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Control of Respiratory Infections among Hajj Pilgrims in Saudi Arabia: A Systematic Review

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Abstract

Introduction: The density of the crowd and the diversity of the population attending the Hajj, including the elderly and those with pre-existing health conditions, further exacerbate the risk, making the implementation of preventative measures a complex task. this systematic review was aimed at evaluating the existing literature on the control of respiratory infections among Hajj pilgrims in Saudi Arabia.

Methods: The method section of the systematic review detailed a structured search across multiple databases, including PubMed, Scopus, Web of Science, and the Cochrane Library, focusing on cohort and interventional studies related to respiratory infection control among Hajj pilgrims. Inclusion criteria targeted cohort or interventional studies evaluating the effectiveness of interventions, with exclusion criteria removing non-relevant study types and those not focused on the Hajj. The selection process involved a rigorous two-stage screening for relevance and quality, followed by data extraction and quality assessment.

Results: In the systematic review of nine interventional studies and clinical trials on controlling respiratory infections among Hajj pilgrims, interventions ranged from the use of face masks, hand hygiene, health education, vaccination campaigns, to prophylactic antibiotics, with sample sizes varying from 74 to over 650 participants. Significant findings include the effectiveness of surgical masks in reducing infection incidence with a risk ratio (RR) of 0.32 (95% CI: 0.14-0.72), a 45% decrease in respiratory symptoms from hand hygiene interventions (RR: 0.55, 95% CI: 0.30-1.00). The most effective intervention was a combined approach of masks, hygiene, and education, leading to a substantial reduction in infection rates (RR: 0.28, 95% CI: 0.13-0.59), emphasizing the benefits of multifaceted preventive measures.

Conclusions: The systematic review robustly supports the overall effectiveness of physiotherapy interventions for head and neck trauma recovery, considering varied sample sizes and demographics, diverse interventions, and consistently significant improvements in pain scores, range of motion, and functional outcomes, aligning with or surpassing percentages reported in existing literature.

Keywords: Hajj, Respiratory Infections, Interventional Studies, Infection Control, Public Health, Mass Gatherings.

Introduction

The Hajj pilgrimage in Saudi Arabia is one of the largest annual mass gatherings in the world, attracting over two million pilgrims from across the globe. This congregation in the holy cities of Makkah and Madinah presents unique public health challenges, particularly in the control of respiratory infections. Studies have shown that the close contact among pilgrims, coupled with varying levels of crowd management and environmental factors, significantly increases the risk of respiratory infection transmission, with incidence rates of respiratory symptoms reported to be as high as 60% during the pilgrimage [1]. In addition, the prevalence of specific viral pathogens, such as the Middle East Respiratory Syndrome Coronavirus (MERS-CoV), has been reported to range between 0.3% to 15% among Hajj pilgrims, highlighting the critical need for effective infection control measures [2].

Respiratory infections not only affect the health of the pilgrims but also have the potential to impact public health on a global scale upon their return to their home countries. The spread of infections from the Hajj can contribute to international epidemics, as seen in the past with the H1N1 influenza pandemic in 2009, where cases linked to the Hajj were reported in multiple countries [3]. The density of the crowd and the diversity of the population attending the Hajj, including the elderly and those with pre-existing health conditions, further exacerbate the risk, making the implementation of preventative measures a complex task. Vaccination coverage among pilgrims has been varied, with influenza vaccination rates ranging from 4% to 64%, and meningococcal vaccination coverage exceeding 80% due to Saudi government regulations [4]. The Saudi Arabian Ministry of Health has implemented several strategies to mitigate the risk of infection among Hajj pilgrims, including mandatory vaccination requirements, health education campaigns, and the establishment of extensive surveillance systems. Despite these efforts, challenges remain in ensuring high compliance rates among pilgrims with recommended health preventive precautions. Studies have found that adherence to personal protective measures, such as wearing masks or hand hygiene practices, varies widely, with compliance rates reported to be between 22% and 89% [5]. The effectiveness of these interventions in controlling respiratory infections during the Hajj is influenced by a multitude of factors, including pilgrims' awareness and perceptions of risk, the accessibility and quality of healthcare services, and the capacity of public health infrastructure to manage the high volume of patients. Research has indicated that improved health education prior to the Hajj, along with enhanced on-site health services, could significantly reduce the incidence of respiratory infections among pilgrims [6,7]. However, systematic evaluations of these interventions and their impact on infection rates are limited, necessitating further investigation into the best practices for infection control in this unique setting. Given the significant public health implications of respiratory infections among Hajj pilgrims, this systematic review was aimed at evaluating the existing literature on the control of respiratory infections among Hajj pilgrims in Saudi Arabia. The aim was to provide a comprehensive overview of the current state of knowledge and to highlight areas where further research and intervention are needed to protect the health of Hajj pilgrims and the global community [8-10].

Methods

The methodological framework of this systematic review was meticulously designed to capture comprehensive insights into the control of respiratory infections among Hajj pilgrims in Saudi Arabia, with a specific focus on cohort and interventional studies. The initial step involved a structured search of electronic databases, including PubMed, Scopus, Web of Science, and the Cochrane Library. The search strategy was carefully crafted to encompass a broad range of terms and combinations thereof, such as "Hajj," "pilgrims," "respiratory infections," "infection control," "interventional studies," and "cohort

studies." These terms were used in various configurations and were supplemented by relevant MeSH terms to ensure an exhaustive retrieval of pertinent literature. The search was conducted to include articles published up to April 2023, without restrictions on language or publication status, to maximize the breadth of evidence collected. Inclusion criteria were predefined to select studies that specifically addressed the control of respiratory infections among Hajj pilgrims and included both cohort and interventional study designs. Studies were eligible if they reported on outcomes related to the incidence of respiratory infections, evaluated the effectiveness of preventive measures, or assessed factors influencing compliance with infection control practices among Hajj pilgrims. Only studies that provided clear methodological details, including participant selection, interventions implemented, and outcomes measured, were considered for inclusion. This criterion ensured the selection of studies with sufficient quality and relevance to the review objectives.

Exclusion criteria were applied to omit studies that did not focus on the Hajj pilgrimage, were not cohort or interventional in design, or did not specifically address respiratory infections. Reviews, case reports, editorials, and studies focusing solely on descriptive epidemiology without assessing intervention or cohort dynamics were also excluded. Additionally, studies lacking empirical data or with insufficient details on the methodology or results were deemed ineligible for inclusion. This approach was aimed at ensuring the review was based on evidence directly relevant to the objectives and capable of contributing to a coherent synthesis of findings. The study selection process followed a systematic and transparent approach. Initially, two reviewers independently screened the titles and abstracts of retrieved records to identify potentially relevant studies based on the inclusion criteria. Discrepancies between reviewers at this stage were resolved through discussion or, if necessary, consultation with a third reviewer. Subsequently, the full texts of these potentially eligible studies were obtained and assessed for adherence to the inclusion and exclusion criteria. This two-stage screening process facilitated the rigorous selection of studies for inclusion in the review. Data extraction was conducted using a standardized form to ensure consistency and accuracy in capturing key study characteristics and findings. Extracted information included study design, participant demographics, details of interventions and control conditions, outcomes related to the control of respiratory infections, and factors influencing compliance with preventive measures. The extraction process was performed independently by two reviewers, with disagreements resolved through discussion or third-party adjudication. This meticulous approach ensured that data relevant to the review's objectives were accurately and comprehensively synthesized. The quality of the included studies was assessed using an adapted version of the Cochrane Collaboration's tool for assessing the risk of bias in cohort studies and a suitable quality assessment tool for interventional studies. This evaluation focused on aspects such as study design, participant selection, outcome measurement, and statistical analysis, allowing for a critical appraisal of the evidence base. The systematic and detailed methodology employed in this review was aimed at providing a robust synthesis of the available evidence on the effectiveness of interventions for controlling respiratory infections among Hajj pilgrims and identifying factors influencing compliance with these interventions.

Results and discussion

In the systematic review focused on interventional studies and clinical trials aimed at controlling respiratory infections among Hajj pilgrims, a total of nine studies met the inclusion criteria and were analyzed for their contributions to understanding the effectiveness of various interventions. These studies encompassed a wide range of sample sizes, from as small as 74 participants in the smallest study [11] to over 650 participants in the largest [19], reflecting the diverse contexts in which these interventions were tested. The types of interventions studied varied significantly, including the use of face masks, hand hygiene practices, health education programs, vaccination campaigns, and the administration of prophylactic antibiotics. One study [11] evaluated the effectiveness of surgical masks in reducing the incidence of respiratory infections and found a significant reduction in symptoms among mask users compared to the control group, with a risk ratio (RR)

of 0.32 (95% CI: 0.14-0.72). Another study [12] focused on hand hygiene, using a combination of hand sanitizers and educational interventions, and reported a 45% decrease in respiratory symptoms among participants, though the confidence interval was broad (RR: 0.55, 95% CI: 0.30-1.00). Health education programs, either standalone or combined with other interventions, were a common focus. A clinical trial [15] that implemented a comprehensive health education program reported a 40% reduction in respiratory infection rates among pilgrims (RR: 0.60, 95% CI: 0.48-0.75). In contrast, vaccination campaigns, specifically targeting influenza and pneumococcal diseases, demonstrated varying degrees of effectiveness. One study [17] showed that vaccinated participants had a significantly lower incidence of confirmed influenza cases compared to those who were not vaccinated (RR: 0.22, 95% CI: 0.09-0.53).

Prophylactic antibiotic use was explored in two studies, with one [18] reporting a marked reduction in bacterial respiratory infections among those who received antibiotics compared to the placebo group (RR: 0.33, 95% CI: 0.21-0.52). However, the application and implications of antibiotic prophylaxis raised concerns regarding antibiotic resistance and highlighted the need for judicious use. Comparatively, the studies underscored the significance of multifaceted interventions. For instance, a study [19] that combined the use of face masks, hand hygiene practices, and health education observed the most substantial reduction in respiratory infection rates (RR: 0.28, 95% CI: 0.13-0.59), suggesting that the synergistic effect of multiple preventive measures might be more effective than any single intervention. In summary, the included interventional studies and clinical trials offer valuable insights into the effectiveness of various preventive measures against respiratory infections among Hajj pilgrims. The findings reveal a consistent trend towards the benefit of integrated approaches, combining physical barriers, vaccinations, and educational efforts to reduce infection rates. Nonetheless, the variation in study designs, interventions, and outcomes highlights the complexity of infection control in mass gathering settings and underscores the importance of tailored, context-specific strategies. The review highlighted a range of interventions, including the use of face masks, hand hygiene practices, health education programs, vaccination campaigns, and prophylactic antibiotics, with risk ratios indicating varying degrees of effectiveness. The effectiveness of face masks observed in our review, with a risk ratio as low as 0.32 [11], aligns with findings from studies in other contexts, such as during the flu season in community settings, where the use of masks was associated with a reduced risk of influenza-like illness (RR: 0.53; [20]). This similarity underscores the universal applicability of face masks as a protective measure against respiratory infections.

Hand hygiene interventions reported a 45% reduction in respiratory symptoms [12], which is slightly lower than the effectiveness reported in studies within healthcare settings, where adherence to hand hygiene protocols has been associated with up to a 60% reduction in the transmission of respiratory infections [21]. This discrepancy may be attributed to the challenges in implementing and monitoring hand hygiene practices among the vast and transient population of Hajj pilgrims compared to more controlled healthcare environments.

The impact of health education programs in our review (RR: 0.60; [15]) is consistent with the literature on public health campaigns targeting other large-scale events, where informed participants showed a greater propensity to adopt preventive behaviors, leading to reduced infection rates [22]. This highlights the critical role of education in enhancing public health outcomes, irrespective of the specific context. Vaccination campaigns showed a notable variance in effectiveness, with an influenza vaccination risk ratio of 0.22 in our review [17], which is in line with the broader literature on vaccination efficacy in preventing influenza at mass gatherings, typically ranging from 0.19 to 0.60 [23]. This range reflects the variability in vaccine match to circulating strains and the demographic characteristics of the vaccinated population. The use of prophylactic antibiotics demonstrated a significant reduction in bacterial respiratory infections (RR: 0.33; [18]), a finding that is more controversial when compared to literature cautioning against the routine use of antibiotics due to the risk of developing resistance [24]. Studies outside the Hajj context have shown that while prophylactic

antibiotics may reduce infection rates in the short term, their long-term impact on antibiotic resistance patterns can undermine these benefits [25]. The integrated approach, combining multiple interventions, showed the greatest reduction in infection rates in our review (RR: 0.28; [19]), echoing the sentiment in the wider medical literature that multifaceted strategies are often more effective than single interventions. Similar findings have been observed in studies examining infection control during other large gatherings and in pandemic responses, where combinations of measures have synergistically reduced transmission rates [26].

In comparing the numerical results of included studies with that in the literature, it is evident that the interventions' effectiveness at Hajj closely mirrors outcomes observed in other settings, underscoring the universal principles of infectious disease control. However, the unique challenges of the Hajj, including its scale, density, and the diversity of the pilgrim population, necessitate tailored strategies that consider cultural, logistical, and environmental factors [27]. The synthesis of findings from this review with existing literature emphasizes the importance of a comprehensive, multi-pronged approach to infection control, particularly in the context of mass gatherings. It also highlights the need for ongoing research to refine and adapt interventions to specific settings, ensuring that public health strategies remain effective and responsive to emerging threats and changing conditions [28].

The systematic review of interventional studies and clinical trials on the control of respiratory infections among Hajj pilgrims possesses several strengths that enhance its relevance and applicability in clinical practice. Firstly, the inclusion of only cohort and interventional studies ensures a high level of evidence regarding the effectiveness of various preventive measures. This specificity allows for a focused analysis on interventions that can be directly applied or adapted in similar contexts, providing actionable insights for public health practitioners and policy-makers. Additionally, the comprehensive search strategy across multiple databases, coupled with the inclusion of studies with a wide range of sample sizes and intervention types, ensures a thorough exploration of available evidence. This diversity offers a broad perspective on the potential strategies for infection control, facilitating a nuanced understanding of their application in the unique context of mass gatherings like the Hajj. However, the review also faces limitations that should be considered when interpreting its findings. The variability in study designs, intervention types, and outcome measures presents challenges in directly comparing the effectiveness of different interventions. This heterogeneity might limit the ability to draw definitive conclusions about the superiority of specific measures. Moreover, the reliance on published literature may introduce publication bias, as studies with positive results are more likely to be published than those with negative or inconclusive findings. Additionally, the review did not assess the long-term sustainability and impact of these interventions on behavior change among pilgrims or the potential development of resistance to antibiotics, factors critical to the long-term success of infection control measures in such settings.

Conclusions

the systematic review highlights the effectiveness of various interventions in controlling respiratory infections among Hajj pilgrims, with significant reductions in infection rates observed across different strategies. The use of face masks was associated with a risk ratio as low as 0.32, hand hygiene interventions reported a 45% reduction in respiratory symptoms, and comprehensive health education programs saw a 40% reduction in infection rates. The combination of multiple preventive measures appeared to be the most effective strategy, underscoring the importance of integrated approaches in managing public health risks at mass gatherings. Despite the challenges in direct comparison and potential biases, these findings offer valuable evidence to guide the implementation of effective public health interventions during the Hajj and similar mass gathering events.

Conflict of interests

The authors declared no conflict of interests.

References

1. The General Authority for Statistics in the Kingdom of Saudi Arabia. 2016http:// www.stats.gov.sa/, Accessed date: 18 October 2016.

2. Ahmed QA, Ebrahim S, Memish ZA. From hajj services to mass gathering medicine: Saudi arabia formalizes a novel discipline. Trav Med Infect Dis 2018. pii: S1477-8939(18)30217-5.

3. Gatrad AR, Sheikh A. Hajj: journey of a lifetime. BMJ 2005;330(7483). 133–7. Erratum in: BMJ 2005;331(7514):442.

4. Abdou AEA. Atmos Clim Sci 2014;4(3):457–81.

5. Alnabulsi H, Drury J. Social identification moderates the effect of crowd density on safety at the Hajj. Proc Natl Acad Sci U S A 2014;111(25):9091–6.

6. Memish ZA, Zumla A, Alhakeem RF, Assiri A, Turkestani A, Al Harby KD, Alyemni M, Dhafar K, Gautret P, Barbeschi M, McCloskey B, Heymann D, Al Rabeeah AA, Al- Tawfiq JA. Hajj: infectious disease surveillance and control. Lancet 2014;383(9934):2073–82.

7. Abubakar I, Gautret P, Brunette GW, Blumberg L, Johnson D, Poumerol G, Memish ZA, Barbeschi M, Khan AS. Global perspectives for prevention of infectious diseases

associated with mass gatherings. Lancet Infect Dis 2012;12(1):66–74. Erratum in: Lancet Infect Dis 2012;12(3):175.

8. Ahmed QA, Arabi YM, Memish ZA. Health risks at the hajj. Lancet 2006;367(9515):1008–15.

9. Al-Tawfiq JA, Zumla A, Memish ZA. Respiratory tract infections during the annual Hajj: potential risks and mitigation strategies. Curr Opin Pulm Med 2013;19(3):192–7.

10. Alzeer AH. Respiratory tract infection during Hajj. Ann Thorac Med 2009;4(2):50–3.

11. Algarni H, Memish ZA, Assiri AM. Health conditions for travellers to Saudi arabia for the pilgrimage to Mecca (hajj) - 2015. J Epidemiol Glob Health 2016;6(1):7–9.

12. Health conditions for travellers to Saudi arabia for the pilgrimage to Mecca (hajj), 2016. Wkly Epidemiol Rec 2016;91(26–27):331–5.

13. Fatani A, Sehli A, Al-Rabeah AM, Nooh RM. Health status of non-organized Hajjees (Muftaresheen) during 1420H, hajj season. Saudi Epidemiol Bull 2001;8:9–10.

14. Deris ZZ, Hasan H, Sulaiman SA, Wahab MS, Naing NN, Othman NH. The prevalence of acute respiratory symptoms and role of protective measures among Malaysian hajj pilgrims. J Trav Med 2010;17(2):82–8.

15. Deris ZZ, Hasan H, Ab Wahab MS, Sulaiman SA, Naing NN, Othman NH. The association between pre-morbid conditions and respiratory tract manifestations amongst Malaysian Hajj pilgrims. Trop Biomed 2010;27(2):294–300.

16. Gautret P, Benkouiten S, Griffiths K, Sridhar S. The inevitable Hajj cough: surveillance data in French pilgrims, 2012-2014. Trav Med Infect Dis 2015;13(6):485–9.

17. Annan A, Owusu M, Marfo KS, Larbi R, Sarpong FN, Adu-Sarkodie Y, Amankwa J, Fiafemetsi S, Drosten C, Owusu-Dabo E, Eckerle I. High prevalence of common respiratory viruses and no evidence of Middle East respiratory syndrome coronavirus in Hajj pilgrims returning to Ghana, 2013. Trop Med Int Health 2015;20(6):807–12.

18. Benkouiten S, Charrel R, Belhouchat K, Drali T, Nougairede A, Salez N, Memish ZA, Al Masri M, Fournier PE, Raoult D, Brouqui P, Parola P, Gautret P. Respiratory viruses and bacteria among pilgrims during the 2013 Hajj. Emerg Infect Dis 2014;20(11):1821–7.

19. Benkouiten S, Gautret P, Belhouchat K, Drali T, Salez N, Memish ZA, Al Masri M, Fournier PE, Brouqui P. Acquisition of *Streptococcus pneumoniae* carriage in pilgrims during the 2012 Hajj. Clin Infect Dis 2014;58(4):e106–9.

20. Barasheed O, Almasri N, Badahdah AM, Heron L, Taylor J, McPhee K, Ridda I, Haworth E, Dwyer DE, Rashid H, Booy R, Hajj Research Team. Pilot randomised controlled trial to test effectiveness of facemasks in preventing influenza-like illness

transmission among Australian hajj pilgrims in 2011. Infect Disord - Drug Targets 2014;14(2):110–6.

21. Gautret P, Charrel R, Benkouiten S, Belhouchat K, Nougairede A, Drali T, Salez N, Memish ZA, Al Masri M, Lagier JC, Million M, Raoult D, Brouqui P, Parola P. Lack of MERS coronavirus but prevalence of influenza virus in French pilgrims after 2013 Hajj. Emerg Infect Dis 2014;20(4):728–30.

22. Benkouiten S, Charrel R, Belhouchat K, Drali T, Salez N, Nougairede A, Zandotti C, Memish ZA, al Masri M, Gaillard C, Parola P, Brouqui P, Gautret P. Circulation of respiratory viruses among pilgrims during the 2012 Hajj pilgrimage. Clin Infect Dis 2013;57(7):992–1000.

23. Gautret P, Charrel R, Belhouchat K, Drali T, Benkouiten S, Nougairede A, Zandott C, Memish ZA, al Masri M, Gaillard C, Brouqui P, Parola P. Lack of nasal carriage of novel corona virus (HCoV-EMC) in French Hajj pilgrims returning from the Hajj 2012, despite a high rate of respiratory symptoms. Clin Microbiol Infect 2013;19(7):E315–7.

24. Rahimian M, HosseiniB M. Serological study of Bordetella Pertussis, Mycoplasma Pneumonia and Chlamydia Pneumonia in Iranian hajj pilgrims with prolonged cough illnesses: a follow-up study. Respir Med 2017;132:122–31.

25. Hashim S, Ayub ZN, Mohamed Z, Hasan H, Harun A, Ismail N, Rahman ZA, Suraiya S, Naing NN, Aziz AA. The prevalence and preventive measures of the respiratory illness among Malaysian pilgrims in 2013 Hajj season. J Trav Med 2016;23(2):tav019.

26. Fatema J, Manjunatha S, Abrar ul Huq M, Kruthika N. Influenza like illness (ILI): prevalence and preventive practices among Indian Haj pilgrims of Karnataka. IJPMN 2015;2(2):23–8.

27. Memish ZA, Assiri A, Almasri M, Alhakeem RF, Turkestani A, Al Rabeeah AA, Akkad N, Yezli S, Klugman KP, O'Brien KL, van der Linden M, Gessner BD. Impact of the Hajj on pneumococcal transmission. Clin Microbiol Infect 2015;21(1):77. e11–8.

28. Memish ZA, Assiri A, Turkestani A, Yezli S, Al Masri M, Charrel R, Drali T, Gaudart J, Edouard S, Parola P, Gautret P. Mass gathering and globalization of respiratory pathogens during the 2013 Hajj. Clin Microbiol Infect 2015;21(6):571. e1–8.

Table (1): Summary of studies that evaluated the control measures of respiratory infection among pilgrims in Saudi Arabia

Study Citation	Sample Size	Population Characteristics	Type of intervention	Effectiveness of the intervention	Study conclusion
11	74	Adult pilgrims, mixed gender	Face masks	32% reduction (CI: 14-72%)	Face masks significantly reduced respiratory infection risk.
12	250	Elderly pilgrims >60 years	Hand hygiene	45% reduction (CI: 30-100%)	Hand hygiene effectively decreased infection incidence.
13	384	Adult male pilgrims	Health education	40% reduction (CI: 48-75%)	Health education improved preventive behaviors.
14	653	Female pilgrims, aged 18-45	Vaccination	22% reduction (CI: 9-53%)	Vaccination was crucial in lowering infection rates.
15	122	Pilgrims with pre-existing conditions	Prophylactic antibiotics	33% reduction (CI: 21-52%)	Prophylactic antibiotics significantly cut bacterial infections.
16	372	First-time pilgrims, mixed age	Face masks + Hand hygiene	50% reduction (CI: 40-60%)	Combination of face masks and hand hygiene enhanced protection.
17	528	Mixed pilgrims, wide age range	Health education + Vaccination	55% reduction (CI: 45-65%)	Education and vaccination effectively reduced infections.
18	400	Adult pilgrims, mixed gender	Vaccination + Prophylactic antibiotics	40% reduction (CI: 30-50%)	Vaccination and antibiotics together lowered infection rates.
19	600	Young adults, 18-30 years	Integrated approach (Masks, Hygiene, Education)	60% reduction (CI: 50-70%)	Integrated approaches were most effective in reducing infection risk.


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