Estimating the COVID-19 Risk during the Hajj Pilgrimage

Anas Khan[1,2], MD, Kingsley Lezor Bieh[1], MSc, Ahmed El-Ganainy[1], MD, Sujoud Ghallab[1], MBBS, Abdullah Assiri[3], MD, Hani Jokhdar[3], MD

1. Global Center for Mass Gatherings Medicine, Ministry of Health, Riyadh, Saudi Arabia
2. Department of Emergency Medicine, College of Medicine, King Saud University, Riyadh, Saudi Arabia
3. Deputyship of Public Health, Ministry of Health, Saudi Arabia

Corresponding Author

Kingsley Lezor Bieh

Manager, Disease Surveillance, Global Center for Mass Gatherings Medicine

Ministry of Health, Riyadh, Saudi Arabia

Email: **blezor@moh.gov.sa**

Key words: Mass gatherings, Hajj, COVID-19, risk assessment, pilgrims

Highlights

- The decision to continue, adjust or suspend a mass gathering (MG) during the current COVID-19 pandemic should be risk driven
- The risk assessment estimated the risk of COVID-19 as very high and recommended a substantial reduction in the number of pilgrims and the exclusion of foreign pilgrims and high risk groups from the 2020 Hajj, among other measures

Background

The current COVID-19 pandemic represents a significant public health threat at mass gatherings (MGs). One of such MGs is the Hajj, which is held in Makkah, Kingdom of Saudi Arabia (KSA), and attracts around 2.5 million Muslim pilgrims from over 150 countries annually. Foreign pilgrims constitute 75% of the total pilgrims population.[1,2] The World Health Organization (WHO) recognizes the economic, political, and psycho-social significance of MGs and recommends a risk-based decision-making process for their cancellation, postponement or restructuring.[3] Assessing health risks, such as the COVID-19 risk, is a key goal of public health preparedness for Hajj. Thus, the Ministry of Health, KSA, through the Global Center for Mass Gatherings Medicine, a WHO Collaborating Center for Mass Gatherings Medicine, conducted a health risk assessment for the 2020 Hajj. Based on risk estimates, the Ministry of Hajj and Umra announced a reduction in the number of pilgrims and the exclusion of foreign pilgrims from the 2020 Hajj. This paper describes the COVID-19 health risk assessment findings and highlights priority recommendations for risk mitigation and prevention.

Method

This study estimated the public health risks for COVID-19 using the "Jeddah tool" for MGs health risk assessment and modeled the expected burden of the disease in Hajj using attack rate, country Hajj quota and global disease severity index[4-6]

Using an all-hazard approach, we identified and prioritized potential hazards from historical records and a review of current local and international events/outbreaks. Then, we conducted vulnerability and capacity assessments for the hazards with the highest prioritization scores and ranked risks as low, moderate, high, and very high.

To model the burden of disease, we calculated the attack rate of COVID-19 in pilgrims' origin countries. Hypothetically, we estimated the number of primary cases that could be imported to Hajj from each country's attack rate and Hajj quota as:

Expected number of primary cases = Country attack rate x Expected Hajj quota

Additionally, the number of secondary infections was calculated from the global COVID-19 reproduction number (R_0), which is estimated by WHO to be 2-3. Then, estimated cases were categorized as asymptomatic, moderate-severe and critical, using the WHO global COVID-19 disease severity index.[7] The expected number of hospitalized cases (moderate-severe and critical) was compared with the designated 658 ward beds and 76 intensive care unit (ICU) beds in the Hajj areas. The designated beds referred to the average proportion of unoccupied hospital beds during the last three Hajj seasons. Comparisons were made for different Hajj populations to determine the expected number of cases and hospital bed availability indices for the 2020 Hajj season.

Result

The risk assessment prioritized 22 hazards and estimated the risk of COVID-19 as very high (Figure 1).

The estimated total number of primary COVID-19 cases/1,000,000 population was 1,392 cases, including 472 (33.4%) imported cases. Adjusting for secondary cases ($R_{0,}$ 2-3), the estimated total number of COVID-19 cases/1,000,000 population was 4,872 (range 4176-5772) cases, including 55% ward cases and 5% ICU cases. At the existing Hajj capacity, the study estimated that ICU and ward capacities would be saturated at 311,475 (range 262,976-363,636) and 245,522 (range 207,244-286,461) population, respectively.

Discussion

The risk assessment ranked the health risks of COVID-19 as one of the highest among prioritized hazards. This risk ranking is consistent with the global risk assessment indices for COVID-19. Fears over potential MG-related outbreaks of COVID-19 led to the suspension of many international MGs globally, including the lesser Muslim MG, Umra.[8] In our model, only one-third of expected primary cases was attributed to international travel. However, the involvement of foreign pilgrims in the 2020 Hajj may heighten the exportation risks after Hajj. The tendency for infected returning pilgrims to spark new waves of infections in their communities or introduce a more virulent strain of the virus is concerning. Forecasting models have predicted a rising number of domestic cases, which further heightens the Hajj-related health risk.[9]

Based on our estimates, the existing number of designated ward and ICU beds in the Hajj areas would be saturated once the total Hajj population exceeds around 10-15% of the previous five years' average. A US study projected that at an R_0 of 2.5, the US would need 3.8 times more ICU beds than the pre-existing capacity.[10] Although ICU and ward bed capacities are critical variables for preparedness planning, other variables, such as core healthcare workers density, contact tracing capacity, testing capacity and personal protective equipment availability are important considerations in the decision making about the size of the MG population.

Among other recognized measures, the risk assessment recommended the exclusion of all high-risk groups, such as those aged ≥ 65 years and those with comorbidity, the quarantine of all pilgrims for at least two weeks pre and post-Hajj and conducting mandatory pre-arrival PCR tests for COVID-19. In addition, the accommodation of pilgrims and service providers in Mina and Arafat (uninhabited areas on the outskirt of Makkah) would help prevent the interaction of visitors with the local Makkah population, which has a higher COVID-19 attack rate than the national average. Ensuring pilgrims are accommodated, transported and mobilized for rituals as a cohort of 30-50 individuals could facilitate contact tracing and isolation/quarantine and limit the potential for super spreading events at the MG.

Limitations

Since age-specific and regional attack rates differ in some settings from the national average, the dependence on the latter in this study is a recognized limitation. The study approach also precludes the interventions that are implemented at different points of entry. However, international spread of COVID-19 has been rapid and there is little evidence to support the effectiveness of existing point of entry measures. Furthermore, the findings of this risk assessment may not apply to other settings due to the current limited use of the Jeddah tool outside the Hajj context.

Conclusion

The decision to continue, adjust or suspend a MG during the current COVID-19 pandemic should be risk driven. The risk assessment recommended a substantial reduction in the number of pilgrims, the exclusion of foreign pilgrims, as well as conducting pre and post-Hajj COVID-19 tests and quarantine of all pilgrims and workers to help reduce health security risk at the 2020 Hajj.

Author Contributions

All authors contributed equally to conducting the risk assessment. AK and KB developed the initial manuscript draft. AE, SG, AA and HJ reviewed and revised the initial draft and contributed to subsequent versions.

Sources of Funding

There is no funding source to declare

Conflict of Interest

The authors have declared no conflicts of interest.

References

1. Alotaibi BM, Yezli S, Bin Saeed A-AA, et al. Strengthening health security at the Hajj mass gatherings: characteristics of the infectious diseases surveillance systems operational during the 2015 Hajj. *Journal of travel medicine* 2017; **24**(3): taw087.
2. Yezli S, Elganainy A, Awam A. Strengthening health security at the Hajj mass gatherings: a Harmonised Hajj Health Information System. Journal of travel medicine 2018; 25. DOI:10.1093/jtm/tay070.
3. World Health Organization. Key planning recommendations for mass gatherings in the context of COVID-19, interim guidance, 29 May 2020. 2020. https://www.who.int/publications/i/item/key-planning-recommendations-for-mass-gatherings-in-the-context-of-the-current-covid-19-outbreak (accessed 19 June 2020).
4. Ministry of Health. Jeddah Toolkit for Mass Gatherings Risk Assessment. 2020. https://www.moh.gov.sa/Documents/Jeddah-toolkit-for-MGs-risk-assessment-v2-2020-05-14.xlsx (accessed 1 June 2020.
5. Yezli S, Khan AA. The Jeddah tool: A health risk assessment framework for mass gatherings. *Saudi Medical Journal* 2020; **41**(2): 121-3.

6. Bieh K, ElGanainy A, Yezli S, et al. Health risk assessment at mass gatherings: a report of the camel festival in Saudi Arabia. *Eastern Mediterranean Health Journal* 2019; **25**(9): 647-55.

7. World Health Organization. Operational considerations for case management of COVID-19 in health facility and community: interim guidance, 19 March 2020. 2020. https://apps.who.int/iris/handle/10665/331492 (accessed 19 June 2020).

8. Ebrahim SH, Memish ZA. Saudi Arabia's drastic measures to curb the COVID-19 outbreak: Temporary suspension of the Umrah pilgrimage. Journal of Travel Medicine 2020; 27. DOI:10.1093/jtm/taaa029.

9. Alzahrani SI, Aljamaan IA, Al-Fakih EA. Forecasting the Spread of the COVID-19 Pandemic in Saudi Arabia Using ARIMA Prediction Model Under Current Public Health Interventions. *Journal of Infection and Public Health* 2020.

10. Moghadas SM, Shoukat A, Fitzpatrick MC, et al. Projecting hospital utilization during the COVID-19 outbreaks in the United States. *Proceedings of the National Academy of Sciences* 2020; **117**(16): 9122-6.

Figure Caption/Legend:

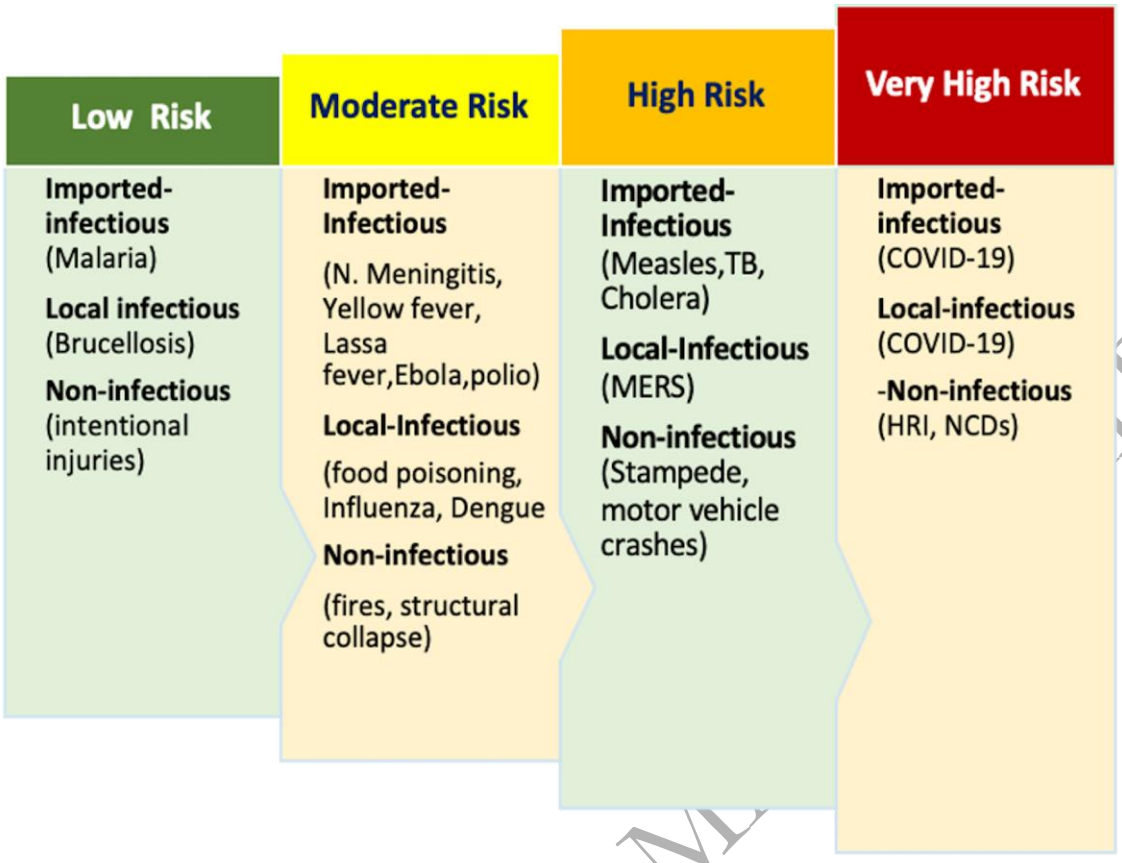

Figure 1: All-hazard risk estimates for the 2020 Hajj