

Tuberculosis infection during Hajj pilgrimage

The risk to pilgrims and their communities

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ABSTRACT

يتوجه ملايين المسلمين إلى مكة كل عام لأداء فريضة الحج. ويأتي كثير من الحجاج من دول تكون نسبة الإصابة بالدرن فيها مرتفعة. وبسبب الازدحام الشديد والارهاق وارتفاع الحرارة والأمراض المزمنة التي يعاني منها كثير من الحجاج من متوسطي وكبيري السن، فإن ذلك يجعلهم أكثر عرضة للإصابة بالعدوى أو بتنشيط الدرن الكامن. وقد دلت دراسات سابقة على ارتفاع نسبة الخطورة للإصابة بالدرن في الحج. وعندما يصاب الحاج بالعدوى فإنه قد ينقل العدوى إلى المخالطين له في بلاده. وهناك تخوف حقيقي من نقل جراثيم الدرن المقاومة للمضادات. والحاجة ملحة لتكثيف جهود السيطرة على المرض لتقليل خطورة العدوى وانتشار المرض. ويمكن فحص الحجاج القادمين من الدول الموبوءة بالدرن بأشعة الصدر، وسيساعد هذا الاجراء على اكتشاف الدرن النشط وعلاجه وبالتالي منع العدوى للأخرين. أما الدول التي يقل فيها الدرن فيمكن أن تقوم بفحص حجاجها قبل وبعد الحج بواسطة اختبار التيوبركلين أو الكوانتينفيرون وذلك لاكتشاف الاصابات الحديثة للدرن وعلاجها. ولا بد من التنسيق المحلي والدولي للتأكيد على تطبيق الاجراءات الوقائية للسيطرة على المرض ومنع انتشاره.

Millions of Muslims travel to Makkah every year to perform Hajj. Many pilgrims come from countries with a high incidence of tuberculosis (TB). Over-crowding, physical exhaustion, heat, and co-morbid conditions of mostly middle-aged and elderly pilgrims make them susceptible to infection, or reactivation of latent TB. Evidence from previous reports indicated a significant risk of acquiring infection during Hajj. Pilgrims infected in Makkah may spread the infection to contacts in their countries. Spread of multi-drug resistant TB is a real concern. Control efforts are required to reduce the risk of infection and transmission. Screening of pilgrims from high burden countries before travel with chest x-ray will help to detect and treat active TB, and prevent infection of others. Low incidence countries may consider carrying out tuberculin skin test or QuantiFERON TB assay for pilgrims before and after Hajj,

to identify and treat recent converters. National and international coordinated efforts are essential for successful implementation of control measures to prevent the spread of the disease.

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The Hajj pilgrimage to Makkah is a religious obligation of all physically-able Muslims. It has to be performed at least once in a lifetime for those who can afford it. It takes place annually from the eighth to the twelfth day of the last month of the Islamic lunar calendar. It is one of the largest mass gatherings in the world, as more than 3 million people from more than 180 countries travel to Makkah during this short period of time. Pilgrims start arriving to Makkah 3-4 weeks before the beginning of the Hajj rituals. On the eighth day of the Hajj month, most pilgrims gather in Mina. This is approximately a 3-kilometer square area where pilgrims are housed in tents that accommodate 50-100 people. They spend 4 of the 5 days of the Hajj in Mina performing their rituals. They move between ritual sites mostly on foot, or in fully loaded buses. These sites are very crowded, and pilgrims move slowly in tight masses in rituals that take hours to complete. Physical exhaustion, heat, over-crowding, and sleep deprivation

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tax the health of most pilgrims. Many of them are middle-aged and elderly people with co-morbid conditions that make them susceptible to infections. The numbers of pilgrims have been increasing over the past decade despite agreed restrictions by various Islamic governments. They grew from 2.01 million in 2002 to 3.16 million in 2012 (Figure 1).¹ This large increase places enormous pressure on various services required for these guests. The limited space of ritual sites is difficult to expand significantly to accommodate larger numbers of pilgrims. Therefore, the challenges of over-crowding and space congestion with their physical, environmental, and health hazards will unfortunately remain with us for years to come. This review aims to evaluate the risk of tuberculosis (TB) infection during the Hajj season, and discuss the implementation of some control measures that may help to reduce the risk of infection.

Risk of TB infection. The unavoidable over-crowding in housing and ritual sites facilitates transmission of infectious agents through shared air. Coughed droplets and aerosols easily spread infection among people living in close proximity, therefore, respiratory infections are very common among pilgrims.¹⁻⁵ Epidemics of influenza and meningococcal meningitis have occurred repeatedly.⁶⁻⁸ Lower respiratory infections are also frequent.^{4,9-11} Pneumonia was found to be the most common cause of hospitalization among pilgrims.⁹ *Mycobacterium tuberculosis* (*M. tuberculosis*) was isolated from 5.9% of patients with pneumonia in this study. Mandourah et al¹⁰ found *M. tuberculosis* in 4.9% of pneumonia cases in pilgrims. Another study carried out during the Hajj reported that *M. tuberculosis* was found in 13 (28%) of 46 pneumonia patients with positive sputum cultures.¹¹ The high frequency of TB among pilgrims with pneumonia is not surprising. Over 50%

of pilgrims come from countries with a high burden of TB such as India, Pakistan Bangladesh, Southeast Asia, and Africa. In the Saudi Ministry of Health (MOH) annual report of 2010, TB was found in 3 of 30 pilgrims who died of respiratory infections.¹² Tuberculosis found in seriously ill patients is probably the tip of the iceberg. Cough among pilgrims is very common. Study series reported cough in more than 50% of pilgrims.^{3,4} These patients are often diagnosed with upper respiratory tract infections. Only those requiring hospitalization are thoroughly investigated. The frequency of active TB in the above reports is alarming. As pilgrims stay in Makkah for only a few weeks, it is likely that active disease during Hajj is either imported or reactivated. Pilgrims are rendered susceptible to reactivation of latent TB infection by physical exhaustion, sleep deprivation, poor nutrition, and co-morbid conditions that may depress their immunity.¹³ No studies on the prevalence of active TB among pilgrims have been carried out. This area deserves further investigation.

The risk of TB transmission to close contacts is high. Under normal not so crowded circumstances, there are approximately 10 close contacts for each active TB case.¹⁴ The situation during the Hajj season is obviously different. Housing areas and ritual sites are excessively congested. Pilgrims remain in close proximity in crowded tents or rooms for several hours per day for several days or weeks. In Mina, 50-100 pilgrims share one tent for 4 days. In Makkah, housing is also overcrowded because of the limited availability of hostels and apartments to accommodate large numbers of pilgrims. Such jammed conditions create bigger numbers of close contacts than usual. Several studies showed that Tuberculin Skin test (TST) conversion rate among close contacts ranges between 30-50% depending on the closeness to the index case, duration of contact, and prior risk of exposure.¹⁵⁻¹⁷ Other factors that may increase the risk of transmission include duration of contact, infectiousness of the patient (that is, being smear positive), and poor ventilation. Transmission may also occur in overcrowded buses particularly with repeated trips. The risk, however is lower than that for household contacts.¹⁸ As most pilgrims travel by air, often for long hours, there is a risk of spreading infection from an active TB passenger to others on board. There are several reports of documented TB infection acquired during air travel particularly on long flights.^{19,20} The risk is greatest for those who sit close to the infectious individual, although the overall risk remains low.

To evaluate the risk of TB infection in Hajj, a group of investigators from Singapore assessed TB immune response in pilgrims using Quanti-FERON TB assay

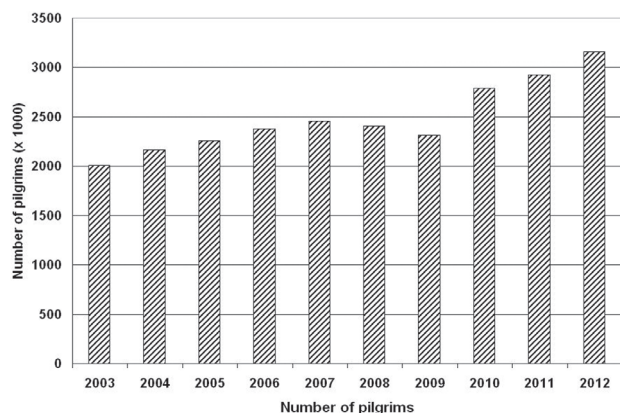


Figure 1 - Number of Hajj pilgrims over 10 years (2003-2012).

(Cellestis Ltd, Australia).²¹ The test was carried out before departure for the Hajj on 357 individuals. Of these 149 were found to be negative. The test was repeated 3 months after returning and was found to be positive in 15 (10%) of the initially negative pilgrims. There is no mention of the development of active TB among them, although 55% of all pilgrims studied complained of prolonged cough. This is the only study that evaluated TST conversion risk among pilgrims. This Hajj-related conversion rate (10%) is higher than the reported TST conversion for general travelers.²² These findings together with reports of high frequency of *M. tuberculosis* isolates among hospitalized pilgrims with pneumonia indicate that the risk of TB transmission is substantial. Public health and preventive measures need to be stepped up to reduce this risk.

Effect on TB incidence in Makkah. The TB incidence rate in Saudi Arabia is approximately 16/100,000.¹² Saudi nationals has a rate of 12/100,000, while Non-Saudis living in the Kingdom have an incidence of 25/100,000. Over the last 10 years, TB incidence trend for the Kingdom has been declining rather slowly.²³ The Makkah region (including Makkah and Jeddah) has approximately 2 times the national TB incidence level (24/100,000) (Figure 2). Moreover, the rate in Makkah region have been rising over the last 10 years, as TB incidence increased from 19/100,000 in 2000 to 25/100,000 in 2010.^{12,24} A national survey of TB prevalence utilizing TST revealed an overall positive reaction rate of 10% in the Kingdom. The Western province that includes Makkah has a rate of

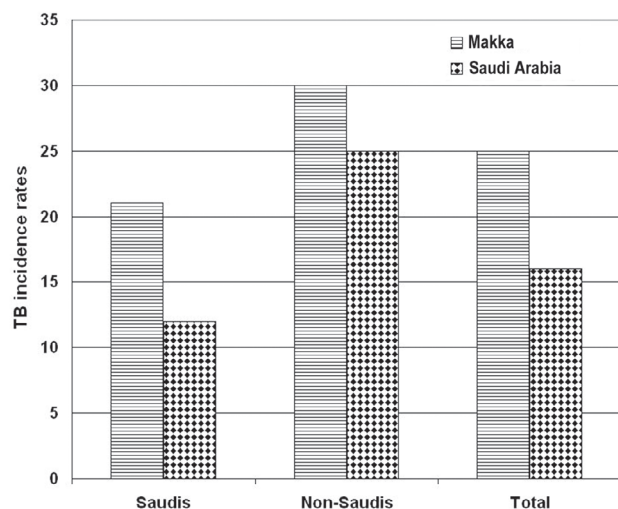


Figure 2 - Tuberculosis incidence rates in Saudi Arabia and Makkah region in 2010.

20%.²⁵ The relatively high incidence and prevalence of TB in the Makkah region is likely to be due to the fact that it receives millions of pilgrims for Hajj and Umrah annually. Many of them come from countries with a high incidence of TB. As these visitors are not screened before entry to the Kingdom, it is likely that some may have active TB. Infection could be transmitted to other pilgrims and to local citizens who are in frequent contact with these guests.

Saudi Arabia has invested heavily in health care services including TB control through a National TB Control Program.²⁶ This includes finding and treating active disease, investigating contacts, offering free anti-TB treatment for all patients (including Non-Saudis) in government hospitals, implementation of directly observed therapy (DOTS) in all regions, compulsory BCG vaccination of all newborn infants, training and improving laboratory services. The annual TB incidence rates in the Kingdom have stabilized and started to decline, while the Makkah region shows a rising trend. This challenge to TB control in the Makkah region needs to be seriously addressed in order to halt and reverse the rising disease trend.

The global risk of disease transmission. The Hajj attracts pilgrims from all over the globe. Returning pilgrims may spread infections to their countries. This mode of global transmission is best illustrated by a *Neisseria meningitidis* (*N. meningitidis*) outbreak in the year 2000 where *N. meningitidis* imported from Africa caused 1300 cases of meningococcal disease in Saudi Arabia and 9 other countries among the Hajj pilgrims and their close contacts.^{7,8}

Tuberculosis infection acquired in Makkah is unlikely to manifest during the Hajj period as pilgrims stay only for several weeks, and TB has a long incubation period. Most infected people have latent TB. Wilder-Smith et al²¹ showed that TB infection rate among pilgrims returning from Makkah was 10%. Pilgrims may not develop active disease until weeks or months after returning to their countries. It is estimated that approximately 5% of patients with recently acquired TB will develop active disease within 2 years.²⁷ These will be a source of infection to their household and other contacts. Some pilgrims come from countries with a high prevalence of multi-drug resistant tuberculosis (MDR-TB) such as India, China, and the Russian Federation. The World Health Organization estimates that 60% of global MDR-TB cases were reported from these 3 countries.²⁸ There is a risk of spreading this form of the disease to other countries after the Hajj. Studies on the prevalence of MDR-TB in Saudi Arabia showed

that the rate of resistance is higher in the Makkah region than in other parts of the Kingdom.^{29,30} Although there is no epidemiological confirmation of its source, it is likely to be imported from other countries during the Hajj and Umrah seasons.

What can be done?. The risk of transmission of TB to susceptible pilgrims during the Hajj seems to be significant. Subsequent spread of infection to other countries, especially those with low or intermediate incidence of the disease is a serious concern. Control measures are required to reduce this seemingly unavoidable risk. Perhaps the best approach would be to catch the disease at its source. Each Hajj visa applicant from countries with a high burden of the disease (Central, South and Southeast Asia, and Africa) should have a CXR. Those with radiographic abnormalities suggestive of TB should be further investigated, and active diseases' treated. Visas are offered when they are declared non-infectious. Those with CXR abnormalities suggestive of old TB, and no evidence of active disease should have a TST or Quanti-FERON TB test to detect latent infection. Individuals with latent TB and abnormal CXR have a higher chance of reactivation particularly when exposed to physical and environmental stresses, such as those in the Hajj. Such individuals are offered preventive therapy. Chest x-ray was found to be a sensitive cost-saving tool for mass screening of immigrants from areas with high burden of tuberculosis.^{31,32} The USA, Canada and Australia use CXR to screen applicants for long-term immigration. It was found to be cost effective for detecting and treating active and latent TB among foreign born immigrants.³²⁻³⁴ Pilgrims need to be educated regarding practices to prevent airborne and other diseases, and recognize symptoms of TB. The use of simple facemasks can reduce transmission of coughed droplets that may contain infectious agents. Their efficacy in preventing upper respiratory infections is controversial.^{35,36} McIntyre et al³⁷ reported that adherence to mask use significantly reduced transmission of influenza-like infections. They, however, found that there was low adherence to the use of masks reducing their effectiveness in preventing respiratory disease. The Saudi MOH continues to recommend wearing facemasks during the Hajj to reduce transmission of airborne diseases.³⁸ Unfortunately, compliance with this advice has been inadequate as only 24% of pilgrims were reported to use them.³⁹ This simple infection control measure may help to reduce the spread of TB infection to close contacts in crowded environments. Low incidence countries may consider screening pilgrims before and

after Hajj for latent TB. Given that the risk of acquiring TB infection during the Hajj is approximately 10%, this approach may be cost effective to identify and treat recent converters, and prevent development of active TB. This approach may not be practical or cost effective in countries with high incidence of the disease.

The TB control in Makkah is another challenge. The TB incidence is rising despite intensive control measures. This is likely due to the fact that contact with large numbers of pilgrims for Hajj and Umrah is frequent and recurring. Public education regarding symptoms of TB and early detection and treatment of disease are essential. Annual screening of those that are in frequent contact with pilgrims using TST and CXR is also important. Disease surveillance of segments of Makkah population may also be considered. Long-term measures need to be taken to reduce crowding in housing, transport, and in Holy sites. The government of Saudi Arabia is taking serious steps to alleviate congestion in ritual sites. One example is the 4-level Jamarat Bridge. This is a major project that helped alleviate mass crowds of pilgrims at Jamarat area, which was the site of several fatal stampedes.

In conclusion, the annual huge mass gathering during the Hajj pilgrimage to Makkah is associated with significant risk of TB infection. Excessive congestion and the potential for spread of infection challenge efforts to control the disease in Saudi Arabia and in countries sending pilgrims. National and international coordinated efforts are required to ensure applying appropriate control measures before, during, and after the Hajj. These hopefully will reduce TB infection and transmission to pilgrims and their communities all over the globe.

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