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Decision making techniques in mass gathering medicine during the COVID-19 pandemia: a scoping review

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Background: The COVID-19 pandemic has profoundly affected mass gatherings (MGs) worldwide, necessitating the implementation of advanced decision support techniques. These techniques, including mathematical models and risk assessment tools, have played a critical role in ensuring the safe conduct of events by mitigating the spread of SARS-CoV-2.

Aim: This mini-review aims to explore and synthesize the decision support methodologies employed in managing MGs during the COVID-19 pandemic.

Methods: A scoping review was conducted following the PRISMA guidelines covering the period from 2020 to 2024. Studies were categorized by event type (e.g., academic, religious, political, sports) and decision-making tools applied. The review identified a range of decision support techniques, with risk assessment and simulation tools being the most commonly employed across various event types.

Results: A total of 199 studies were initially identified, with 10 selected finally for inclusion based on relevance to decision support techniques. Case studies included the successful risk mitigation strategies during the 2020 Hajj, the 2021 Tokyo Olympics, and the 2022 FIFA World Cup in Qatar. Techniques such as fuzzy logic, Bayesian analysis, and multi-criteria decision-making were also highlighted, particularly in complex scenarios. These tools significantly contributed to reducing COVID-19 transmission risks at large-scale events.

Conclusion: The review underscores the importance of decision support systems in the safe management of MGs during the pandemic. Further research should focus on the integration of emerging technologies and the long-term impacts of decision support tools on public health management.

KEYWORDS

mass gathering, decision support techniques, COVID-19, disaster medicine, population surveillance

1 Introduction

The COVID-19 pandemic has profoundly affected the organization and management of mass gatherings around the world. Several studies have investigated the implications of SARS-CoV-2 on these events, exploring protective measures, mathematical modeling, and decision support tools to improve safety and a way to improve the level of disaster preparedness at the municipal, provincial, and national levels (1).

Decision support techniques are those mathematical or statistical procedures used as a decision-making aid, which are frequently used in medical decision-making (2). In the specific case of epidemiology and public health surveillance, there are numerous examples of its applications, both in the human and animal kingdoms (3–5).

This mini-review synthesizes the existing literature on decision support techniques in mass gathering medicine during the pandemic, with all the difficulties involved in holding events during this period due to the diversity of opinions and approaches to their safety. Our aim is to provide a comprehensive view of the methodologies adopted to mitigate risks and manage events safely.

2 Methods

Our methodology focuses on a short-format scoping review (6) following the PRISMA recommendations (7) for systematic reviews.

2.1 Eligibility criteria

A bibliographic search is carried out in Web of Science (WoS) within the Topic field, including the terms "mass gathering" and "COVID" and that are within the period 2020–2024. The search yielded 199 results, with three works discarded due to duplicity. Two reviewers (P.L & J.M.R.R.) independently screened all manuscript titles and abstracts identified in the literature search as potentially relevant. Disagreements were resolved by consulting a third independent reviewer (G.G.A). During the different stages of the selection process, references were managed using Excel. A total of 29 papers are identified that make direct reference in their abstracts to decision support techniques.

2.2 Study selection

The three authors of this work independently moved on to the complete reading phase of these 29 works, 19 being discarded in a consensual manner for the following reasons: no reference to MGs or hypothetical MGs ($n = 7$), correspondence, commentary, editorial, opinion or letter ($n = 6$), review ($n = 3$), no article peer-reviewed ($n = 2$); not decision-making technique ($n = 1$) with finally, 10 studies were included in this review.

2.3 Data extraction

Data were extracted by one reviewer (P.L.) and verified by the second reviewer (J.M.R.R). Data were extracted using specific marking colors to match the outcomes of interest. MGs can be classified according to the type of event as religious, sports, cultural, political or musical (8). We will develop the selected works more broadly according to the type of event.

2.4 Data synthesis and analysis

A narrative synthesis of the selected works is carried out, classifying them according to the decision support tools used. No meta-analysis was performed. We focus our data analysis on identifying, by fully reading the works, the different decision-making techniques, as well as synthesizing the main conclusions of each of the works. We rely on Microsoft® Excel ® to build a table and radial visualization graphs where each of the decision tools are observed being present in the selected works.

3 Results

Ten articles were analyzed, and MGs were categorized according to the type of event studied and the methodologies used in the selected works. Figure 1 provides a summary of 10 documents analyzed. Despite the variety of available techniques, some predominate over others in the selected documents. Notably, some studies stood out for their combination of events and methodologies.

3.1 Academic MGs

The study, conducted at the University of October 6 in Egypt (9), assesses the risk of mass gatherings during the COVID-19 pandemic in Egypt, following the WHO Strategic Response Plan. The implementation of intra-action reviews at mass events at the university suggested that the high preparedness reduces the transmission of COVID-19. Coordination among the plan's 10 pillars was crucial to preventing transmission during student meetings.

3.2 Political MGs

During the United States Republican Convention (10), the successful use of the Johns Hopkins University risk assessment tool at the Republican National Convention is described, which allowed for the safe holding of the event. These data-driven strategies helped protect communities and the local health system, providing lessons applicable in the reopening of schools and public services.

3.3 Religious MGs

In this type of event, we identified three jobs. In the study dedicated to the effect of non-pharmaceutical interventions in Malaysia (11), a heterogeneous SEIR (Susceptible, Exposed, Infected, Removed) model, which is a mathematical model for the study of infectious diseases was used to assess the impact of non-pharmaceutical interventions following the second wave of COVID-19 in Malaysia. The study showed that the motion control command was effective in reducing transmission. Statistical analyses provided relevant information about the local dynamics of the disease and aided in the decision-making of the Malaysian Ministry of Health.

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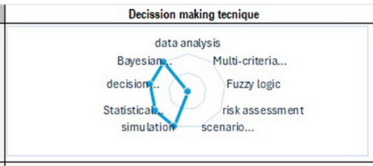
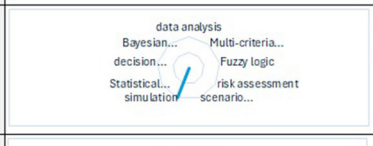
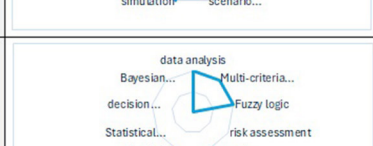
Article	MGs Type	MGs Country	Decission making tecnique	Main Conclusion
Dass SC et al., (11)	Religious	Malaysia		The analysis here also quantitatively demonstrates how quickly transmission rates fall under effective NPI implementation within a short time period. The models and methodology used provided important insights into the nature of local transmissions to decision makers in the Ministry of Health, Malaysia
Saeed, H.M. et al., (9)	Academic	Egypt		The results of this study suggested that the harmonization in the ten-pillar performance and the high level of Readiness–Capacity during mass gathering events contributed to reduced COVID-19 transmission between students during on-campus exams. Future pandemic waves could overwhelm the higher education system and healthcare infrastructure if proactive planning is not appropriate
Shimizu K et al., (14)	Sports	Japan		Heat illness along with increasing heat stress index is definitely one of the large health threats for MGEs in Tokyo, especially among the elderly, and an overstretched health system capacity need to be comprehensively discussed through an all-hazards approach. Ensuring openness and transparency for health risk assessment will be critical to prevent irreparable impact on the trajectory of COVID-19 and global sports during this global public health emergency
Jokhdar H et al., (12)	Religious	KSA		The national mitigation plan as outlined in this article aimed to ensure the safety of all pilgrims and personnel and limit the transmission of COVID-19 within and beyond Saudi borders. This model will be replicated and modified for Umrah to ensure the safe return of Umrah as a vital Islamic ritual in the near future
Gould A et al., (18)	Music Festival; Bussines conference	UK		Our observational findings reflect an ongoing lack of appreciation as to the utility of behavioral science for effective policy and practice. A critical avenue for future research would be to emphasize the quantification of behavior as the dependent variable in empirical studies, to gain deeper insights into the systematic influences on behavior within these contexts.
Tofighi M et al., (13)	Religious	KSA		This study presented a simulation tool that can be relevant for the risk assessment of a variety of (respiratory) infectious diseases, in addition to COVID-19 in the Hajj season. This tool can be expanded to include other contributing elements of disease transmission to quantify the risk of the mass gathering events
Asadi, S. et al., (17)	Various	Malaysia		According to the findings of the current study, factors including social media sharing, canceling mass gatherings, control of the movements, restrictions on international travels, and distance learning can significantly affect the prevention of COVID-19 increasingly rapid outspread. People's mass gatherings at religious ceremonies and sports will be associated with different health risks such as infection transmission, physical injuries, and effects on the local and international health systems and services. Moreover, our method can be optimized with the help of new fuzzy methodologies developed.
Dergaa I et al., (15)	Sports	Qatar		The FIFA-WC 2022 in Qatar showed that large-scale sporting events can be safely organized during a pandemic with proper measures. Our study highlights the impact of the event on COVID-19 cases and deaths in Qatar. The study emphasizes the importance of high vaccination coverage, continuous monitoring, and collaboration between organizers, healthcare authorities, and governments. The FIFA-WC 2022 serves as a model for future events, emphasizing evidence-based decision-making and public health preparedness. Further research is needed to understand long-term effects and to refine best practices for event organization during pandemics
Linton NM et al., (16)	Sports	Japan		Despite extraordinary planning and precautions more than five hundred Olympic Games accredited individuals were infected just before or during the Games. Stricter infection prevention guidance and better adherence to such guidance may have been able to reduce spread among these individuals after immigration to the Games accredited population (arrival in Tokyo and beginning of Games-associated duties). However, with the pandemic uncontrolled both in Tokyo and abroad, complete suppression of transmission was unlikely given the nature of the OPG as they involve intense physical exertion, close contact, and—inevitably—cheering on athletes who are doing their best to take home Olympic gold. Suppressing local transmission and encouraging risk-aware behavior is key to limiting the impact of mass gathering events such as the OPG on COVID-19 spread
Callaway D et al., (10)	Political	USA		The deployment of the JHU Toolkit was an operational and quality assurance decision. Publically reported data revealed that using the Toolkit allowed the team to identify four (4) COVID-19-positive individuals before entry into the NSSE and engagement with other attendees. Since the conclusion of the RNC, there are no reports of COVID-19 transmission from the RNC

FIGURE 1
Synthesis of findings.

In the Hajj Risk Management work in 2020 (12), Saudi Arabia successfully implemented measures to mitigate COVID-19 risks during the Hajj in 2020, limiting participation to 1,000 pilgrims. No cases of COVID-19 were identified among participants or staff, highlighting the effectiveness of mitigation strategies implemented by the Saudi government to prevent outbreaks at mass events.

Finally, and related to the Hajj, agent-based simulations are used to model risky contacts between pilgrims during the Hajj (13). The results indicated that as the number of pilgrims increased, it was more difficult to maintain physical distancing, suggesting that contact management is key to assessing transmission risks in future events.

3.4 Sports MGs

Related to sporting events we find three other works. The first refers to the impact of heat and COVID-19 on the Tokyo 2021 Olympic Games (Japan) (14), where the interaction between the increase in COVID-19 cases and heat illness in Tokyo during the 2021 Olympic Games was analyzed. The authors highlighted that the double burden of COVID-19 and heat-related illnesses could overwhelm health care systems if adequate countermeasures are not put in place.

Secondly, within this type of event we have the assessment of the impact of COVID-19 on the 2022 FIFA World Cup in Qatar (15). This study looked at the impact of COVID-19 during the 2022 FIFA World Cup, revealing a significant increase in cases during the event, but with low mortality rates. The study emphasizes the importance of vaccination and effective collaboration between organizers and health authorities to manage risks at mass events.

Finally, and related to the Tokyo Olympic Games, transmission scenarios are studied through a model of multiple branching processes (16), evaluating the potential transmission of COVID-19 during the Tokyo 2020 Olympic Games. It was estimated that preventive measures could significantly reduce cases, underlining the importance of keeping transmission levels below epidemic levels to avoid contagion between groups.

3.5 Other MGs

Our selection of publication highlights two that cannot be classified in the previous points since they address more than one type of MGs.

Malaysia's response to the COVID-19 pandemic (17) used DEMATEL (Decision Making Trial and Evaluation Laboratory) and Fuzzy Rule-Based techniques to assess responses to the pandemic in Malaysia. Movement control orders, international travel restrictions, and the cancellation of mass gatherings were identified as key factors in preventing COVID-19 transmission in the country.

On the other hand, observations of behavior during mass events in Wales (18), an observational study during mass events in Wales showed that personal protective behaviors, such as social distancing and mask wearing, were influenced by the design of the environment and social norms. The results suggest that system-level changes may improve adherence to healthy behaviors in future challenges.

3.6 Decision support tools

The most identified decision support tools in our selection of documents have been risk assessment (10, 12–14) which is widely used to assess the potential risks associated with mass gatherings and implement appropriate measures and simulation (9, 11–13) is applied to predict the spread of the virus and assess the impact of different protective measures. To a lesser extent, Bayesian analysis (10), decision support systems (11, 13), statistical modeling (11), data analysis (17, 18), multicriteria decision making (17), fuzzy logic (17) and scenario analysis (16) have been recognized.

4 Discussion

The discussion focuses on the current state of decision support techniques and knowledge networks in MGs medicine during the COVID-19 pandemic. We identify research gaps, controversies, and potential future developments in the field.

Regarding research gaps, there are emerging technologies that have been left out of the document selection process, such as blockchain, and that may be interesting to integrate into the management of COVID-19 in mass gatherings (19, 20), in order to track and guarantee compliance with health measures. There is also a need for more exhaustive studies on the long-term impacts of the strategies implemented on public health.

Regarding possible future developments, we recommend: enhanced artificial intelligence powered decision support tools that can provide real-time updates and recommendations and strengthening international collaborations to share data and best practices more effectively.

This work is an initial review of the topic and does not cover many significant works on the topic of interest, e.g. decision making and pandemic management tools developed in Europe. It would be desirable to extend the analysis in the future, to account for more recent and most advanced promising findings.

The study has also a main limitation due to the heterogeneity of the included studies, so interpretation of the results should be taken with caution.

5 Conclusion

Our review underscores the critical role of decision support techniques and knowledge networks in managing MGs during the COVID-19 pandemic. By synthesizing existing research and analyzing key collaborations, we provide valuable insights into effective strategies and highlight areas for future research. Continued collaboration and the development of advanced decision support tools are essential to ensure the safety and success of mass gatherings in the post-pandemic era.

Author contributions

PL-N: Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Investigation. J-MR-R: Investigation, Writing – review &

editing, Conceptualization, Writing – original draft. GG-A: Investigation, Writing – review & editing, Conceptualization, Writing – original draft.

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Conflict of interest

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References

1. Lund A, Gutman SJ, Turris SA. Mass gathering medicine: a practical means of enhancing disaster preparedness in Canada. *CJEM*. (2011) 13:231–6. doi: 10.2310/8000.2011.110305

2. National Library of Medicine. *Decision Support Techniques MeSH Descriptor Data 2024*. (2024). Available at: https://meshb.nlm.nih.gov/record/ui?ui=D003661 (accessed August 22, 2024).

3. Drewe JA, Snary EL, Crotta M, Alarcon P, Guitian J. Surveillance and risk assessment for early detection of emerging infectious diseases in livestock. *Rev Sci Tech*. (2023) 42:120–7. doi: 10.20506/rst.42.3355

4. Dong J, Wu H, Zhou D, Li K, Zhang Y, Ji H, et al. Application of big data and artificial intelligence in COVID-19 prevention, diagnosis, treatment and management decisions in China. *J Med Syst*. (2021) 45:84. doi: 10.1007/s10916-021-01757-0

5. Shausan A, Nazarathy Y, Dyda A. Emerging data inputs for infectious diseases surveillance and decision making. *Front Digit Health*. (2023) 5:1131731. doi: 10.3389/fdgth.2023.1131731

6. Grant MJ, Booth A. A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Info Libr J*. (2009) 26:91–108. doi: 10.1111/j.1471-1842.2009.00848.x

7. *PRISMA 2020 Checklist*. Available at: https://www.prisma-statement.org/prisma-2020-checklist (accessed August 1, 2024).

8. Llorente Nieto P, González-Alcaide G, Ramos JM. Gestión de la atención médica en las reuniones masivas de personas (mass gatherings): revisión sistemática [Mass gatherings: a systematic review of the literature on large events]. *Emergencias*. (2017) 29:257–65.

9. Saeed HM, Saad Elghareeb A, El-Hodhod MAA, Samy G. Assessment of COVID-19 preparedness response plan on higher education students simulation of WHO intra-action review in Egypt. *Sci Rep*. (2023) 13:741. doi: 10.1038/s41598-023-27713-1

10. Callaway D, Runge J, Mullen L, Rentz L, Staley K, Stanford M, et al. Risk and the republican national convention: application of the novel covid-19 operational risk assessment. *Disaster Med Public Health Prep*. (2022) 16:1612–7. doi: 10.1017/dmp.2020.499

11. Dass SC, Kwok WM, Gibson GJ, Gill BS, Sundram BM, Singh S, et al. A data driven change-point epidemic model for assessing the impact of large gathering and subsequent movement control order on COVID-19 spread in Malaysia. *PLoS ONE*. (2021) 16:e0252136. doi: 10.1371/journal.pone.0252136

12. Jokhdar H, Khan A, Asiri S, Motair W, Assiri A, Alabdulaali M. COVID-19 mitigation plans during Hajj 2020: a success story of zero cases. *Health Secur*. (2021) 19:133–9. doi: 10.1089/hs.2020.0144

13. Tofighi M, Asgary A, Tofighi G, Najafabadi MM, Arino J, Amiche A, et al. Estimating social contacts in mass gatherings for disease outbreak prevention and management: case of Hajj pilgrimage. *Trop Dis Travel Med Vaccines*. (2022) 8:19. doi: 10.1186/s40794-022-00177-3

14. Shimizu K, Gilmour S, Mase H, Le PM, Teshima A, Sakamoto H, et al. COVID-19 and heat illness in Tokyo, Japan: implications for the summer olympic and paralympic games in 2021. *Int J Environ Res Public Health*. (2021) 18:3620. doi: 10.3390/ijerph18073620

15. Dergaa I, Ben Saad H, Zmijewski P, Farhat RA, Romdhani M, Souissi A, et al. Large-scale sporting events during the COVID-19 pandemic: insights from the FIFA World Cup 2022 in Qatar with an analysis of patterns of COVID-19 metrics. *Biol Sport*. (2023) 40:1249–58. doi: 10.5114/biolsport.2023.131109

16. Linton NM, Jung SM, Nishiura H. Not all fun and games: potential incidence of SARS-CoV-2 infections during the Tokyo 2020 Olympic Games. *Math Biosci Eng*. (2021) 18:9685–96. doi: 10.3934/mbe.2021474

17. Asadi S, Nilashi M, Abumalloh RA, Ali Abumalloh R, Samad S, Ahami A, et al. Evaluation of factors to respond to the COVID-19 pandemic using DEMATEL and fuzzy rule-based techniques. *Int J Fuzzy Syst*. (2022) 24:27–43. doi: 10.1007/s40815-021-01119-5

18. Gould A, Lewis L, Evans L, Greening L, Howe-Davies H, West J, et al. COVID-19 personal protective behaviors during large social events: the value of behavioral observations. *Behav Sci*. (2024) 14:63. doi: 10.3390/bs14010063

19. Ahmad RW, Salah K, Jayaraman R, Yaqoob I, Ellahham S, Omar M. Blockchain and COVID-19 pandemic: applications and challenges. *Cluster Comput*. (2023) 1–26. doi: 10.36227/techrxiv.12936572.v2

20. Singh S, Verma SB. Resolving COVID-19 with blockchain and AI: a systematic review. *Adv Distrib Comput Artif Intell J*. (2024) 13:e31454. doi: 10.14201/adcaij.31454