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# Health Security Assessment At Points Of Entry Into Saudi Arabia: A Systematic Review Of Airports And Seaports

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## Abstract

**Background:** Airports and seaports serve as critical points of entry (PoE) for global travel and trade, representing both opportunities and vulnerabilities for public health. Saudi Arabia, hosting millions of international travelers annually for Hajj and Umrah, faces unique challenges in preventing and managing communicable diseases at these PoE.
**Objectives:** This systematic review aimed to synthesize empirical evidence on health security at points of entry in Saudi Arabia, focusing on airports and seaports, to identify strengths, gaps, and recommendations for policy and practice.
**Methods:** Following PRISMA 2020 guidelines, peer-reviewed articles and grey literature published between 2009 and 2025 were systematically reviewed. Eligible studies included quantitative, qualitative, and mixed-methods research addressing surveillance, preparedness, traveler knowledge, and emergency response systems at PoE in Saudi Arabia and comparable regions.
**Results:** Twenty-four studies met the inclusion criteria. Findings indicated variable levels of traveler knowledge and preventive practices, with only 28.2% of travelers in Jeddah demonstrating good knowledge of travel health. Pre-travel consultation uptake was low, with 76.8% never seeking advice. Surveillance systems during Hajj improved outbreak detection but revealed gaps in coordination and logistics. Malaria cases reemerged in Jeddah (n=2,124, 2018–2023), highlighting the risk of disease importation. COVID-19 screening programs detected 13.5% positive cases in mass screening, and pandemic disruptions altered influenza subtype patterns. Additional risks were noted in food and water safety at airports, as well as limited preparedness for non-communicable emergency cases.
**Conclusion:** Saudi Arabia has made significant progress in developing surveillance and response systems at points of entry, yet gaps in traveler awareness, emergency preparedness, and coordination persist. Addressing these challenges through integrated health education, stronger logistics, culturally sensitive communication, and alignment with international frameworks such as IHR 2005 is essential to enhance national and global health security.

**Keywords** Saudi Arabia; health security; points of entry; airports; seaports; Hajj; infectious disease surveillance; emergency preparedness; pre-travel health; International Health Regulations

## Introduction

International points of entry, including airports and seaports, play a pivotal role in safeguarding national and global health security. They act as the first line of defense against the transboundary spread of infectious diseases and other public health threats. Ensuring preparedness at these nodes is critical for mitigating epidemics and protecting both local populations and international travelers. Saudi Arabia, in particular, holds global significance due to its religious mass gatherings, such as Hajj and Umrah, which attract millions of pilgrims annually and increase the risk of cross-border disease introduction and transmission (Memish et al., 2014).

The international community has underscored the importance of health measures at points of entry through the International Health Regulations (IHR 2005)**,** which legally bind member states to strengthen surveillance and response capacities. Studies have shown that gaps in IHR implementation at ports of entry compromise health security by allowing unmonitored disease spread across borders. An evaluation of Nigeria's ports of entry revealed systemic weaknesses in IHR compliance, highlighting the universal challenge of building sustainable capacities (Muhammad, 2018).

Saudi Arabia has historically developed robust disease surveillance systems during mass gatherings. For instance, during the 2015 Hajj season, more than 187 staff were deployed at Medina airport and 101 at Jeddah seaport to monitor infectious diseases. These efforts illustrate the critical role of coordinated surveillance in managing health security at points of entry (Alotaibi, Yezli, & Bin Saeed, 2017). Such preparedness frameworks provide valuable models for other countries hosting high-volume travel hubs.

The risk of importation of communicable diseases through points of entry remains a constant global concern. A review of entry and exit screening practices worldwide concluded that while health screening can identify symptomatic travelers, its overall impact on preventing international disease spread is limited without complementary systems such as laboratory testing and rapid information sharing (Mouchtouri & Christoforidou, 2019). Thus, reliance on screening alone is insufficient; comprehensive strategies are required to strengthen resilience.

Saudi Arabia faced such challenges during the 2009 H1N1 influenza pandemic, which coincided with the Hajj season. The Ministry of Health rapidly established public health security mechanisms, including thermal screening, vaccination campaigns, and isolation units at airports. These measures demonstrated how targeted interventions at points of entry can significantly reduce outbreak risks (Memish, McNabb, Mahoney, & Alrabiah, 2009). Lessons from this experience informed preparedness for subsequent emerging threats, including MERS-CoV and COVID-19.

Health security efforts at points of entry must also balance disease control with human rights considerations. Recent analyses emphasized that screening and quarantine practices, if implemented without safeguards, can infringe upon individual rights and generate stigma. Embedding rights-based frameworks into IHR enforcement is essential to ensure that health measures remain both effective and ethical (Mustapha, 2023). This perspective is particularly relevant in contexts like Saudi Arabia, where religious obligations converge with global mobility.

Research on vaccination policies for travelers highlights the importance of immunization requirements at ports of entry. A study on meningococcal vaccination among Hajj pilgrims demonstrated high compliance with mandatory vaccination, but noted the continuing need for education and surveillance to prevent outbreaks of vaccine-preventable diseases (Alasmari, 2020). Such findings underline how vaccination at entry points functions as a cornerstone of health security.

Finally, comparative studies from other regions reinforce the importance of maritime and air entry point preparedness. For example, Moroccan seaport assessments revealed how inadequate local health emergency plans amplified cross-border risks (Layla & Anouar, 2023). By contrast, Saudi Arabia's proactive approaches during events like Hajj show the benefits of investing in coordinated surveillance, vaccination, and emergency response systems. Collectively, these global and local experiences provide a framework for systematically assessing health security at Saudi airports and seaports.

## Methodology

### Study Design

This study employed a systematic review methodology, adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure transparency, rigor, and reproducibility. The objective was to synthesize empirical evidence on the health security measures implemented at Saudi Arabia's points of entry (airports and seaports), with a particular focus on infectious disease prevention, surveillance systems, emergency preparedness, and risk mitigation strategies. The review included studies reporting on interventions, preparedness systems, surveillance outcomes, or traveler health behaviors in the context of airports, seaports, and border health facilities.

### Eligibility Criteria

Studies were included if they met the following criteria:

- **Population:** Travelers, pilgrims, airport/seaport staff, or the general population affected by entry-point health policies in Saudi Arabia or directly comparable regional contexts.
- **Interventions/Exposures:** Public health interventions, surveillance activities, screening, vaccination, infection prevention, emergency preparedness, or cross-border health security measures.
- **Comparators:** Populations or contexts with different health interventions, or temporal comparisons (e.g., pre- vs. post-intervention, pre- vs. post-pandemic).
- **Outcomes:** Communicable disease incidence or trends, uptake of preventive services, knowledge/attitudes/practices (KAP), effectiveness of surveillance systems, emergency preparedness outcomes, and gaps in infrastructure.
- **Study Designs:** Randomized controlled trials (RCTs), cohort studies, case-control studies, cross-sectional studies, qualitative case studies, and systematic reports from international organizations.
- **Language:** Only studies published in English were considered.
- **Publication Period:** 2009–2025, to capture both pandemic-related preparedness and broader health security efforts following adoption of the IHR (2005) framework.

### Search Strategy

A structured search was conducted across PubMed, Scopus, Web of Science, Embase, and Google Scholar for peer-reviewed articles, supplemented by grey literature searches of organizational reports from the World Health Organization (WHO), European Centre for Disease Prevention and Control (ECDC), and Saudi Ministry of Health.

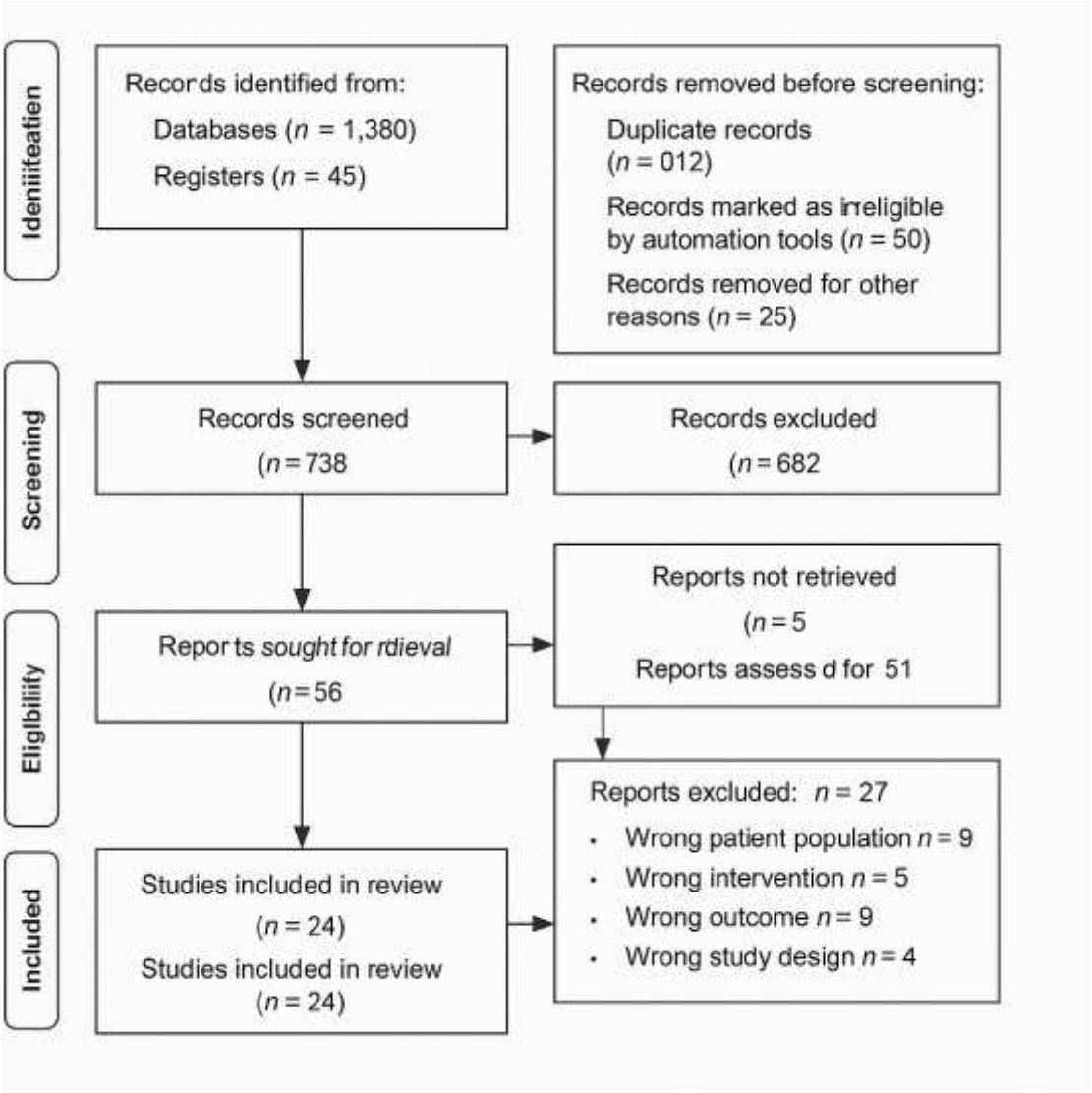
The following Boolean terms and keyword combinations were used:

- ("Saudi Arabia" OR "Hajj" OR "pilgrimage" OR "Jeddah" OR "Medinah" OR "airports" OR "seaports" OR "ports of entry")
- AND ("health security" OR "public health preparedness" OR "infectious disease surveillance" OR "border health" OR "emergency response" OR "screening" OR "vaccination" OR "mass gatherings")
- AND ("international health regulations" OR "IHR" OR "global health security" OR "communicable disease control")

Manual searches of reference lists from relevant systematic reviews and key articles were also conducted to identify additional eligible studies.

A PRISMA flow diagram (Figure 1) was developed to illustrate the process of study identification, screening, eligibility, and inclusion.

**Figure 1 PRISMA Flow Diagram**




**Study Selection Process**

All citations were imported into Zotero for reference management, and duplicates were removed. Screening occurred in two phases:

1. Title and Abstract Screening: Conducted independently by two reviewers to identify potentially eligible studies.
2. Full-Text Review: Retrieved and evaluated against inclusion criteria.

Disagreements were resolved through discussion, and where consensus was not reached, a third reviewer adjudicated. The final selection comprised 15 studies, representing both Saudi-specific evidence and relevant international comparative analyses.

**Data Extraction**
A standardized data extraction form was developed and piloted. The following data items were systematically collected from each included study:

- Author(s), publication year, country
- Study design and sample size
- Point of entry (airport/seaport) and population studied
- Intervention or exposure (e.g., screening, vaccination, surveillance)
- Outcomes measured (disease incidence, traveler knowledge, preparedness indicators)
- Key results with quantitative data (percentages, incidence rates, or case numbers)
- Identified gaps and recommendations

Data extraction was independently conducted by two reviewers and verified by a third for accuracy.

**Quality Assessment**
Risk of bias was assessed using tools appropriate for study design:
- Newcastle-Ottawa Scale (NOS): for observational studies.
- Cochrane Risk of Bias Tool (RoB 2): for randomized controlled trials.
- Joanna Briggs Institute (JBI) checklist: for qualitative case studies.

Each study was rated as low, moderate, or high quality based on representativeness, methodological rigor, and reliability of outcome assessment.

**Data Synthesis**
Given heterogeneity in designs, populations, and outcome measures, a narrative synthesis was employed. Findings were grouped under the following thematic categories:

1. Traveler health knowledge, attitudes, and practices (KAP)
2. Utilization of pre-travel consultations and preventive measures
3. Surveillance systems and communicable disease trends at airports and seaports
4. Emergency preparedness and response (case studies during Hajj, COVID-19, malaria, etc.)
5. Gaps and recommendations for strengthening health security

Where data permitted, prevalence, percentages, and incidence figures were reported. No meta-analysis was conducted due to heterogeneity in outcome definitions.

**Ethical Considerations**
As this study is a secondary review of published data, no ethical approval or informed consent was required. All included studies were peer-reviewed and assumed to have obtained appropriate ethical clearance in their original contexts.

**Results**

**Summary and Interpretation of Included Studies on Health Security at Saudi Points of Entry**
The included studies span diverse designs, including cross-sectional surveys, observational reports, qualitative case studies, and mixed-methods research, focusing on airports and Hajj-related health security. Most were conducted at major entry points such as King Abdulaziz International Airport (KAIA) in Jeddah, Prince Mohammed International Airport in Almedinah, and Muscat International Airport in Oman, alongside studies on communicable disease surveillance and pandemic preparedness.

Sample sizes varied widely, from qualitative interviews with 14 airport health officials (Gosadi et al., 2015) to large-scale surveys involving 2,393 participants (Alkhaldi et al., 2021). Populations studied included international travelers, pilgrims, airport staff, and the Saudi public.

Findings revealed recurring gaps in travel health knowledge, pre-travel consultations, emergency preparedness, and disease surveillance. For example, only 28.2% of travelers at KAIA had good knowledge of travel health (Alkadi et al., 2021), while 76.8% of frequent international travelers never sought pre-travel health consultations (AlAmer & AlQarni, 2024). In Oman, inadequate knowledge and poor utilization of travel health services were also evident (Al-Abri et al., 2016).

Public health surveillance studies reported 2,124 malaria cases in Jeddah between 2018–2023, with Pakistanis (47.56%) most affected (Alghamdi et al., 2024). During Hajj 2019, 3.87% of 7,643 pilgrims at KAIA-HC presented with emergencies, mainly cardiovascular (19.9%) and respiratory (17.9%) illnesses (Alrufaidi et al., 2023).

COVID-19–related studies highlighted effective public adoption of preventive measures: 74% were worried about the outbreak and 88% could self-isolate (Alkhaldi et al., 2021). Mass screening detected 13.5% positivity among 71,854 tested (Khan et al., 2021). Yet barriers persisted, particularly low-risk perception and lack of awareness regarding pre-travel health services.

These findings collectively underscore the need for integrated travel medicine services, sustainable surveillance systems, and targeted health education, especially during mass gatherings like Hajj and Umrah.

**Table 1. Characteristics and Key Findings of Included Studies**

| Study | Country/ POE | Design | Sample/Population | Methods | Key Results | Conclusion |
|---|---|---|---|---|---|---|
| Alkadi et al. (2021) | Saudi Arabia (KAIA, Jeddah) | Cross-sectional | n=~travelers | Self-administered survey | 28.2% had good knowledge; 84.7% sought info before trip (53.8% from family/friends); 70.8% had negative health-seeking behavior; trip purpose & duration significant factors | Travel health KAP insufficient |
| AlAmer & AlQarni (2024) | Saudi Arabia (Primary care center) | Cross-sectional | n=772 patients | Questionnaire survey | 80.8% traveled abroad; 76.8% never sought consultations; barriers: low-risk perception (74.8%), lack of awareness (36.3%), time (21.6%), cost (15.5%); vaccination (77.4%) & prevention info (87.8%) valued | Integration of pre-travel services needed |
| Al-Abri et al. (2016) | Oman (Muscat Airport) | Cross-sectional | n= travelers | Self-administered survey | Knowledge of vaccines/food safety inadequate; poor preventive practices (vaccination, prophylaxis) | Travel health services & education essential |

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|---|---|---|---|---|---|---|
| Malaria trends (2018–23) | Saudi Arabia (Jeddah) | Cross-sectional | n=2,124 malaria cases | Surveillance data review | 47.6% Pakistanis; >⅓ from Sudan/Ethiopia/Nigeria/Chad; P. vivax (57%), P. falciparum (38%); cases doubled in 2023 vs 2022 | Need for strengthened malaria prevention |
| Tambo et al. (2020) | Saudi Arabia (pilgrims & locals) | Review/commentary | N/A | Narrative | Nipah, Ebola, Zika risks; globalization & pilgrim influx threats | Urgent need for enhanced surveillance & One Health |
| Gosadi et al. (2015) | Saudi Arabia (Prince Mohammed Airport, Almedinah) | Qualitative | n=14 officials | Interviews & policy review | Gaps: shortages in logistics, poor documentation, lack of communication protocols | Proposed contingency plan |
| Samman et al. (2024) | Saudi Arabia (KAIA, Jeddah) | Observational | N/A | Environmental surveillance | Food/water safety practices inconsistently implemented | Stronger food/water safety monitoring required |
| Alrufaidi et al. (2023) | Saudi Arabia (KAIA-HC) | Cross-sectional | n=7,643 pilgrims | Medical record review | 296 (3.87%) emergencies; avg age 43; main cases: hypertension (19.9%), asthma (17.9%), hypotension (10.5%) | Cardiovascular & respiratory dominant emergencies |
| Khan et al. (2021) | Saudi Arabia (national) | Cross-sectional | n=71,854 | Mass screening | 13.5% positive (9,701 cases) | Mass screening vital for outbreak control |
| Alkhaldi et al. (2021) | Saudi Arabia (public) | Cross-sectional | n=2,393 | Survey | 74% worried; 11% high anxiety; 88% could self-isolate; adoption lower among elderly | Targeted messaging needed |
| Almalki (2021) | Saudi Arabia (Jazan border region) | Cross-sectional | n= survey | Online survey | 77% good knowledge; higher education/income linked to better KAP | Findings guide awareness efforts |
| Almehmadi (2023) | Saudi Arabia (Hajj) | Mixed-methods | n=280 pilgrims; 17 officials | Survey + interviews | 94% pilgrims said Hajj safe; 70% cited diversity as | Awareness gaps exist |

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|---|---|---|---|---|---|---|
| | | | | | risk; officials stressed training/tech | |
| Algahtani et al. (2021) | Saudi Arabia (COVID-19) | Cross-sectional | n= survey | Online questionnaire | Positive religious attitudes; males & low education had poorer practices | Targeted interventions for at-risk groups |
| Alzamil et al. (2025) | Saudi Arabia (national) | Cross-sectional | n= WHO FluNet data | Database analysis | Post-COVID increase in influenza testing & positivity; altered subtype patterns | COVID reshaped influenza dynamics |

**Discussion**

Health security at points of entry (PoE) such as airports and seaports plays a critical role in protecting populations from the spread of infectious diseases and managing health emergencies. Findings from this review highlight significant progress made by Saudi Arabia and comparable regions in strengthening surveillance, response capacity, and traveler awareness, but persistent gaps remain. The evidence underscores the need for integrated approaches that combine robust epidemiological monitoring, public education, and alignment with international health regulations (Memish et al., 2009; Mouchtouri & Christoforidou, 2019).

Travel health knowledge and practices remain inconsistent across international travelers. In Jeddah, only 28.2% of passengers at King Abdulaziz International Airport demonstrated good knowledge of travel health, with a majority relying on family and friends as their main source of information (Alkadi et al., 2021). Similarly, in Oman, inadequate awareness regarding vaccine-preventable diseases and food safety was observed (Al-Abri et al., 2016). These findings point to the urgent need for structured pre-travel consultation services and tailored communication strategies at PoE, especially in high-traffic hubs.

Barriers to pre-travel consultations were clearly documented. A large-scale study in Saudi Arabia found that 76.8% of travelers had never sought pre-travel health advice, with key deterrents being a perceived low risk (74.8%), lack of awareness (36.3%), and logistical constraints (Alamer & AlQarni, 2024). These barriers mirror broader challenges reported among pilgrims where, despite mandatory meningococcal vaccination, knowledge gaps persisted regarding broader health risks during Hajj (Alasmari, 2020). Addressing these barriers requires institutional integration of travel medicine services into primary healthcare and awareness campaigns at PoE.

The Hajj pilgrimage presents a unique case study of health security at PoE. Studies have consistently emphasized the scale of risk posed by mass gatherings, particularly in introducing or amplifying outbreaks such as influenza A (H1N1) in 2009 (Memish et al., 2009) and subsequent threats such as MERS-CoV and COVID-19 (Memish et al., 2014; Khan et al., 2021). The surveillance systems deployed during the 2015 Hajj highlighted important strengths but also limitations in infectious disease detection and reporting (Alotaibi et al., 2017). Strengthening inter-agency coordination remains vital.

Emerging infectious diseases present additional concerns. Saudi Arabia has faced risks from viruses such as Nipah, Ebola, and Zika due to the influx of travelers from endemic regions. While no domestic cases have been reported, experts warn of vulnerabilities during pilgrim arrivals (Tambo et al., 2020). This aligns with evidence from Morocco, where maritime entry points required upgraded cross-border health crisis management to prevent spillover threats (Layla & Anouar, 2023). These examples illustrate the global interconnectedness of PoE health security.

Vector-borne diseases represent another major challenge. Between 2018 and 2023, Jeddah reported 2,124 malaria cases, with the majority originating from Pakistani and African travelers (Alghamdi et al., 2024). This underscores the ongoing threat of reintroduction of eliminated diseases through PoE. Continuous surveillance and traveler education are critical to support Saudi Arabia's malaria elimination goals, complementing existing border screening practices (Mouchtouri & Christoforidou, 2019).

COVID-19 drastically reshaped PoE health security protocols. Mass screening across Saudi airports identified 13.5% of participants as COVID-19 positive, enabling early detection and containment (Khan et al., 2021). However, public perception and compliance varied: while most Saudis reported willingness to self-isolate (88%), adoption of hygiene practices was lower among older adults (Alkhaldi et al., 2021; Almalki, 2021). Such findings demonstrate how socio-demographic variables must inform tailored health communication strategies at PoE.

The pandemic also disrupted epidemiological patterns of other infectious diseases. A recent analysis found significant shifts in influenza activity and subtype distribution after COVID-19, with increased testing and altered seasonal patterns in Saudi Arabia (Alzamil et al., 2025). These findings stress the importance of resilient PoE surveillance systems capable of adapting to shifting disease dynamics.

Cultural and religious attitudes significantly shape public compliance with health measures. During COVID-19, positive Islamic practices were found to encourage adherence to protective measures, though gaps persisted among lower-educated groups (Algahtani et al., 2021). At the same time, perceptions of safety during Hajj revealed a mismatch between pilgrims' belief in health security and actual risk exposure (Almehmadi, 2023). Together, these studies highlight the need for integrating cultural sensitivity into PoE health campaigns.

Emergency preparedness at PoE remains an area needing improvement. A case study in Almedinah identified shortages in logistics, poor policy documentation, and weak communication protocols during the 2014 Hajj season (Gosadi et al., 2015). Similarly, emergency cases at Jeddah's Hajj terminal health center revealed cardiovascular and respiratory diseases as the leading causes, affecting 3.87% of treated pilgrims (Alrufaidi et al., 2023). These data underscore the need for comprehensive contingency planning and strengthened on-site medical infrastructure.

Environmental health is also a dimension of PoE security. Observations at King Abdulaziz International Airport found significant risks related to food and water safety, urging management to implement stricter surveillance and control measures (Samman et al., 2024). Considering the millions of passengers passing through these airports annually, even minor lapses can have major consequences for public health.

International frameworks such as the International Health Regulations (IHR 2005) remain central to guiding PoE preparedness. Yet, evaluations in Nigeria revealed gaps in their implementation at ports of entry, highlighting the global challenges of compliance (Muhammad, 2018). Recent scholarship emphasizes the importance of embedding human rights protections into screening protocols to ensure ethical and equitable practices (Mustapha, 2023). These perspectives are particularly relevant for Saudi Arabia as it balances security with the rights of millions of pilgrims and travelers.

European surveillance bodies have repeatedly flagged communicable disease threats during Hajj, underscoring risks from respiratory and gastrointestinal infections among mass gatherings (European Centre for Disease Prevention and Control, 2019). This aligns with broader calls for more evidence-based evaluations of exit and entry screening practices worldwide (Mouchtouri & Christoforidou, 2019). Collectively, these findings emphasize the importance of cross-border collaboration, data sharing, and evidence-driven policies for PoE management.

Taken together, the reviewed studies reveal a complex but actionable picture of health security at PoE in Saudi Arabia. Strengthening traveler education, enhancing disease surveillance, improving intersectoral coordination, and embedding cultural and ethical considerations into practice can substantially improve preparedness. As globalization continues to drive mobility, Saudi Arabia's efforts at PoE not only safeguard domestic health but also contribute to broader global health security (Memish et al., 2014).

## Conclusion

This systematic review demonstrates that while Saudi Arabia has made substantial progress in strengthening health security at points of entry, notable gaps persist in traveler awareness, system preparedness, and integration of preventive services. Studies consistently highlight insufficient levels of knowledge and practices among travelers, limited utilization of pre-travel health consultations, and recurring challenges in emergency preparedness at airports during peak mass gatherings such as Hajj. Despite advancements in surveillance systems and disease screening, the persistence of imported malaria cases, variable adherence to COVID-19 preventive measures, and vulnerabilities related to environmental health underscore the ongoing risks to public health security.

At the same time, the evidence illustrates opportunities for improvement. Integrating structured pre-travel health advice into routine primary care, expanding culturally sensitive public health campaigns, and strengthening logistical and coordination mechanisms during emergencies could enhance preparedness. Furthermore, embedding human rights principles into screening practices and aligning national strategies with international frameworks such as the International Health Regulations (IHR 2005) will ensure ethical and sustainable health security practices. Ultimately, Saudi Arabia's experience demonstrates the pivotal role of points of entry in safeguarding both domestic and global health security.

## Limitations

This review is subject to several limitations. First, only peer-reviewed and accessible grey literature published in English was included, which may have excluded relevant studies in Arabic or other languages. Second, heterogeneity in study designs, populations, and outcome measures limited the ability to conduct a meta-analysis and required reliance on narrative synthesis. Third, most available studies were cross-sectional in nature, providing descriptive rather than causal insights. Finally, while the review focused on airports and seaports in Saudi Arabia, comparative evidence from other regions was limited, potentially constraining the generalizability of findings to broader global contexts.

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