Use of facemasks and other personal preventive measures by Hajj pilgrims and their impact on health problems during the Hajj.

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Abstract

Background

The Hajj is one of the world's largest pilgrimage and gathers millions of Muslims from different nationalities every year. Communicable diseases have been reported frequently, during and following the Hajj and these have been linked to individual behavioural measures. This study aimed to measure the effect of personal preventive measures, such as facemask use, hand hygiene and others, adopted by pilgrims in reducing the acquisition of health problems.

Methods

We conducted a cross-sectional study at the Hajj terminal in King Abdulaziz International Airport in Jeddah, Saudi Arabia. Pilgrims were approached in the airport lounges after the 2017 Hajj season and prior to the departure of their flights from Jeddah to their home countries. An electronic data collection tool ('Open Data Kit' (ODK)), was used to gather survey data in regards to health problems and preventive measures during the Hajj.

Results

2,973 Hajj pilgrims were surveyed. 38.7% reported symptoms of upper respiratory tract infections (URTI) and 5.4% reported symptoms of travel diarrhoea. Compliance with facemask use was 50.2%. Changing a facemask every 4 hours was found to be significantly associated with lower prevalence of URTIs (adjusted OR 0.56; (95% CI; 0.34 – 0.92), p=0.02).There was no statistical difference between overall facemask use and URTI acquisition. The main source of food, eating raw vegetables/food, frequency of hand washing or use of hand sanitisers were not found to be significantly

associated with reported travellers' diarrhoea . Unlicensed barbers were used by 12% of pilgrims and 9.2% of pilgrims reported using blades that were re-used by other pilgrims.

Conclusion

Preventive measures are the most effective way to prevent infections Pilgrims can benefit from a facemask by changing it frequently . There is still limited information on the effect of the use of facemask in decreasing the risk of URTI in mass gatherings.

Introduction

Hajj, the Islamic annual pilgrimage to Mecca, is the fifth and last pillar of Islam and expected to be performed by physically and financially capable Muslims once during their lifetime.[1] Over two million Muslims from different ethnicities, age groups and socioeconomic status attend this religious gathering every year.[2] Domestic and international pilgrims should be registered through authorised Hajj agencies and via the Saudi authorities, in order to perform the Hajj.[3, 4] The agency is responsible for providing accommodation and food for their Hajj travellers who typically share the same tent in Mina, the principal Hajj location close to Mecca, where pilgrims spend most of the Hajj period.[5] The tents can accommodate up to 100 or more pilgrims, although this number varies.[6] Overcrowding at various Hajj sites together with the sharing of accommodation, has led to adverse health effects such as the acquisition of respiratory illnesses.[7] A key recommendation from the Saudi Ministry of Health (MoH), the World Health Organization (WHO) and the US Centers for Disease Control and Prevention (CDC) to complement mandatory vaccinations, is the use of simple physical non-pharmaceutical interventions such as maintaining hand hygiene and wearing a facemask in crowds to reduce the risk of respiratory infections among pilgrims.[8-11]

Gastroenteritis and diarrhoea have been a threat during previous Hajj seasons.[12] The reduction in travellers' diarrhoea in recent years likely reflects the Saudi government's efforts to improve sanitary conditions at Hajj sites. These initiatives have included for example restrictions on the food pilgrims are allowed to consume while at the Hajj. [12, 13] However, diarrhoea experienced by travellers and food-borne disease outbreaks

are still commonly reported among pilgrims.[12] Pilgrims are advised to maintain hand hygiene, avoid street vendors and wash vegetables and fruits prior to consumption.[10]

Shaving male heads is one of the rituals associated with Hajj and the majority of male pilgrims shave their heads as Hajj nears its end.[6] Pilgrims who share razor blades for shaving or use the services of unlicensed barbers, are at risk of blood borne infections such as HIV and hepatitis B and C [6, 14, 15 16]. The risk is higher in pilgrims who come from countries where such infections are highly prevalent.[14, 17 18]

Few studies have analysed the role of personal preventive measures, such as facemask use , hand hygiene and others in the prevention of health problems during the Hajj.[4 8, 19] Most have restricted their focus on certain nationalities and have relatively small sample sizes. This study aimed to measure the effect of personal preventive measures adopted by pilgrims from different countries in reducing the acquisition of infectious diseases during the 2017 Hajj season.

Methods and materials

The current study took place at the Hajj terminal in King Abdulaziz International Airport in Jeddah, Saudi Arabia. Pilgrims were approached in the airport lounges after the Hajj and prior to the departure of their flights from Jeddah to their home countries. An electronic data collection tool ('Open Data Kit' (ODK))[20], was employed to gather questionnaire data .Questionnaires were translated into a number of different languages including Arabic, Albanian, Bengali, Bosnian, Chinese, English, French, Hindi, Indonesian, Kurdish, Malay, Pashto, Russian, Turkish, and Urdu.

The electronic questionnaire consisted of demographic items, personal health preventive measures adopted by pilgrims and a list of symptoms pilgrims had during

and immediately after the Hajj. Upper respiratory tract infections and travellers' diarrhoea were diagnosed based on syndromic criteria and by combining diagnostic symptoms.

Ethical approval

Ethical approval was obtained from the ethics committee of the London School of Hygiene and Tropical Medicine (approval #11260).

Case definition

Travellers' diarrhoea

A recent graded expert panel report on the prevention and treatment of travellers' diarrhoea recommends using a functional impact severity definition rather than a frequency-based definition for travel diarrhoea.[21, 22] To avoid any misunderstanding, medical symptoms for diarrhoea were described in the electronic survey tool (ODK) as a '*passage of 3 or more loose stools during 24 hours*'.[23, 24] Travellers' diarrhoea was separately defined in the analyses as a '*passage of 3 or more loose stools in 24 hours with other enteric symptoms'.* Symptomatology could include abdominal pain, nausea, fever or/and vomiting during and after the Hajj and before leaving Saudi Arabia.[23]

Upper respiratory tract infection

Upper respiratory tract infection was defined as developing "*at least one of the constitutional symptoms (fever, headache, myalgia) and one of the local symptoms (running nose, sneezing, throat pain, cough with/or without sputum)*" [4].

Statistical methods

Descriptive statistics and regression analyses were performed using Stata 15 via the *svy* family of commands to incorporate survey weighting and clustering.[25] Flight numbers and number of pilgrims in each flight were used to calculate the weight used in the analysis to ensure that the probability of selection for each pilgrim sampled from flight is the same as the overall probability of selection for all pilgrims. We presented descriptive statistics for the preventive measures adopted by pilgrims. We examined the associations between the categorical exposure variable “facemask use” and the binary outcome variable “upper respiratory tract infections’’. Facemask use was categorised as 0: never, 1: sometimes and 2: most of the time. The analyses were adjusted for potential confounders: age, sex, smoking status, type of facemask, facemask usage techniques, frequency of changing facemask, influenza vaccine status, pneumococcal vaccine status, antibiotic use, exposed to cough , length of stay in Saudi Arabia, number of pilgrims inside the tent where the participant slept and country classification by income according to the World Bank report [26] for 2017-2018. We selected five times a day as a cut off of hand washing because washing hands five times a day is the standard frequency of hand washing completed by Muslims who perform the ablution prior to each of the five daily prayers.

First, univariate analysis was performed to assess any associations between each of the explanatory variables and the outcome measure. Variables that were found to have a Wald test p-value of 0.1 and below were retained in the final model. Some of the remaining explanatory variables were considered to be relevant and therefore were used in the final model. Similar analyses were used to examine risk factors associated with travellers’ diarrhoea and were adjusted for potential confounders such as sex, age, country classification by income, hand wash, use of hand sanitiser, antibiotic use, raw food and main source of food.

Results

A total of 2,973 interviews were conducted with pilgrims from different nationalities (Figure1). Table 1 summarises the demographic data of pilgrims. The uptake of influenza and pneumococcal vaccines were reported as 50.18% and 22.7%, respectively.

The number of pilgrims living inside tents during the Hajj varied substantially. In this study, 16.3% of the interviewed pilgrims reported living in tents occupied by 6-8 pilgrims, 13.9% by 10-20 pilgrims, 39.5% by 50-100 pilgrims and 30.3% by 100 or more pilgrims. The total length of stay during the Hajj journey (n=2973) averaged 33.8 (SD: 12.92) days in the 2017 Hajj season. The majority (89.41%) of pilgrims were non-smokers. Additionally, over half (55·8%) reported that they had taken antibiotics during or immediately after the Hajj.

Symptoms of upper respiratory tract infections were reported by 38.7% and diarrhoea by 5.4% of pilgrims. During the Hajj trip, 44.35% of pilgrims reported that they were exposed to cough. Table 2 summarises personal health preventive measures adopted by pilgrims.

After adjusting for potential confounders, the analysis did not show any significant association between the occurrence of diarrhoea among Hajj pilgrims and the main source of food, eating raw vegetables/food, frequency of hand washing or use of hand sanitisers (Table 4).

Changing a facemask every 4 hours was found to be significantly associated with lower prevalence of symptoms of URTIs (adjusted OR 0.56; (95% CI; 0.34 – 0.92), *p*-value 0.02). However, there was no evidence of an association between URTIs and

the overall use of a facemask. Having (symptoms) of URTIs was found to be significantly associated with country classification by income as shown in Table 3. More pilgrims with URTIs (symptoms) were reported from higher income countries, upper middle income countries and lower-middle income countries compared to those coming from low income countries; adjusted OR 3.2 (95% CI; 1.6, 6.4, *p*-value 0.001), 2.3 (95% CI; 1.3, 2.9, *p*-value 0.003) and 1.9 (95% CI; 1.2, 2.9, *p*-value 0.002) respectively.

Discussion

Upper respiratory tract infections are among relevant health problems during the Hajj. Based on syndromic criteria, the results of this study reveal that more than one third of pilgrims had URTI's (symptoms) during or immediately after the Hajj. Around half of pilgrims used the facemasks. Data from previous Hajj studies indicate a gradual increase in the use of face masks from 24% in 1999 to 64% in 2014.[27] In previous Hajj studies, avoid transmission of infections and protection from air pollution were the most common reasons for compliance with facemask usage.[27, 28] On the other hand, discomfort and difficulty in breathing were the most commonly reported reasons for non- compliance with facemask usage.[27, 29, 30] The hot climate in Mecca[31] may make it difficult for pilgrims to continue wearing a facemask, especially the elderly.[8]

Face mask and hand hygiene are low-cost physical measures that can be adopted to reduce the risk of respiratory infections.[32] The ritual washing performed by Muslims before each of the five daily prayers involves washing the hands, which made the recommendation of hand hygiene acceptable and easy to implement for most pilgrims.[33] The majority of pilgrims in this study (82.1%) reported hand washing more than five times a day. This finding is in agreement with a different study which

demonstrated that 90.3% of domestic pilgrims had washed their hands more than five times per day.[4]

This study shows a significant lower frequency of URTIs (symptoms) among those who changed their mask every 4 hours compared to those who did not change masks. Gatrad et al. showed that facemasks should be changed on a regular basis, at least every six hours in order to remain effective.[34] Facemasks have been shown to be effective in preventing or decreasing nosocomial transmission of pandemic influenza since the time of the 1918 Influenza epidemic and could therefore play a role in other types of respiratory virus epidemics.[35, 36] Lower infection rates have been observed among nurses using a well-designed face mask which were frequently changed every two hours.[35, 36] The effectiveness of facemasks in reducing respiratory infections is influenced by several factors including quality, design, technique of application and frequency of face mask change.[34, 37]

Effectiveness of facemasks to prevent URTI's has been examined in previous studies and data were observed either to be unconvincing or contradictory.[38-49] Data from a large randomised controlled trial among Hajj pilgrims did not show any effect of facemask use against clinical or laboratory-confirmed viral respiratory infections.[50] Another observational study among French pilgrims found a higher prevalence of respiratory infections among those who reported wearing face masks. The authors argued that this could indicate that pilgrims with respiratory symptoms are more willing to wear a facemask to avoid spreading infections to others.[51]

More than half of pilgrims in this study, self reported using antibiotic during and immediately after the Hajj. The prevalence of URTIs symptoms was higher among pilgrims who used antibiotic. URTIs are mainly caused by viruses, therefore antibiotics are not likely to prove effective.[52 53] The receipt of pneumococcal vaccine was also

associated with an increased prevalence of URTIs symptoms. Pneumococcal vaccine is recommended for those at risk; including elderly travellers and those with chronic diseases.[54] Risk groups are shown to be at higher risk of respiratory infections.[55]

URTIs symptoms were more frequently reported from higher income, upper middle and lower-middle income countries compared to those coming from low income countries. These differences could be due to the lower numbers of pilgrims coming from low income countries. The size of the crowd inside tents of low income countries was lower than that from higher income countries, which could affect the transmission of respiratory infections among pilgrims inside the tents.

Proactive preventive measures have been taken by the Saudi government after the emerging Novel Coronavirus (COVID-19), by temporarily banning all Umrah pilgrimages to Mecca.[56, 57] This raise additional challenges for Saudi and international authorities, as pilgrims arriving from all over the world could lead to the spread of this and similar new emerging infections.[58] Improve health security surveillance[59] and strict compliance with preventive measures such as facemask use and hand hygiene is highly recommended. Hajj agencies play an important role in pilgrim's health education.[60] Pilgrims have confidence in the advice provided by these agencies.[60]

This study examined the effectiveness of facemasks on URTIs solely based on syndromic criteria. A future study could investigate the effectiveness of facemasks used by study participants on laboratory-confirmed respiratory pathogens. There is a potential for recall bias in this study although the time between performing Haj and departing home was usually a few days to weeks. The study is limited by the lack of information on the effect of beards for males and Niqab covering in females.[4]

In this study, diarrhoea was based on syndromic criteria and was self-reported among 5.4% of pilgrims. Gastroenteritis was in the past the most common cause of hospital admission in Hajj pilgrims. [61] However, the rate of diarrhoea in the Hajj has been observed to be consistently decreasing in the last few years. The Saudi authorities do not allow pilgrims to travel with fresh food when arriving in Saudi Arabia. [62] Pilgrims are only allowed to carry small quantities of canned food.[1, 62]

In this study, 63.1% of pilgrims used the catering services provided by their Hajj tour operators. Although hand washing is a daily ritual practise by Muslims before every prayer, some authors argue that a more effective practice is using alcohol-based hand rubs regularly with respect to hand hygiene.[12] Alcohol-based hand rubs may be better than traditional hand washing as they are quicker and associated with better compliance and a lower rate of infections.[63-65] This study indicates that more than half of the pilgrims (58.6%) used hand sanitisers, although the frequency of use was not captured in the questionnaire. As study conducted on local pilgrims in 2009 reported similar results of this studies findings which did not show any significant association between hand hygiene and diarrhoea.[4] The daily main source of food for the pilgrims was also not identified in this study. These gaps in information could have contributed to this results that did not find an association between all known risk factors and travellers' diarrhoea. [64, 66]

Unlicensed barbers are still operating illegally during the Hajj season. We found that 12.3% of male pilgrims had their heads shaved by unlicensed barbers, while 9.9% used other pilgrims' shaving tools to shave their heads. The findings of the current study are consistent with those obtained by Al-Jasser et al.**,** who performed a study among domestic pilgrims confirming that 10% of pilgrims had used the services of an unlicensed barber.[4] Reusing razor blades was also observed in an alternative study

among pilgrims from 53 different nationalities revealing that 25% of pilgrims reused blades from other pilgrims.[67] This is relevant, as the behaviour of reusing blades from other pilgrims and using the services of unlicensed barbers who may use non-sterile blades can put pilgrims at risk of spreading blood borne infections such as hepatitis B and C as well as HIV.[1] Hepatitis B vaccine is not among the Hajj travel vaccines recommended by the Saudi authorities as it is difficult for many pilgrims to take due to the cost and time required to complete the vaccination course.[1] Although this study has demonstrated that particular pilgrims are still using unlicensed barbers and sharing shaving tools, the risk of hepatitis B and C and HIV transmission in relation to pilgrims had not been investigated using laboratory testing in this or any other Hajj study . To investigate the risk of blood borne infections we recommend undertaking a study based on laboratory confirmed results of blood samples from pilgrims before and after the Hajj .

This study is one of the largest studies conducted among Hajj pilgrims from different nationalities. Pilgrims were sampled using the most relevant random sampling method for the Hajj conditions. The survey was translated into several common languages and piloted before the main study was completed. This strengthened this study by ensuring that all pilgrims understood the survey questions.

Conclusion

Respiratory tract infections, travellers' diarrhoea and blood borne infections are among frequent health risks encountered during the Hajj. These diseases could potentially be prevented by adherence to personal preventive measures to minimise the transmission of these diseases. The effect of facemask use and technique on the significant reduction of URTIs in mass gatherings needs to be further investigated. The

health education of pilgrims prior to their arrival in Saudi Arabia may play a role in increasing the compliance with preventive measures and decrease the risk of these diseases among hajj pilgrims.

Contributions

AKA designed the study with support from RB. AKA was responsible for data collection with logistic support from AA. AKA did statistical analysis, with support from PE . AKA wrote the first draft of the article with further contributions from PE, AA, RB and AB. All authors reviewed and approved the final version of the article.

Conflicts of interest

The authors have declared no conflicts of interest

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Table 1: Pilgrims demographic profile.

Characteristics	**%**
Sex	
Male	68%
Female	32%
Age in years	
≤ 34	16%
35-44	27.7%
45 to 54	26.3%
55 to 64	22%
≥ 65	8%
Education level	
Low	16%
Middle	36.9%
High	47.1%
Ethnicity	
Arab	20.9%
African	15.8%
South Asian	30.3%
Caucasian	4.3%
Mixed race	2.5%
Other	26.2%
Country classification by income	
Low	5·84%
Low-middle	56·98%
Upper-middle	28·15%
High	9·02%

Employment status	
Employed	67
Unemployed	33

Education was classified as: low (Illiterate pilgrims or those who could only read and write), middle (pilgrims with qualification of two years college, high school, or less than high school), and high (pilgrims with doctoral, master's, or bachelor's degree).
All descriptive analysis were weighted

Table 2: Health preventive measures adopted by pilgrims

Preventive measures	**%**
Face mask use	
Most of the time	19.8%
Sometimes	30.4%
Never	49.8%
Type of face mask	
Surgical facemask	90%
N95 facemask	4%
Unknown facemask	6%
Face mask usage technique	
By covering the mouth only	3.6%
By covering both nose and mouth	84.7%
Using both ways	11.7%
Changing face mask	
Never	17.7%
Every 4 hours	26.8%

Every 6 hours	19.6%
Every more than 6 hours	35. 9%
Eat raw food/vegetables	
Yes	44.3%
No	55.7%
Hand wash	
More than 5 times a day	82.1%
Less than 5 time a day	17.9%
Use of hand sanitiser	
Yes	58.6%
No	41.4%
Main source of food	
Canned	4.4%
Street	6.8%
Self-cooking	17.9%
Tour	63.1%
Other	7.8%
Shaves head for males	
Unlicensed barber	12.3%
Licensed barber	53.7%
Myself using my tools	11.4%
Myself using other's tools	2.6%
Fellow pilgrim shaved my head using other's tools	7.3%
Fellow pilgrim shaved my head using my tools	12.7%

All descriptive analysis were weighted

Table3: Risk factors of upper respiratory tract (symptoms)among Hajj pilgrims in 2017.

Exposure	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Sex				
Female	Reference			
Male	0.97 (0.74,1.2)	0.85	1.2 (0.9, 1.8)	0.15
Age				
<35	Reference			0.85#
35-44	1.3 (0.83, 2)	0.23	1.2 (0.76, 2.)	0.35
45-54	1.3 (0.92,1.8)	0.12	1 (0.6, 1.6)	0.8
55-64	0.9 (0.6, 1.4)	0.8	1.1 (0.7, 1.9)	0.52
65 and above	1 (0.73, 1.5)	0.7	1 (0.56, 1.8)	0.93
Country classification by income				
Low income	Reference			**0.001#**
Lower middle income	1.2 (0.94, 1.7)	0.1	1.9 (1.2, 2.9)	**0.002**
Upper middle income	1.4 (0.85, 2.5)	0.16	2.3 (1.3, 4)	**0.003**
High income	1.4 (0.76, 2.6)	0.25	3.2 (1.6, 6.4)	**0.001**
Facemask use				
Never	Reference		-	-
Sometimes	1.7 (1.1 , 2.5)	0.004	Reference	-
Most of the time	1.3 (1 , 1.8)	0.05	0.8 (0.6 , 1.2)	0.45
Face mask frequency				
Never	Reference			0.05#
Every 4 hours	0.47 (0.24,0.88)	0.02	0.56 (0.34,0.92)	**0.02**
Every 6 hours	0.73 (0.35,1.5)	0.41	0.74 (0.43, 1.2)	0.28
Every more than 6 hours	0.71 (0.43,1.2)	0.18	0.84 (0.54, 1.3)	0.44

Pneumococcal vaccine				
No	Reference			
Yes	1.5 (1, 2.3)	0.035	1.5 (1, 2.5)	**0.02**
Influenza vaccine				
No	Reference			
Yes	1.1 (0.86, 1.5)	0.32	1.3 (0.92, 1.8)	0.12
Antibiotic use				
No	Reference			
Yes	1.1 (0.92, 1.5)	0.16	1.3 (0.97, 1.7)	0.06
Exposed to cough				
No	Reference			
Yes	0.89 (0.68, 1.2)	0.43	0.87 (0.62, 1.2)	0.4
N. of pilgrims in the tent				
6-8	Reference			0.09
10-20	1.2 (0.69, 2.1)	0.48	1.2 (0.72, 2.2)	0.38
50-100	1.5 (0.97, 2.5)	0.06	1.6 (0.98, 2.7)	**0.05**
More than 100	1.2 (0.76, 1.9)	0.4	1 (0.66, 1.7)	0.77

*Some selected potential confounders such as (Smoking status, type of facemask, facemask usage techniques, length of stay in Saudi Arabia) were found to have a Wald test p-value more than 0.1 and were removed in the final model. All analysis were weighted.

#Overall P-value

Table 4 : Risk factors of travel diarrhoea among Hajj pilgrims in 2017.

Exposure	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Sex				
Female	Reference			
Male	0.92(0.6, 1.4)	0.73	0.97 (0.64, 1.4)	0.88
Age				
<35	Reference			0.9#
35-44	0.84 (0.43,1.6)	0.62	1 (0.53, 1.9)	0.9
45-54	0.72 (0.4, 1.3)	0.28	0.83 (0.48, 1.4)	0.49
55-64	0.76 (0.39,1.4)	0.42	0.9 (0.47, 1.7)	0.76
65 and above	0.75 (0.32,1.7)	0.51	0.83 (0.35, 1.9)	0.66
Country classification by income				
Low income	Reference			0.25#
Lower middle income	1.1 (0.69, 2)	0.51	1.1 (0.6, 1.8)	0.7
Upper middle income	0.72 (0.37, 1.3)	0.33	0.69 (0.35, 1.3)	0.26
High income	0.85 (0.3, 2.3)	0.76	0.57 (0.17, 1.8)	0.35
Antibiotic use				
No	Reference			0.85#
Yes	1.1 (0.74, 1.6)	0.6	1.1 (0.74, 1.6)	0.6
Hand wash				
More than 5 time a day	Reference			
Less than 5 time a day	1.4 (0.84, 2.3)	0.18	1.4 (0.75, 2)	0.39
Hand sanitiser				
No	Reference			

Yes	1 (0.62, 1.7)	0.86	1.1 (0.6, 1.7)	0.86
Raw food				
No	Reference			
Yes	1.3 (0.89, 2.1)	0.14	1.2 (0.78, 1.8)	0.38
Main source of food				
Canned	Reference			0.28#
Street	1.3 (0.53, 3.2)	0.54	1 (0.4, 2.3)	0.99
Self	0.49 (0.19, 1.2)	0.15	0.5 (0.19, 1.2)	0.19
Tour	0.75 (0.34, 1.6)	0.47	0.7 (0.33, 1.5)	0.33
Other	0.49 (0.12, 1.8)	0.29	0.47 (0.12, 1.7)	0.12

All analysis were weighted.
#Overall p-value

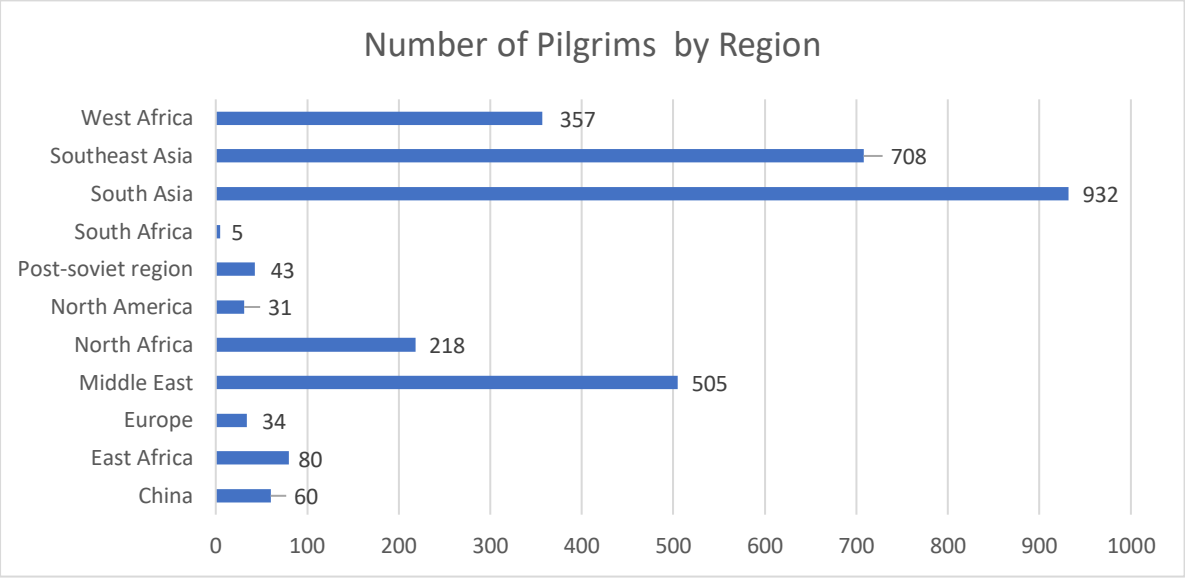

Figure 1: Number of sampled pilgrims and their regions.