

Operationalizing the One Health Approach via Health Information Systems: A Systematic Review of Enablers, Barriers, and Technological Innovations

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Abstract:

The escalating complexity of global health challenges, including emerging infectious diseases and antimicrobial resistance, necessitates integrated frameworks connecting human, animal, and environmental health. This systematic literature review evaluated the current implementation of One Health principles within Health Information Systems (HIS) and identified associated integration opportunities and challenges. Following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, we systematically searched Google Scholar, PubMed, ProQuest, ScienceDirect, and IEEE Xplore for literature published between 2015 and 2025. From an initial pool of 18,092 records, seven studies met the strict inclusion criteria for final qualitative synthesis, highlighting a significant gap in empirical cross-sectoral HIS research. Findings demonstrate that One Health-oriented HIS significantly enhances disease surveillance, facilitates intersectoral collaboration, and supports evidence-based decision-making. Technological innovations, notably mobile health (mHealth) and geographic information systems (GIS), drive these improvements by enabling real-time data collection and advanced spatial analysis across diverse ecological settings. Critical implementation barriers persist. Interoperability limitations, inadequate digital infrastructure, severe resource constraints, fragmented governance, and persistent cross-sector data-sharing challenges severely impede seamless system integration. Maximizing the effectiveness of One Health-based HIS requires strengthening policy frameworks, promoting universal interoperability standards, and investing heavily in foundational digital infrastructure. This review provides critical evidence to guide the development of robust, integrated health information systems that can improve global preparedness, surveillance, and response to complex, multisectoral health threats.

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INTRODUCTION

The increasing frequency of emerging and re-emerging infectious diseases, antimicrobial resistance (AMR), environmental degradation, climate change, and zoonotic outbreaks has

highlighted the interconnected nature of human, animal, and environmental health. Recent global health crises, including the COVID-19 pandemic, have demonstrated that health threats rarely occur within a single sector and instead emerge from complex interactions among humans, animals, and ecosystems (Aslam & Aljasir, 2025). Consequently, traditional siloed approaches to health management are increasingly considered inadequate for addressing contemporary public health challenges. A more integrated and collaborative framework is therefore required to improve surveillance, preparedness, prevention, and response capacities across sectors.

The interconnectedness of human, animal, and environmental health necessitates an integrated and holistic approach to address complex health challenges (Roy et al., 2025). The One Health concept, which emphasizes the interdependence of these domains, has gained prominence as a framework for understanding and managing health issues that transcend traditional disciplinary boundaries. In this context, Health Information Systems (HIS) play a critical role in collecting, analyzing, and disseminating data across the One Health spectrum (Asaduzzaman et al., 2024).

The One Health approach has emerged as a globally recognized framework for addressing these interconnected challenges. One health is defined as a collaborative, multisectoral, and transdisciplinary approach that operates at local, national, regional, and global levels to achieve optimal health outcomes by recognizing the interdependence between people, animals, plants, and their shared environment (Yasobant et al., 2021). Recent studies have emphasized that effective operationalization of One Health requires strong collaboration among public health authorities, veterinary services, environmental agencies, academic institutions, and policymakers to facilitate coordinated actions against zoonotic diseases, antimicrobial resistance, food safety threats, and environmental health risks.

A comprehensive HIS capable of integrating data from various health sectors is essential for effective surveillance, prevention, and response strategies (Sharan et al., 2023). Such systems enable stakeholders to detect emerging health threats, track disease outbreaks, and implement coordinated interventions to safeguard public, animal, and ecosystem health. Despite growing recognition of the One Health approach, integrating its principles into HIS remains a challenging and evolving endeavor (Prata et al., 2021).

The role of integrated HIS has become increasingly important as countries seek to strengthen surveillance systems capable of detecting emerging health threats at the human-animal-environment interface (Delpy et al., 2024). Integrated information systems facilitate early warning mechanisms, support outbreak investigations, improve resource allocation, and enhance communication among stakeholders. Evidence from multiple countries indicates that integrated surveillance systems significantly improve the timeliness and accuracy of disease detection while supporting coordinated responses to complex public health emergencies. Recent studies on antimicrobial resistance surveillance further demonstrate that integrated digital platforms can strengthen data sharing across sectors and improve situational awareness among decision-makers (Manageiro et al., 2023).

This manuscript presents a systematic literature review to evaluate the current state of Health Information Systems within the One Health framework. By synthesizing existing research, we seek to identify the strengths, gaps, and opportunities in the implementation of HIS that support One Health initiatives. Our review provides a comprehensive overview of the methodologies, technologies, and collaborative efforts documented in the literature, offering insights for future research and policy development.

The findings of this review are expected to inform practitioners, researchers, and policymakers about best practices and potential areas for improvement in designing HIS capable of addressing the multifaceted nature of health threats. Ultimately, this study aims to advance integrated health

information systems aligned with the One Health vision, fostering a more resilient and responsive global health infrastructure.

METHOD

This systematic literature review utilizes data from original research articles found in various online journal databases. The databases searched include Google Scholar, PubMed, ProQuest, ScienceDirect, and IEEE Xplore. The search employed English keywords such as "One Health," "Health Information System," "Integration," and "Interdisciplinary." The review focused on literature published between 2015 and 2025. Articles meeting the inclusion and exclusion criteria were selected for further analysis.

The search identified research literature from multiple databases: Google Scholar (n=3,080), PubMed (n=129), ProQuest (n=4,761), ScienceDirect (n=14,676), and IEEE Xplore (n=2). Initial screening by title resulted in 18,092 articles. Titles that were not relevant, not open access, or not accessible in full text were excluded (n=15,432). A second screening process was conducted on the remaining articles (n=100), excluding those with incompatible subjects, research variables, or content (n=7). The final screening identified articles aligning with the research objectives.

This review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, consisting of three stages: identification, screening, and inclusion. The application of the PRISMA framework ensures a rigorous, transparent review process, thereby enhancing the reliability and validity of the findings.

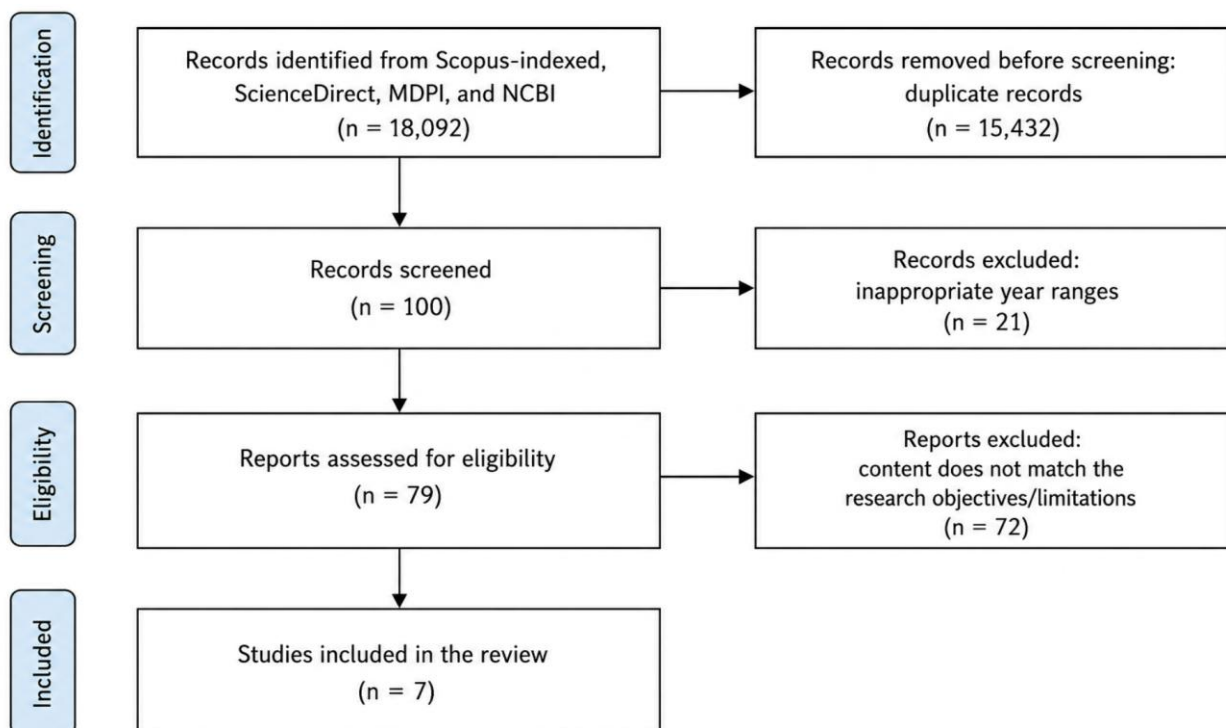


Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Diagram

This study explores the integration of the One Health approach within Health Information Systems (HIS). The perceptions and experiences of healthcare professionals across various sectors, human, animal, and environmental health, are examined to understand the current landscape and

identify best practices. The literature review is divided into two parts: the first addresses stakeholders' perceptions of using HIS within the One Health framework, and the second discusses strategies to optimize the implementation and functionality of these systems. Most research employs qualitative methods to capture participants' insights and perspectives on integrating One Health principles into HIS.

RESULT

The results of this review are summarized in Table 1. Seven studies published between 2020 and 2024 were analyzed. The studies examined various aspects of health information systems and One Health implementation, including digital surveillance, data governance, information system adoption, and cross-sectoral collaboration. The evidence was synthesized based on study objectives, methods, findings, conclusions, and recommendations.

Table 1. Summary of Previous Studies Related to One Health and Health Information Systems

Author (Year)	Aim	Method	Key Findings	Conclusion	Recommendations
Herawati et al. (2022)	To examine the application of the One Health approach during the COVID-19 pandemic.	Systematic literature review of English-language studies on One Health and COVID-19.	One Health supported surveillance, prevention, control measures, and policy development through interdisciplinary collaboration.	Integration of human, animal, and environmental health sectors is essential for pandemic preparedness and response.	Strengthen cross-sector collaboration, surveillance systems, interdisciplinary research, and One Health-based policies.
Oberin et al. (2022)	To review the costs and cost-effectiveness of MDR-TB treatment interventions.	Systematic review of economic evaluations and treatment cost studies.	MDR-TB treatment costs vary substantially across interventions and settings.	Economic considerations are critical for MDR-TB control and resource allocation.	Prioritize cost-effective interventions and improve affordability and accessibility of treatment.
Asaduzzaman et al. (2024)	To explore nursing unit managers' perceptions of Nursing Information Management System (NIMS) implementation.	Qualitative case study using semi-structured interviews and thematic analysis.	Implementation was hindered by resistance to change, inadequate training, and technical barriers, despite recognized benefits.	Addressing managerial concerns is crucial for successful NIMS implementation.	Enhance communication, provide adequate training, and involve stakeholders throughout implementation.
Farokhzadian et al. (2020)	To investigate nurses' perceptions of Management Information Systems (MIS).	Systematic literature review.	Nurses generally viewed MIS positively, but usability and technology readiness influenced acceptance.	MIS adoption depends on organizational support and technological preparedness.	Strengthen training programs and technical support for nurses.
Mremi et al. (2023)	To assess human and animal health surveillance systems in Tanzania and identify integration opportunities.	Mixed-methods study involving literature review, stakeholder interviews, and comparative analysis.	Human and animal surveillance systems showed similarities and gaps that support integration opportunities.	An integrated One Health surveillance platform is needed.	Improve collaboration, data sharing, infrastructure, and workforce capacity.

Author (Year)	Aim	Method	Key Findings	Conclusion	Recommendations
Asaduzzaman et al. (2022)	To understand AMR transmission pathways and explore integrated digital surveillance in Ethiopia.	Mixed-methods study combining surveys, interviews, and digital surveillance approaches.	AMR was prevalent across human, animal, and environmental sectors; digital surveillance showed strong potential.	One Health-based digital surveillance can strengthen AMR monitoring and control.	Develop integrated surveillance systems, enhance intersectoral collaboration, and promote antimicrobial stewardship.
Aisyah et al. (2022)	To assess data governance in Indonesia's National Health Information System during COVID-19.	Case study and policy analysis.	Challenges were identified in data governance, data sharing, infrastructure, and stakeholder coordination.	Effective data governance is fundamental for public health emergency management.	Improve data-sharing protocols, collaboration, data quality assurance, and technological infrastructure.

Several studies have highlighted the growing importance of integrating health information systems, surveillance platforms, and One Health principles to address complex public health challenges. The increasing interconnectedness of human, animal, and environmental health has accelerated demand for comprehensive information systems that support surveillance, decision-making, and coordinated responses across sectors.

Research on the One Health approach has consistently demonstrated its value in strengthening public health preparedness and response. Herawati et al. (2022) emphasized that interdisciplinary collaboration among human, animal, and environmental health sectors played a significant role in surveillance, prevention, and policy development during the COVID-19 pandemic. Similarly, Mremi et al. (2023) identified substantial opportunities for integrating human and animal health surveillance systems through a unified One Health platform, while Asaduzzaman et al. (2022) highlighted the potential of integrated digital surveillance systems to monitor antimicrobial resistance across multiple sectors. These studies collectively suggest that digital integration is a critical component of effective One Health implementation.

The literature also highlights the importance of health information systems in supporting healthcare management and service delivery. Studies by Farokhzadian et al. (2020) and Asaduzzaman et al. (2024) found that healthcare professionals generally recognize the benefits of management information systems and nursing information management systems in improving clinical and administrative processes. However, challenges such as resistance to change, inadequate training, technical limitations, and organizational readiness frequently hinder successful implementation. These findings indicate that technological innovation alone is insufficient without adequate human resource capacity and stakeholder engagement.

In addition, effective data governance has emerged as a key determinant of health information system performance. Aisyah et al. (2022) reported that Indonesia's National Health Information System faced significant challenges related to data quality, interoperability, infrastructure, and stakeholder coordination during the COVID-19 pandemic. Their findings underscore the need to establish robust governance mechanisms to ensure reliable data exchange and evidence-based decision-making. Likewise, studies on integrated surveillance systems emphasize the importance of standardized data-sharing protocols and cross-sector collaboration to maximize the utility of health information resources.

Beyond surveillance and information management, economic considerations remain important for the sustainability of the healthcare system. Oberin et al. (2022) demonstrated that substantial variations in the costs and cost-effectiveness of multidrug-resistant tuberculosis interventions

influence resource allocation decisions, highlighting the need for information systems that can support efficient planning and evaluation of health programs.

The reviewed studies reveal four major themes. First, there is broad consensus regarding the importance of the One Health approach in addressing contemporary public health threats through collaboration among human, animal, and environmental health sectors. Second, digital health information systems and integrated surveillance platforms are increasingly recognized as essential tools for monitoring diseases, supporting decision-making, and improving healthcare delivery. Third, implementation success depends not only on technological infrastructure but also on organizational readiness, stakeholder engagement, user acceptance, and workforce capacity. Fourth, robust data governance mechanisms, including interoperability standards, data-sharing protocols, and quality assurance systems, are necessary to ensure the effectiveness of integrated health information systems.

Despite these advances, the literature remains fragmented. Existing studies tend to focus on specific components, such as surveillance integration, information system adoption, nursing information management systems, antimicrobial resistance monitoring, or data governance. Few studies have proposed a comprehensive conceptual framework that simultaneously integrates One Health principles, digital health information systems, surveillance functions, interoperability, governance structures, and stakeholder collaboration within health service settings. Consequently, a significant research gap remains in developing and validating an integrated One Health-based Health Information System framework capable of supporting both healthcare service delivery and public health preparedness. Addressing this gap may contribute to more resilient, coordinated, and data-driven health systems in the future.

DISCUSSION

Integrated Health Information Systems (HIS) grounded in the One Health framework enhance disease surveillance and response efficacy. These systems aggregate and analyze multisectoral data spanning human, animal, and environmental domains. This cross-sectoral synthesis provides a comprehensive understanding of health threats, enabling more accurate and timely outbreak detection (Saleh et al., 2021). Traditional surveillance architectures that focus exclusively on human health frequently miss critical early warning signs within animal populations or in shifting environmental conditions. Integrated HIS facilitates early detection and rapid response to disease outbreaks by monitoring illness patterns in animal populations, enabling health authorities to identify potential zoonotic threats before human spillover (Isiaka et al., 2024). Environmental metrics, such as shifting weather patterns or pollution levels, also offer predictive insights into conditions that precipitate outbreaks. Real-time data sharing across sectors enables coordinated interventions, minimizing disease transmission. Comprehensive data access further supports optimal resource allocation and decision-making during public health emergencies, ensuring that medical supplies and personnel are deployed where they are most needed (Redman-White et al., 2023). Integrated platforms also improve the accuracy of epidemiological modeling, generating reliable forecasts that aid policymakers. Continuous data collection across all three domains identifies long-term trends and emerging threats, informing robust future public health strategies (Ibrahim et al., 2020).

The successful operationalization of One Health within HIS relies fundamentally on robust intersectoral collaboration. This necessitates coordinated efforts among public health authorities, veterinary services, environmental agencies, and allied stakeholders. Each sector contributes unique expertise and critical data to address health issues that transcend traditional boundaries (Arredondo et al., 2021). Veterinary services provide essential insights into animal health trends and

zoonotic reservoirs, while environmental agencies supply data on ecological shifts. Public health authorities synthesize these diverse streams to formulate comprehensive threat assessments. Effective partnerships enable the sharing of resources, information, and strategies, yielding more timely responses to health threats. Fostering this collaboration requires overcoming inherent barriers stemming from differing organizational cultures, data management practices, and institutional priorities (Abbas et al., 2022). Establishing formal frameworks and dedicated communication channels facilitates regular interaction. Joint training programs enhance mutual understanding and trust among diverse professionals. Long-term partnerships ultimately drive the development of integrated HIS platforms capable of continuously monitoring cross-sectoral data, generating novel insights into complex human-animal-environment interactions.

Integrating diverse data types into a cohesive HIS presents substantial methodological challenges. Clinical, epidemiological, and environmental data originate from disparate sectors and employ distinct collection methodologies. This results in significant discrepancies in data structure, format, and quality. Clinical records typically utilize specific medical coding systems, whereas epidemiological data follow public health surveillance formats. Environmental datasets often include geospatial information or biodiversity metrics, each with its own standards. The primary obstacle is the absence of standardized data formats. Without uniformity, disparate datasets cannot be seamlessly merged or analyzed together, leading to processing delays and errors. Rapidly combining data from hospitals, veterinary clinics, and environmental stations during a zoonotic outbreak becomes highly inefficient without standardization. Ensuring system interoperability is equally critical. Interoperability demands both technical solutions, such as common data exchange protocols, and organizational alignment (Jnr et al., 2024). Stakeholders must collectively agree upon and adhere to these standards. Technological advancements, including Application Programming Interfaces (APIs) and health data exchange platforms, actively promote interoperability by enabling real-time communication between systems. Successful deployment of these technologies requires overcoming legacy system limitations, securing adequate funding, and building user technical capacity. Effective data integration ultimately enhances data comprehensiveness, facilitating informed decision-making and targeted interventions.

Technological advancements significantly amplify the capabilities of One Health-integrated HIS. Mobile health (mHealth) and geographic information systems (GIS) represent particularly transformative innovations. mHealth leverages wireless technology to improve health service delivery and information dissemination. In the One Health context, mHealth applications enable real-time data collection from diverse, remote, and underserved locations. Field workers utilize mobile applications to report zoonotic disease outbreaks, track environmental health indicators, and monitor animal health, contributing to a highly integrated surveillance architecture. GIS offers powerful tools for spatial analysis and visualization (Shin & Kang, 2020). This technology maps and analyzes data across varying geographic scales, identifying spatial patterns and relationships between health determinants. Integrating GIS with HIS allows health authorities to visualize disease spread, identify geographic hotspots, and predict future outbreaks based on environmental risk factors. Mapping vector species habitats and overlaying this with human population data predicts areas at high risk for vector-borne diseases. The synthesis of mHealth and GIS creates a dynamic, interactive health information system. Real-time mHealth data collection, paired with GIS spatial analysis, supports proactive decision-making and rapid responses to cross-sectoral health threats.

Integrating HIS across sectors encounters profound technical and logistical barriers. Software and hardware incompatibilities frequently impede seamless data integration. Health data related to humans, animals, and the environment are managed using distinct systems tailored to specific sectoral needs (Singh et al., 2024). Veterinary health records often use database structures

incompatible with those in human healthcare facilities. Logistical issues related to data sharing further compound these technical challenges. Data exchange is frequently hampered by the lack of robust governance frameworks that facilitate intersectoral cooperation (Balasubramanian et al., 2021). Organizations remain reluctant to share sensitive information due to privacy, security, and misuse concerns. Variations hinder practical data transfer due to differences in update frequencies, data entry practices, and data quality. Physical infrastructure deficits present another major logistical barrier. Many regions, particularly low- and middle-income countries (LMICs), lack reliable internet connectivity, sufficient data storage, and advanced computing resources (Haleem et al., 2021). Optimizing healthcare delivery via the Internet of Things requires foundational technological infrastructure that is frequently absent (Kumbarani et al., 2025). Human resource shortages further constrain LMICs. Skilled personnel with expertise in health informatics and interdisciplinary collaboration are essential for successful One Health HIS implementation (Hartmann & Briskorn, 2022). Brain drains and limited educational opportunities exacerbate these workforce deficits.

Policy and governance deficiencies represent formidable barriers to One Health HIS integration. The absence of coherent policies and governance structures specifically addressing One Health complexities leaves stakeholders without a clear framework for collaboration. Ambiguity regarding roles, responsibilities, and data ownership frequently arises. Different government agencies often possess overlapping mandates in health, agriculture, and environmental management. Unclear delineation of responsibilities risks duplication of efforts, inefficient resource allocation, and persistent data silos. Robust governance structures are necessary to enforce compliance with data sharing standards. Inadequate oversight mechanisms result in inconsistent data quality, privacy breaches, and security vulnerabilities. Stakeholders may withhold participation if they lack trust in data integrity and confidentiality. Harmonizing regulations across jurisdictions is equally critical. Health challenges such as zoonotic outbreaks and environmental pollution frequently transcend national borders. Differing legal frameworks and regulatory requirements across countries inherently hinder cross-border collaboration and data exchange (Andanda & Mlostshawa, 2024). Harmonizing policies at regional or international levels facilitates seamless information sharing. Addressing these governance issues requires multi-stakeholder engagement and sustained political commitment. Developing comprehensive legal frameworks and institutional arrangements supports the interoperability and effectiveness of HIS at the human-animal-environment interface.

CONCLUSION

This systematic literature review underscores the indispensable role of integrated Health Information Systems (HIS) in mitigating complex health challenges at the human-animal-environment interface. Synthesizing existing evidence reveals that embedding One Health principles within HIS significantly enhances disease surveillance, accelerates outbreak detection, and optimizes strategic resource allocation. Realizing these operational benefits necessitates robust intersectoral collaboration among public health, veterinary, and environmental sectors, underpinned by rigorous data standardization and interoperability protocols. Technological innovations, particularly mobile health applications and geographic information systems, provide vital mechanisms for real-time data collection, spatial analysis, and cross-sectoral visualization. Persistent technical, logistical, financial, and governance barriers continue to impede seamless implementation, demanding targeted investments in digital infrastructure and workforce capacity. Establishing comprehensive policy frameworks and fostering sustained political commitment are imperative to dismantle existing data silos and enable secure, equitable information exchange. Advancing this holistic paradigm requires continuous empirical research and strategic global

partnerships to fully harness the potential of One Health HIS, ultimately fortifying global health security and improving population outcomes.

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CONFLICT OF INTEREST

The authors declared that there is no conflict of interest.

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