Correspondence Nature Medicine

Reducing the risk of highly pathogenic avian influenza A H5N1 transmission during the Hajj

Authors: Shahul H Ebrahim[1], Alimuddin Zumla [2,3], Justin Wong [4], Mujeeb Ur Rahman[5], Seif S Al-Abri [6], Abdullah A Al Rabeeah[7], Ziad A Memish[8,9]

Institutional affiliations:

1. University of Sciences, Technique and Technology of Bamako, Bamako, Mali. Electronic address: ebrahim2@gmail.com"ebrahim2@gmail.com

2. Department of Infection, Division of Infection and Immunity, Centre for Clinical Microbiology, University College London. Electronic address: a.zumla@ucl.ac.uk"a.zumla@ucl.ac.uk

3. NIHR Biomedical Research Centre, University College London Hospitals NHS Foundation Trust, London, UK.

4. Center for Disease Control, Ministry of Health, Brunei
Electronic address: justin.wong@moh.gov.bn"justin.wong@moh.gov.bn

5. Nizar hospital, Valanchery, Malappuram, Kerala, India. Electronic address: drnmmujeeb@gmail.com"drnmmujeeb@gmail.com

6. Disease Surveillance and Control, Ministry of Health, Muscat, Oman. Electronic address: salabri@gmail.com"salabri@gmail.com

7. King Salman Humanitarian & Relief Center, Royal Court, Riyadh, Saudi Arabia Electronic address: alrabeeah.a@ksrelief.org

8. Research and Innovation Center, King Saud Medical City, Ministry of Health & College of Medicine, Al Faisal University, Riyadh, Saudi Arabia. Electronic address: zmemish@yahoo.com"zmemish@yahoo.com

9. Hubert Department of Global Health, Rollins School of Public Health, Emory University, Atlanta, USA.

Word count: 779 words

References: 11

Key words: One-Health; Animals; Avian Influenza; HPAI A (H5N1); transmission; Eid ul-Adha; sacrifice; Hajj; prevention; risk reduction; control

Correspondence: Professor Ziad A Memish. Email: zmemish@yahoo.com

Nearly 2 billion Muslims worldwide will celebrate the Festival of Sacrifice, Eid ul-Adha, during the 3rd week of June 2024. During this festival animals are sacrificed as part of a religious ritual (3,4), which could pose a risk for zoonotic transmission of highly pathogenic influenza H5N1, recently identified in dairy cattle in the USA.

The Festival of Sacrifice marks the conclusion of the annual Hajj pilgrimage to Mecca, Saudi Arabia, attended in person by approximately 4 million Muslims. Animal sacrifice is performed as part of the Hajj pilgrimage, as well as by all Muslims in their respective home countries (4), with an estimated 143 million animals sacrificed during this period. Animal sacrifice may be performed by individuals or families, although outsourcing to community organizations is increasing, with the meat both consumed by family members and distributed among the community. In the non-Hajj community settings worldwide, adults and children can be exposed to the animals, as well as to uncooked meat, which is typically cooked and consumed the same day, without refrigeration.

In Saudi Arabia, over three million animals are sacrificed during the Hajj, of which about one million are imported from Sudan, Somalia and Djibouti;the remaining two million are procured domestically . In the past, pilgrims either personally slaughtered the animals at the Hajj or oversaw the slaughtering, exposing themselves and others to potential health risks. In 1983, the Saudi Arabian government established The Saudi Projectfor Utilization of Hajj Meatto streamline ritual slaughter and limit related adverse outcomes, including zoonotic spread . This project, overseen by the Islamic Development Bank, allows pilgrims to pay for animal slaughter online, eliminating direct contact with animals or visits to the

abattoir in Makkah or Mina . The Mina abattoir, the world's largest, can handle 300,000 herds daily — equivalentto New Zealand's entire meat-processing industry . The process involves approximately 40,000 people, including 800 veterinary physicians responsible for health checks, ensuring compliance with best practices, elimination of ill animals and maintenance of safe abattoir practices. The Islamic Development Bank distributes frozen meat to low- income communities in 25 countries across north Africa, the Eastern Mediterranean and the central Asia region.

The circulation of highly pathogenic avian influence H5N1 in dairy cattle during the 2024 sacrifice season poses challenges for the Hajj, for Muslim communities worldwide, and for global efforts to combat viral transmission. First, First, although the current H5N1 outbreak among cattle has been reported only among US dairy cattle,the virus has been associated with large and deadly outbreaks in wild and farmed bird populations across multiple continents since 2020 (refs 2,8). During 2003–2023, ofthe cumulative 868 human highly pathogenic avian influenza virus H5N1 cases and 457 deaths reported from 23 countries, 66% of cases and 64% of deaths occurred in nine countries with Muslim-majority populations . Ifthe virus is prevalent among animals in exporting countries, importation and mass herding of animals in Saudi Arabia before Hajj offers opportunities for adaptation and establishment of H5N1 strains among various animal species used for sacrifice, including goat, sheep, camel and cattle.[2,9] Second, the mode of animal to human transmission is not fully understood, and exposure of the virus from cattle to several million humans in the same period could allow for further viral adaptation for human transmission. Third, there is limited animal surveillance infrastructure in the countries who export animals for the Hajj; the lack of clarity on the

incubation period among animals could mask subclinical or asymptomatic infections. Fourth, it is unlikely that animal sacrifice in community settings would adhere to sufficient hygiene practices to prevent viral transmission or use appropriate personal protective equipment. Fifth, the lack of detection of H5N1 outside of the USA may cause a lack of vigilance elsewhere, which could increase the risk of undetected animal-to-animal or animal-to-human transmission.

Avian influenza H5N1 has been detected in humans in several countries in the Eastern Mediterranean region, including Iraq and Egypt, but the actual prevalence of the virus in animals is largely unknown. Vigilance and preparedness (**box 1**) for reducing the risk of transmission of influenza H5N1 during the Festival of Sacrifice are critical. An organized response is required for human and animal pathogen surveillance and conduct of priority research in order to advance knowledge on the transmission potential of H5N1, development of new rapid diagnostics, treatments and vaccines, with sharing of data and biobanks

The Hajj provides a unique opportunity to fully implement a One-Health approach to mass gathering preparedness that can improve H5N1 surveillance and assist with other zoonoses.

This One Health approach should include global stakeholders for human and animal health, such as the Quadripartite Collaboration on One Health, as well as the Organization of Islamic Cooperation, the Gulf Cooperation Council, Arab League, and the Islamic Development Bank. The Islamic Development Bank has a unique role in aiding countries to conduct surveillance and preparedness, as well as risk communication, given their role in the global distribution of sacrificed meat from the Hajj mass gathering. Proactive steps to avert large scale inter-animal and animal to human transmissions is a global health security priority.

Competing interests All authors have an academic interest in infectious diseases with epidemic potential. All authors declare no other conflicts of interest.

Acknowledgements: Prof Sir Ali Zumla acknowledges support from the Pan-African Network for Rapid Response, Research and Preparedness for Emerging and Re-Emerging Infections (PANDORA-ID-NET) funded by the EU-EDCTP2 - EU Horizon 2020 Framework Program He is in receipt of a UK NIHR Senior Investigator Award and is a Mahathir Science Award and EU-EDCTP Pascoal Mocumbi Prize Laureate.

Priority	Recommendation
For animal surveillance in Saudi Arabia	Surveillance of animals in source countries, and rapid data sharing
	Sero-surveillance of representative biological samples by each type of animal and by country, at the Jeddah seaport
	Symptom surveillance in animals, from arrival to slaughter
	Post-slaughter organ sampling for H5N1
	Environmental sampling of animal excreta from holding areas
	Environmental sampling from sewage
For human surveillance and training in Saudi Arabia	Onboarding process to include education and certification on the importance of influenza H5N1 and other zoonotic diseases
	Provision of personal protective equipment to workers with potential contact with animals
	Active syndromic and pre- and post- event sero-surveillance for H5N1 (and other zoonotic pathogens) to assess evidence of unrecognized human transmission
	Post exposure antiviral prophylaxis with oseltamivir plus isolation of human contacts exposed to confirmed animal or human cases
	Adequate stocks of medical countermeasures including PPE
For communities worldwide	Availability of rapid diagnostics for H5N1 screening in healthcare facilities
	Strengthen capacities of national influenza and public health centers
	Risk communication and reinforcement of post-Hajj surveillance systems in countries from where pilgrims originate.
	Engagement and education of religious leaders, to alert community members of the potential risk of influenza H5N1 and other zoonotic diseases, and implementation of risk avoidance and infection control measures.
	Countries with One Health or other animal surveillance programs to conduct opportunistic or active surveillance in animal marketplaces

	Risk communication by public health and medical organizations to alert physicians and health care providers on the need for vigilance
	Assure supply of medical countermeasures

Table 1. Steps to minimize transmission of influenza H5N1 during the Festival of Sacrifice

References

1. Kojima N, Adlhoch C , Mitja O, Dat VQ, Lescano AG, Klausner JD. Building global preparedness for avian influenza. The Lancet Published online May 9, 2024 https://doi.org/10.1016/S0140-6736(24)00934-6

2. Memish ZA, Kattan RF, Ebrahim SH, Sharma A, Azhar EI, Zumla A. Proactive surveillance for avian influenza H5N1 and other priority pathogens at mass gathering events. Lancet Public Health 2024 Published Online May 15, 2024 https://doi.org/10.1016/S2468-2667(24)00103-8

3. Tapan M, Yaşar B, Ergani HM, Ceylan SC. Plastic and Reconstructive Surgery in the Wake of the Eid al-Adha: A Single-Center, Five-Year Investigation. J Clin Med. 2024 May 4;13(9):2704.

4. Mahmood Shah SM. Pandemics and prayer: The impact of cattle markets and animal sacrifices during the Muslim Eid festival on COVID-19 transmission and public health. Int J Health Plann Manage. 2020 Nov;35(6):1620-1622.

5. World Health Organization. Cumulative number of confirmed human cases for Avian influenza A(H5N1) reported to WO, 2003-2023, 5 January 2023 https://www.who.int/publications/m/item/cumulative-number-of-confirmed-human-cases-for-avian-influenza-a(h5n1)-reported-to-who-2003-2022-5-jan-202328 March 2024

6. Basturk M, Katirci Y, Ocak T, Yurdakul MS, Duran A, Baspinar I. Patients admitted to emergency units with injuries related to the four Hajj-associated annual animal sacrifice feasts from 2010 to 2013. Ann Saudi Med. 2016 Mar-Apr;36(2):139-42.

7. Kristensen C; Jensen HE, Trebbien R, Webby RJ, Larsen LE. The Avian human influenza A receptors sialic acid (SA)-a2,3 and SA-a2,6 are widely expressed in the bovine mammary gland. doi: https://doi.org/10.1101/2024.05.03.592326

8. Almasri M, Ahmed QA, Turkestani A, Memish ZA. Hajj abattoirs in Makkah: risk of zoonotic infections among occupational workers. Vet Med Sci. 2019 Aug;5(3):428-434.

9. The National. How Saudi Arabia's Eid Al Adha sacrifice for Hajj has changed: Online services and sterile slaughterhouse kitchens have taken over from the traditional market July 7 2022.

https://www.thenationalnews.com/gulf-news/2022/07/07/hajj-2022-how-saudi-arabias-eid-al-adha-sacrifice-has-evolved/ -Accessed 22 May 2024

10. BBC News. Saudis open huge slaughterhouse 11 March 2000. http://news.bbc.co.uk/2/hi/middle_east/674088.stm -Accessed 22 May 2024

11. Mohamed NA, Solehan HM, Mohd Rani MD, Ithnin M, Arujanan M. Understanding COVID-19 vaccine hesitancy in Malaysia: Public perception, knowledge, and acceptance. PLoS One. 2023 Apr 27;18(4):e0284973.