributed to various nationalities as follows: Two isolates were isolated from Indian pilgrims, 0 before performing Hajj and 2 after performing Hajj. Two isolates were isolated from Nigerian pilgrims, 0 before performing Hajj and 2 after performing Hajj. Two isolates were isolated from Syrian pilgrims, 2 before performing Hajj and 0 after performing Hajj. Three isolates were isolated from Turkish pilgrims, 0 before performing Hajj and 3 after performing Hajj.

No statistical significance was found in the difference in the presence of positive *Streptococcus pyogenes* in pilgrims before and after performing Hajj (p-value = 0.2) (Table 3).

3.3. Antibiotics Susceptibility Testing of *Streptococcus pyogenes* Isolated from Pilgrims during the Hajj Season

The study conducted antibiotics susceptibility testing on the nine *Streptococcus pyogenes* isolates that were collected from pilgrims and found them all to be sensitive to ceftriaxone, cefotaxime, and vancomycin antibiotics (Table 4).

Table 2. Antimicrobial Susceptibility testing of *Streptococcus pyogenes* isolated from Umrah visitors during the Umrah season.

Antibiotics	<i>Streptococcus pyogenes</i> isolated before Umrah Total (2)				<i>Streptococcus pyogenes</i> isolated after Umrah Total (7)			
	Susceptible		Non-susceptible		Susceptible		Non-susceptible	
	No.	%	No.	%	No.	%	No.	%
Azithromycin	2	100.00	0	0.00	4	57.14	3	42.86
Cefotaxime	2	100.00	0	0.00	7	100.00	0	0.00
Ceftriaxone	2	100.00	0	0.00	7	100.00	0	0.00
Ciprofloxacin	1	50.00	1	50.00	5	71.43	2	28.57
Levofloxacin	2	100.00	0	0.00	6	85.71	1	14.29
Erythromycin	2	100.00	0	0.00	5	71.43	2	28.57
Vancomycin	2	100.00	0	0.00	7	100.00	0	0.00
Augmentin	2	100.00	0	0.00	6	85.71	1	14.29
Clindamycin	1	50.00	1	50.00	5	71.43	2	28.57
Penicillin	1	50.00	1	50.00	5	71.43	2	28.57
Amoxicillin	1	50.00	1	50.00	4	57.14	3	42.86

Table 3. Rates of infection with *Streptococcus pyogenes* among Pilgrims during the Hajj season.

Nationality	Number of Pilgrims	Before Hajj				After Hajj				P
		+ Pilgrims		- Pilgrims		+ Pilgrims		- Pilgrims		
		No.	%	No.	%	No.	%	No.	%	
Indian	161	0	0	161	100	2	1.2	159	98.8	0.4
Nigerian	102	0	0	102	100	2	2	100	98	0.5
Indonesian	95	0	0	95	100	0	0	95	100	-
Libyan	90	0	0	90	100	0	0	90	100	-
Syrian	68	2	2.9%	66	97.1	0	0	68	100	0.5
British	46	0	0	46	100	0	0	46	100	-
Turkish	35	0	0	35	100	3	8.6	32	91.4	0.2
Australian	11	0	0	11	100	0	0	11	100	-
Swedish	3	0	0	3	100	0	0	3	100	-
Iranian	2	0	0	2	100	0	0	2	100	-
Total	613	2	0.3	611	99.7	7	1.1	606	98.9	0.2

P-value of the difference between positive pilgrims before performing Hajj and positive pilgrims after performing Hajj.

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

Antibiotics	<i>Streptococcus pyogenes</i> isolated before Hajj Total (2)				<i>Streptococcus pyogenes</i> isolated after Hajj Total (7)			
	Susceptible		Non-susceptible		Susceptible		Non-susceptible	
	No.	%	No.	%	No.	%	No.	%
Azithromycin	1	50.00	1	50.00	5	71.43	2	28.57
Cefotaxime	2	100.00	0	0.00	7	100.00	0	0.00
Ceftriaxone	2	100.00	0	0.00	7	100.00	0	0.00
Ciprofloxacin	1	50.00	1	50.00	6	85.71	1	14.29
Levofloxacin	1	50.00	1	50.00	6	85.71	1	14.29
Erythromycin	1	50.00	1	50.00	6	85.71	1	14.29
Vancomycin	2	100.00	0	0.00	7	100.00	0	0.00
Augmentin	2	100.00	0	0.00	6	85.71	1	14.29
Clindamycin	1	50.00	1	50.00	5	71.43	2	28.57
Penicillin	1	50.00	1	50.00	7	100.00	0	0.00
Amoxycillin	1	50.00	1	50.00	5	71.43	2	28.57

4. Discussion

There are various ways in which Group A streptococci (GAS) is transmitted, such as inhaling droplets directly from another person in a crowd [14]. According to studies, the GAS carrier rate is below 4% in healthy adults [15]. While this percentage increases among children under 15 years of age and reaches between 16 and 18%. Although GAS was discovered many years ago, it still plays an important role in causing illness and death, especially among children and young adults in developed countries [16] [17] [18]. While GAS was discovered several years ago, it continues to be a major cause of illness and death, particularly in children and young adults in developed countries [19] [20] [21] [22]. Studies have also noted that this disease is more prevalent in poor communities because of the low economic and social conditions that hinder their inability to afford health care costs [23] [24] [25]. Other studies have shown that nearly 18.1 million people suffer from a serious GAS disease presently, that 1.78 million new cases and 500,000 deaths occur annually in 110 low- and middle-income countries, and that the disease is endemic in developed countries disadvantaged groups [26] [27].

In the present study, *Streptococcus pyogenes* were isolated from 0.2% and 0.7% Umrah visitors before and after they performed Umrah, respectively. The 979 Umrah visitors were from diverse countries such as Turkey, Indonesia, Pakistan, Syria, Nigeria, Egypt, Iran, India, Britain, Iraq, Malaysia, Libya, Sweden, America, and Jordan. The difference in the positive *Streptococcus pyogenes* prevalence found in Umrah visitors before and following them performing Umrah did not have statistical significance (p-value = 0.2). Of the 979 Umrah visitors, 129 Turkish visitors had a 0-carrier rate of the potentially pathogenic bacteria before performing Umrah, which increased to 1 (0.8%) after performing Umrah, and this difference did not have statistical significance (p-value = 1.0). From the Indonesian and Pakistani Umrah visitors, no *Streptococcus pyogenes* were isolated before or after performing Umrah. Of the 979 Umrah Visitors, 99 Syrian visitors were 1% positive and 0% positive for potentially pathogenic bacteria before and after performing Umrah, respectively, and this difference did not have statistical significance (p-value = 1.0). Next, the 56 Iraqi visitors were 1% and 3.5% positive for potentially pathogenic bacteria before and after performing Umrah, respectively. For the 39 Malaysian visitors, 0% and 2.5% were positive for *Streptococcus pyogenes* before and after performing Umrah, respectively, and this difference did not have a statistical significance (p-value = 0.4). For the 27 Libyan, 14 Swedish, 4 American, and 1 Jordanian visitors, no *Streptococcus pyogenes* were isolated before or after performing Umrah.

Streptococcus pyogenes were isolated from 613 pilgrims during the Hajj season from 0.3% before performing Hajj and 1.1% after performing Hajj. No statistical significance was found in the difference in the presence of positive *Streptococcus pyogenes* in pilgrims before and after performing Hajj (p-value = 0.2).

The present study involved 1226 samples (two swabs from every pilgrim, once upon arrival in Saudi Arabia, and once before they departed from Saudi Arabia)

gathered from 613 pilgrims from various countries including India, Nigeria, Indonesia, Libya, Syria, Britain, Turkey, Australia, Sweden, and Iran. The 161 Indian pilgrims showed a 0% carrier rate of the potentially pathogenic bacteria before performing Hajj and a 1.2% carrier rate after performing Hajj, and this difference had no statistical significance (p-value = 0.4). The 102 Nigerian pilgrims were a 0% and 2% positive for the potentially pathogenic bacteria before and after performing Hajj, respectively, and this difference had no statistical significance (p-value = 0.5). The 68 Syrian pilgrims were 2.9% and 0% positive for *Streptococcus pyogenes* before and after performing Hajj, respectively, and this difference did not have statistical significance (p-value = 0.5). Out of the 613 pilgrims selected in this study, 0 (0%) were positive for *Streptococcus pyogenes* before performing Hajj and 3 (8.6%) were positive after performing Hajj and this difference was not statistically significant (p-value = 0.2).

Further, for the 95 Indonesian pilgrims, 90 Libyan pilgrims, 46 British pilgrims, 3 Swedish pilgrims, and 2 Iranian pilgrims, no *Streptococcus pyogenes* were isolated before or after performing Hajj. The present study found that Cefotaxime, Ceftriaxone, and Vancomycin antibiotics were the most effective against *Streptococcus pyogenes*, while Amoxicillin had the lowest efficiency. The study further noted that only a few countries had systematic monitoring systems and comprehensive data concerning *Streptococcus pyogenes* infection (pharyngitis) outbreaks [28] [29] [30]. Thus, regular assessments are crucial for monitoring infection trends in seasons that involve large gatherings in crowded places [31]. Numerous studies have affirmed that the GAS genetic diversity is a major factor that has made this bacterial infection persistent in all countries, although its percentage differs in different countries based on the environmental, economic development, living conditions, health care, and efforts made for addressing the spread of epidemic across the world [23] [31] [32] [33].

Antibiotics are necessary for treatment because complications may occur from an untreated infection. untreated pharyngitis could lead to scarlet fever [34]. This results in rheumatic heart disease, a chronic condition that is a major cause of GAS morbidity and mortality [35] [36]. The risk of these complications is limited when GAS infections are rapidly treated. penicillin is the gold standard of antibiotic treatment for many GAS infections [37]. β -lactams target penicillin-binding proteins (PBPs) to block peptidoglycan cross-linking in metabolically active bacteria, leading to bacterial death [38]. This study has some limitations. This study was conducted on fifteen nationalities only due to the extreme crowding during the Hajj season and the limited research resources. However, this study gave indications about the level of infection transmission before and after performing Hajj and Umrah. This study, therefore, recommends further research in this field during the Hajj, and Umrah seasons to address other aspects that this study was unable to focus on. This study, therefore, emphasized this type of bacterial pathogen given its prevalence in the Hajj and Umrah seasons and recommend further research in this field during the Hajj, and Umrah seasons to address other aspects that this study was unable to focus on.

5. Conclusion

The *Streptococcus pyogenes* carrier rate was 0.2% and 0.7% before and after performing Umrah, respectively, and 0.3% and 1.1% before and after performing Hajj, respectively. It was noted that the Iraqi Umrah visitors were the most ethnic group that carried *Streptococcus pyogenes* prior to performing Umrah at 1.7% and after performing Umrah at 3.6%. Moreover, the Syrian pilgrims were the ethnic group carrying *Streptococcus pyogenes* before performing Hajj at 2.9%, whereas the Turkish pilgrims were the ethnic group carrying *Streptococcus pyogenes* after performing Hajj at 8.6%. The study found Cefotaxime, Ceftriaxone and Vancomycin antibiotics to be most effective against *Streptococcus pyogenes* isolated from Umrah visitors and pilgrims. These results can thus help medical decision-makers to determine the carriage prevalence of these pathogenic bacteria and develop epidemiological information regarding the microbial respiratory tract carriage while assessing the existing antibiotics design and policy and implement the necessary prophylactic and treatment measures. This bacteria's increasing resistance to antibiotics and the lack of a vaccine pose a serious threat in terms of the spread of infection and emphasizes the need for better global surveillance of these epidemics.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

Declarations

Ethics approval was obtained from the Ethics Committee of the Faculty of Medicine.

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