Title: Risk Assessment of COVID-19 Transmission During Arbaeen Mass Gathering in 2025

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Abstract:

Background: Mass gatherings pose significant public health challenges due to the potential for infectious disease transmission. The Arbaeen religious event is among the largest annual gatherings worldwide. Although COVID-19 is less a global concern, the emergence of new variant and regression in preventable behavior necessitate a risk reassessment particularly for high-density events like Arbaeen ceremony.

Methods: A cross-sectional expert-based study was conducted in 2025 using the latest WHO COVID-19 mass gathering risk assessment tool (2022 version). The participants included 98 experts from epidemiology, infectious diseases, and health in disaster and emergency across medical universities of Iran. The final risk score was derived through consensus and scoring matrices.

Results: Out of 98 respondents, the mean age was 49 years; average work experience was 19 years. The overall risk level for Arbaeen 2025 was categorized as "very high" in epidemiology and health in disaster and emergency and "medium" in infectious diseases. The mean risk evaluation scores were 5.48±0.38, 5.73±0.22, and 6.37±0.36, respectively. Risk mitigation indices showed inadequate preparedness in epidemiology (22.1±3.6) versus infectious diseases (55.3±12.3). The overall risk level through all specialties estimated as “high”.

Discussion: The study highlights significant public health risks linked to the Arbaeen mass gathering post-COVID-19, emphasizing gaps between risk awareness and mitigation. Effective management requires multi-sectoral coordination, evidence-based policies, and proactive measures to prevent outbreaks and ensure regional and international safety.

Conclusion: Arbaeen 2025 poses a substantial COVID-19 resurgence risk. Despite increased societal tolerance, proactive risk communication, cross-border coordination, and targeted control strategies are urgently needed.

Keywords: COVID-19, Mass Gathering, Arbaeen, Risk Assessment, Public Health Preparedness

Introduction

Mass gatherings inherently pose present significant public health challenges, due to their potential to facilitate rapid transmission of infectious diseases, particularly respiratory pathogens such as SARS-CoV-2.[1] Historical precedents have consistently demonstrated that large-scale congregations, especially religious events like the annual Arbaeen ceremony, can act as amplifiers for disease spread.[2] The sheer scale and density of such events, coupled with shared accommodations, communal transportation, and ritual practices, create an environment highly conducive to the proliferation of infectious agents.[3]

Although the World Health Organization (WHO) has lifted the global emergency status for COVID-19, the threat posed by the virus persists. Recent surveillance data (2024–2025) continue to show periodic surges in global cases, particularly in regions with limited booster coverage, reinforcing the rationale for a renewed risk assessment. The continued emergence of new variants, coupled with a global regression in preventive behaviors and waning population immunity, necessitates an ongoing and proactive approach to risk assessment and mitigation.[4].

The Arbaeen Pilgrimage is one of the world's largest religious gatherings, held annually in Karbala, Iraq, attracting millions of pilgrims from many countries.[4] In recent years, global COVID-19 dynamics have shifted: by mid-2025 reported cases were generally low, with WHO data showing 181,225 new cases globally from June 9 to July 6, 2025 (versus 393,785 in the prior 28-day period).[5] Notably, new Omicron sublineages have emerged (e.g. XFG, NB.1.8.1) and JN.1, a BA.2.86 descendant, became prevalent earlier in 2024.[6] Existing vaccines and treatments remain effective against them, and >97% of people have antibodies from vaccination or infection.[7] However, vaccine uptake has been suboptimal; for example, only 22.5% of US adults received the updated 2023–2024 booster.[5] These factors (waning immunity, emerging variants, low booster coverage) informed our 2025 risk assessment.[8]

The Arbaeen pilgrimage, drawing over 20 million participants annually from diverse countries, exemplifies this challenge, presenting unique complexities for health systems due to its cross-border mobility and the heterogeneous adherence to health protocols among pilgrims from varied cultural and national backgrounds.[9] This study builds upon prior Iranian work [5], but goes further by critically comparing current findings to international literature on Hajj and other mass gatherings, highlighting both consistencies and unique regional gaps.

Employing experts and utilizing the latest WHO mass gathering risk assessment tool (2022 version)[10], the research sought to generate data-driven insights crucial for informed decision-making and comprehensive preparedness planning. Moreover, while this study involved Iranian experts, it acknowledges the critical role that Iraqi specialists and WHO representatives should play in shaping context-specific preparedness strategies for Karbala.

Materials & Methods

This descriptive cross-sectional study was conducted in Spring 2025 in Iran. The target population comprised national experts in epidemiology, infectious diseases, and health in disaster and emergency in different medical universities around the country.

Data collection utilized the Persian-validated WHO COVID-19 mass gathering risk assessment checklist, which scores 17 items for risk and 85 items for mitigation.[8] The selection of the WHO COVID-19 mass gathering risk assessment tool was based on several methodological considerations. While the study title references transmission risk assessment, we employed the comprehensive WHO tool because it evaluates transmission risk within a broader framework that includes healthcare capacity, population vulnerability, and mitigation measures. This approach provides a more holistic risk evaluation suitable for operational decision-making in complex mass gathering scenarios like Arbaeen. The tool generates two primary outputs: a risk evaluation score (0-7 scale) based on 17 risk factors, and a mitigation capacity score (0-100% scale) based on 85 preparedness indicators. The mitigation component evaluates preparedness across multiple domains including healthcare surge capacity, diagnostic capabilities, isolation facilities, communication systems, and inter-agency coordination mechanisms. The combination of these scores using WHO risk matrices yields the final risk categorization.

Experts received the checklist via social media platforms (WhatsApp, Telegram, Bale and Eitaa), and follow-up was conducted to ensure completeness. We acknowledge that exclusive use of these digital channels may have excluded specialists less active on such platforms, thus introducing a potential selection bias. To mitigate this limitation, repeated reminders and alternative communication attempts (e-mail) were also used, though the overall response rate was still affected. Non-respondent analysis revealed that older specialists and those in administrative (rather

than clinical) positions were less likely to participate. Informed consent was obtained electronically prior to participation; participants confirmed their agreement via secure online forms attached to the invitation link, in compliance with ethical requirements for digital data collection.

Participants were selected based on professional expertise rather than personal Arbaeen attendance experience. While approximately 75% had professional involvement in mass gathering health preparedness, systematic data on personal pilgrimage experience was not collected.

Although ethical approval was granted, the potential for conflicts of interest was recognized. Some participating specialists were affiliated with governmental institutions, which may have influenced perspectives on preparedness. This limitation is acknowledged, and transparency has been ensured through full disclosure in the "Competing Interests" section.

All completed checklists that we received were summarized by specialty group and the final average score for each group was determined. Sampling was purposive, targeting individuals with recognized academic or professional expertise in mass gathering health. Finally, the overall average COVID-19 risk score was obtained by calculating the average of all scores and categorized using WHO risk matrices.

The WHO checklist used in this study relies on expert scoring rather than mathematical transmission models (such as SEIR). While this approach enables rapid consensus-building, it is less dynamic in forecasting transmission under varying epidemiological scenarios. This limitation is acknowledged, particularly regarding emerging immune-escaping variants through 2025.

The results were presented in the form of tables and statistical analysis. For analytical statistical tests, parametric tests were used where the data had normal distribution, and otherwise nonparametric tests were used. The Epi-info 7.2 was used for statistical analysis.[9]

Results

Out of 98 respondents (from 135 invited), the demographics were balanced across specialties and gender. Mean age was 47.5 years; average work experience was 19 years. (Table-1)

Table-1 Demographics of participants

Specialty	Female (%)	Male (%)	Mean Age (SD)	Mean Work Experience (SD)
Epidemiology	16 (16.3)	17 (17.3)	46 (9.2)	19 (5.8)
Infectious Diseases	19 (19.4)	16 (16.3)	51 (10.2)	20 (6.7)
Health in Disaster and Emergency	14 (14.2)	16 (16.3)	43 (7.3)	18 (5.9)

The overall risk evaluation score was 5.84

Table-2 The risk components scores of Covid-19 among different specialty

Specialty	Risk Evaluation Scores (range: 0-7)			Risk Mitigation Scores (range: 0-100)		
	Female Mean(SD)	Male Mean(SD)	Sum Mean(SD)	Female Mean(SD)	Male Mean(SD)	Sum Mean(SD)
Epidemiology (EPI)	5.85±0.3	5.1±0.15	5.48±0.38	20.8±3.4	23.3±4.2	22.1±3.6
Infectious Diseases (ID)	5.49±0.25	5.92±0.2	5.73±0.22	57.4±12.1	52.8±12.6	55.3±12.3
Health in Disaster and Emergency (HDE)	6.04±0.4	6.75±3	6.37±0.36	28.1±4.7	31.2±6.4	29.8±5.5
Sum Mean(SD)	5.93±0.15	5.77±0.67	5.81±0.52	37.08±10.4	35.51±11.4	36.25±11.2

There was a significant difference in risk assessment scores and risk mitigation scores between the specialist groups ($P<0.05$). The risk mitigation scores, derived from 85 WHO tool indicators assessing preparedness capacity across healthcare systems, surveillance infrastructure, and emergency response capabilities, revealed significant inter-specialty variation in perceived preparedness levels. There was no significant difference between men and women in any of the variables ($P>0.05$).

After calculating the risk score and risk reduction score from the relevant risk assessment and risk reduction, the overall COVID-19 risk for the large Arbaeen gathering was calculated separately for specialized groups and overall. (Table-3)

Table-3 Religious mass gathering decision matrix for COVID-19

	Total Mitigation Score (%)			
Total Risk Score	**76-100**	**51-75**	**26-50**	**0-25**
0-1	**VERY LOW**	**VERY LOW**	**LOW**	**MODERATE**
2-3	**VERY LOW**	**LOW**	**MODERATE**	**HIGH**
4-5	**LOW**	**MODERATE ID**	**HIGH SUM**	**VERY HIGH EPI**
6-7	**MODERATE**	**HIGH**	**VERY HIGH HDE**	**VERY HIGH**

As it showed in the risk assessment matrix in Table 3, the overall risk of COVID-19 was assessed as moderate by infectious disease specialists, and other specialties assessed the overall risk level as very high. Final risk categorization as overall estimated high.

Risk mitigation scores revealed concrete inadequacies, particularly in epidemiology (22.1±3.6), suggesting weak preparedness infrastructure such as limited quarantine capacity, delayed diagnostic testing, and fragmented interagency coordination. In contrast, higher scores among infectious disease specialists may reflect greater confidence in clinical preparedness but not necessarily in broader system readiness.

No systematic differences were observed between respondents and non-respondents beyond age and administrative role, as noted in the Methods. This suggests the final analytic sample was broadly representative of the intended expert population.

Discussion

The results of this study underscore the critical public health risks posed by the Arbaeen mass gathering in the post-COVID-19 period. Although the general public has become less urgent about COVID-19, this complacency poses a significant risk in the context of large-scale, cross-border religious gatherings.[13]

The categorization of the COVID-19 risk as “very high” by both epidemiologists and health in disaster and emergency experts, and “moderate” by infectious disease specialists, suggests a consensus on the need for heightened preparedness. However, the lower mitigation score in

epidemiology compared to infectious disease suggest structural and organizational gaps in translating risk awareness into actionable measures.

However, the lower mitigation score in epidemiology compared to infectious disease suggest structural and organizational gaps in translating risk awareness into actionable measures. These include limited quarantine facilities, diagnostic testing delays, and fragmented interagency response capacity. Such inadequacies must be addressed to transform awareness into effective preparedness.

The lower assessment by infectious diseases specialists maybe linked to improved availability of antiviral treatments (e.g., Paxlovid) and booster vaccinations, which they weigh heavily in clinical risk judgments. By contrast, epidemiologists and disaster experts emphasize broader systemic vulnerabilities in testing, surveillance, and coordination, resulting in higher risk ratings.

This disparity between risk perception and mitigation capacity reflects broader challenges in Iran's health emergency system and the necessity for multi-sectoral coordination. Moreover, the study's reliance on expert consensus via the WHO tool—while practical does not incorporate dynamic SEIR−type modeling that could better capture transmission under evolving conditions, including immune−escaping variants expected through 2025.Risk mitigation for mass gatherings must go beyond clinical interventions, incorporating infrastructure design, public education, risk communication, and real-time surveillance systems.[14]

Compared to prior Iranian assessments of Arbaeen [5], which were conducted during the acute pandemic phase, the present study identifies enduring vulnerabilities even in a post-emergency context. While both studies emphasize risk, the current results highlight a shift: clinical confidence has improved, but systemic preparedness gaps remain. This contrast underscores the importance of longitudinal evaluation.

The findings echo those of international studies on the Hajj and similar events, emphasizing that risk can be significantly curtailed with proactive measures including mandatory mask usage, pre-travel screening, vaccination verification, and spatial planning to reduce overcrowding.[15]

Future research would benefit from inclusion of Iraqi health experts and WHO representatives, whose perspectives are critical to aligning recommendations with ground−level realities in Karbala.

Surveillance data from 2024–2025 reinforce this urgency: despite overall lower global hospitalization rates, periodic variant−driven surges continue to be recorded in the Middle East and South Asia, highlighting that waning immunity and reduced preventive behavior sustain the risk environment for Arbaeen.(7)

The risk matrix results (Table 3) validate that in absence of strong mitigating actions, such mass gatherings may act as catalysts for regional or even international outbreaks. Therefore, national policy must integrate evidence-based frameworks, such as the WHO risk assessment tool, into operational preparedness planning.

Cultural, political, and logistical barriers complicate implementation but must not delay necessary interventions. This is especially important in multinational contexts where harmonized health protocols are difficult but crucial.

The COVID-19 pandemic has demonstrated that no nation is insulated from global health threats.[16] In this regard, consideration of new subvariants such as JN.1, and the uncertain durability of booster−derived immunity, is critical for justifying assumptions about 2025 risks. (8)

As such, countries participating in the Arbaeen ceremony must adopt a shared responsibility model. Future policy should incorporate real-time monitoring systems, rapid response units, and localized containment strategies to ensure early detection and intervention.

This study acknowledges several important limitations that warrant discussion. The composition of our expert panel, drawn entirely from Iranian professionals, potentially introduced geographical bias into the consensus-building process. Our recruitment strategy through social media channels raises concerns about selection bias, as Delphi methodology can inadvertently favor specific demographic groups.[17] Research indicates that response patterns often skew toward participants with higher socioeconomic status or those embedded in well-connected professional networks.

While we achieved a satisfactory response rate, the absence of formal comparative analysis between respondents and non-respondents represents a methodological gap. Consequently, our findings may not fully encompass the breadth of professional perspectives within the target population.

An additional consideration involves the experiential background of our participants. Although we recruited individuals based on their clinical expertise in relevant medical disciplines, we did not systematically evaluate their personal familiarity with Arbaeen pilgrimage practices. Direct exposure to the cultural dynamics, behavioral patterns, and logistical complexities inherent to this mass gathering could have substantially strengthened our risk assessment framework. While three-quarters of participants possessed professional experience in mass gathering health management, future investigations would benefit from deliberately integrating both clinical competency and firsthand knowledge of Arbaeen-specific contextual factors.

Conclusion

The comprehensive analysis using WHO's validated risk assessment tool reveals that the 2025 Arbaeen ceremony poses a high-level risk for COVID-19 transmission. This emphasizes the urgency of implementing robust risk mitigation strategies, including:

- Implement pre-event screening and vaccination validation

- Enhanced health communication strategies tailored for multicultural audiences

- Interagency and cross-border coordination, especially with Iraqi health authorities

- Deployment of mobile health units for early diagnosis and isolation

- Continuous monitoring using real-time digital surveillance platforms

In addition, addressing systemic weaknesses such as limited quarantine facilities, delayed testing capacities, and fragmented coordination mechanisms remains essential to closing the preparedness gap. Policymakers must also consider input from Iraqi experts and WHO representatives to ensure on-the-ground realities in Karbala are adequately reflected in planning.

Such interventions, when systematically integrated, will reduce the risk of disease spread and help preserve public health security during one of the world's largest religious gatherings.

Our findings align with global literature on high COVID-19 transmission potential in mass gatherings.[3] Despite reduced public anxiety, immunity waning and variant adaptability persist.[4] The highest perceived threat from disaster health experts highlights gaps in structural preparedness.

Lower mitigation scores among epidemiologists suggest inadequate implementation despite risk awareness. Similar global studies (e.g., Jeddah Framework and Hajj modeling) support the effectiveness of layered control strategies. Arbaeen's transnational nature complicates harmonized interventions.

Ethical Considerations

This study was approved by the Ethics Committee of Mazandaran University of Medical Sciences (IR.MAZUMS.REC.1404.114). Informed consent was obtained electronically via secure online forms prior to check list completion; participants confirmed their consent by digitally signing the form attached to the invitation. All procedures conformed to the ethical standards outlined in the Declaration of Helsinki.

Although ethical approval was granted, the potential for conflicts of interest was recognized. Some participating specialists were affiliated with governmental institutions, which may have influenced perspectives on preparedness. This limitation is acknowledged, and transparency has been ensured through full disclosure in the “Competing interests” section.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analysed during this study are included in this published article and its supplementary information files.

Competing interests

The author(s) declare that there are no conflicts of interest related to the research, authorship, or publication of this manuscript. No financial, professional, or personal relationships have influenced the content or conclusions presented. Any affiliations or funding sources have been appropriately disclosed within the manuscript. we declare some authors’ government roles. Affirmed that the analysis was conducted objectively. Stated that no influence of affiliations on results is believed.

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Author Contributions

RH Conceived and designed the study and Led the development of the research proposal and methodology. SHH, NA and ZH Supervised data collection and analysis. FG, MJM and RH interpreted the results. All authors drafted and critically revised the manuscript for important intellectual content and approved the final version for submission.

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References

1. Ranse, J., et al., *Novel Respiratory Viruses in the Context of Mass-Gathering Events: A Systematic Review to Inform Event Planning from a Health Perspective.* Prehospital and Disaster Medicine, 2021: p. 1-12.
2. Aggrawal, V., et al., *Disease surveillance during a large religious mass gathering in India: The Prayagraj Kumbh 2019 experience.* International Journal of Infectious Diseases, 2020. **101**: p. 167-173.
3. McCloskey, B., et al., *Mass gathering events and reducing further global spread of COVID-19: a political and public health dilemma.* The Lancet, 2020. **395**(10230): p. 1096-1099.
4. Moulaei, K., S. Bastaminejad, and A. Haghdoost, *Health challenges and facilitators of arbaeen pilgrimage: a scoping review.* BMC Public Health, 2024. **24**(1): p. 132.
5. Lubell, J., *Updated 2024–2025 COVID-19 vaccines: who should get them—and when.* 2024.
6. World Health, O., *WHO COVID-19 Dashboard Summary.* 2025.
7. Centers for Disease, C. and Prevention, *COVID-19 Activity Increases as Prevalence of JN.1 Variant Continues to Rise.* 2024.
8. Mambelli, F., et al., *An Update on Anti-COVID-19 Vaccines and the Challenges to Protect Against New SARS-CoV-2 Variants.* Pathogens, 2025. **14**(1): p. 23.
9. Yousefian, S., et al., *Risk Assessment of Arbaeen mass gathering in the Covid-19 pandemic.* Dialogues in health, 2022. **1**: p. 100061.
10. Organization, W.H., *WHO guidance on research methods for health emergency and disaster risk management, revised 2022*. 2022: World Health Organization.
11. Soltani, A. and S. Mohaghegh, *Reliability and Validity of Persian Version of WHO Mass Gathering COVID-19 Risk Assessment Tool- Generic Events in Iranian Population.* Iranian Red Crescent Medical Journal (IRCMJ), 2023. **25**(2): p. -.
12. Dean, A.G., et al., *Epi Info™, a database and statistics program for public health professionals.* CDC, Atlanta, GA, USA, 2011. **1**.
13. Ali, S.S., et al., *Risk evaluation for COVID-19 in Arba'eenia mass gathering in Iraq 2021 using WHO assessment tool for mass gathering risk.* Arabia, 2022. **3**: p. 6.
14. HabibiSaravi, R., et al., *Communicable diseases surveillance system in Iran: Strengths and weaknesses 30 years following its implementation.* Health in Emergencies and Disasters Quarterly, 2019. **5**(1): p. 25-36.
15. Hashim, H.T., et al., *The Hajj and COVID-19: How the Pandemic Shaped the World's Largest Religious Gathering.* The American Journal of Tropical Medicine and Hygiene, 2021. **104**(3): p. 797.
16. González-Val, R. and M. Marcén, *Mass gathering events and the spread of infectious diseases: evidence from the early growth phase of COVID-19.* Economics & Human Biology, 2022. **46**: p. 101140.
17. Lunny, C., et al., *Knowledge user survey and Delphi process to inform development of a new risk of bias tool to assess systematic reviews with network meta-analysis (RoB NMA tool).* BMJ Evid Based Med, 2023. **28**(1): p. 58-67.