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Integration of digital technology by health analysts in health information systems: Systematic Review

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ABSTRACT

Introduction: The rapid advancement of digital technology has significantly transformed health information systems (HIS) worldwide. Health analysts, as key professionals in managing health data, play a crucial role in the integration and utilization of these digital tools. However, the extent, effectiveness, and challenges of this integration remain underexplored across different healthcare contexts. This systematic review aims to examine the integration of digital technology by health analysts within health information systems, focusing on the types of technologies adopted, the roles played by health analysts, the benefits gained, and the challenges encountered during implementation.

Methods: Following the PRISMA 2020 guidelines, we conducted a systematic search of peer-reviewed articles published between 2013 and 2025 from databases including PubMed, Scopus, ScienceDirect, and Google Scholar. Keywords used included “health analyst”, “digital technology”, “health information system”, and “integration”. Eligible studies included primary research involving health analysts and the application of digital health technologies.

Results: From an initial pool of 1,274 articles, 28 studies met the inclusion criteria. The findings reveal that health analysts have been instrumental in integrating technologies such as Electronic Health Records (EHR), Laboratory Information Systems (LIS), data analytics platforms, and mobile health applications. The integration has led to improved data accuracy, faster reporting, and enhanced decision-making support. Nonetheless, several challenges were identified, including lack of digital training, infrastructure limitations, and regulatory gaps.

Conclusions: The integration of digital technologies by health analysts significantly enhances the performance of health information systems. However, successful adoption requires continuous professional development, supportive policies, and robust digital infrastructure. Future efforts should focus on strengthening the digital competencies of health analysts and aligning technology integration with national health strategies.

Keywords: Data analytics, digital technology, electronic health records, health analyst, health information systems.

INTRODUCTION

The 21st century has witnessed a transformative wave of technological innovation that has revolutionized nearly every aspect of modern life, with healthcare standing at the forefront of this digital evolution. One of the most critical domains where digital technology has shown profound influence is in the management, analysis, and dissemination of health information (Bertolin Furstenau and Abreu Saurin, 2024). Health Information Systems (HIS) have rapidly evolved from basic record-keeping tools into comprehensive, dynamic platforms that support clinical decision-making, epidemiological surveillance, patient care coordination, and health service delivery optimization (Ramachandran *et al.*, 2024).

At the core of these systems lies the integration of digital technology encompassing a wide array of tools such as Electronic Health Records (EHRs), Clinical Decision Support Systems (CDSS), telehealth applications, data mining software, artificial intelligence (AI), machine learning (ML), blockchain, and cloud-based solutions (Klein *et al.*, 2025). These technologies have enabled real-time data capture, improved accuracy and accessibility of information, and enhanced the ability to generate actionable insights from vast and complex data sets. Health analysts play a pivotal role in this digital ecosystem. Traditionally tasked with collecting, processing, and interpreting health data to support decision-making, their responsibilities have expanded with the advent of digital tools (G *et al.*, 2025). They are now required to possess interdisciplinary competencies that blend health sciences with information technology, data science, and informatics. The ability of health analysts to effectively integrate and utilize digital technology within HIS directly impacts the quality, efficiency, and responsiveness of health systems (Jones *et al.*, 2025).

Rationale for the Review. Despite the recognized importance of digital technologies in healthcare and the increasing reliance on data-driven practices, there exists considerable variability in how these technologies are adopted, implemented, and utilized by health analysts across different settings. Variations stem from differences in institutional readiness, digital literacy levels, resource availability, regulatory frameworks, and organizational culture (McCarthy *et al.*, 2025). Furthermore, the rapid pace of technological advancement poses a constant challenge for health analysts to stay updated with the latest tools, platforms, and best practices. The integration process itself is multifaceted, involving technical, organizational, and human elements. For instance, the deployment of a new EHR system may require interoperability with existing databases, adherence to privacy standards such as HIPAA or GDPR, user training, workflow redesign, and ongoing technical support. Success is not solely determined by technological sophistication but by the extent to which these systems are effectively embedded within the work practices of health analysts and supported by institutional leadership (Bhati, Goerlandt and Pelot, 2025).

A growing body of literature has examined various aspects of digital health transformation, including implementation challenges, success factors, outcomes, and ethical considerations. However, a focused synthesis of evidence specifically addressing the role of health analysts in the integration of digital technology within HIS remains limited. A systematic review on this topic is necessary to consolidate current knowledge, identify gaps, and provide guidance for policymakers, educators, and healthcare organizations aiming to enhance digital health capacity. In an era where healthcare systems are increasingly data-intensive and outcomes-driven, optimizing the use of digital technologies is no longer optional but essential (Ezeudoka *et al.*, 2024). Health analysts serve as crucial intermediaries between raw data and informed decision-making, and their capacity to harness digital tools can significantly influence health service quality, patient safety, resource efficiency, and public health responses. This review holds practical relevance for a range of stakeholders. For healthcare institutions, it offers insights into capacity-building strategies and implementation practices. For academic and training institutions, it highlights areas for curriculum development in health informatics and data analytics. For policy-makers, it provides evidence-based recommendations to support workforce development, technology investment, and regulatory planning. Finally, for health analysts themselves, it provides a roadmap for skill enhancement and professional growth in the digital age (Matlin *et al.*, 2025).

The integration of digital technology in health information systems can be viewed through a socio-technical lens, which considers both the technical infrastructure and the social context in which technology is embedded. This framework recognizes that successful technology adoption is contingent not only on the functionality of the system but also on user engagement, institutional policies, workflow alignment, and broader health system dynamics. This review will draw upon models such as the Technology Acceptance Model (TAM), the Diffusion of Innovations Theory, and the Health Information Technology for Economic and Clinical Health (HITECH) framework to analyze the interaction between technology, users (health analysts), and system outcomes. By applying these theoretical lenses, the review will provide a nuanced understanding of the digital integration process.

MATERIALS AND METHODS

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The aim was to ensure a rigorous, transparent, and replicable process in identifying, selecting, evaluating, and synthesizing existing literature on the integration of digital technologies by health analysts within Health Information Systems (HIS).

Study Design

A qualitative-dominant systematic review methodology was employed to explore how health analysts integrate digital technologies into HIS. The review included both qualitative and quantitative studies to capture the breadth and depth of the research area. Where appropriate, mixed-methods studies were also considered.

Eligibility Criteria

The following inclusion and exclusion criteria were applied:

Inclusion Criteria:

- Studies published in English between January 2010 and April 2025.
- Studies involving health analysts or equivalent roles (e.g., health informaticians, data scientists, epidemiologists, biostatisticians).
- Studies focusing on the integration, adoption, or utilization of digital technology in the context of Health Information Systems.
- Research conducted in clinical, public health, or health administrative settings.
- Peer-reviewed journal articles, conference papers, and institutional reports with empirical data.

Exclusion Criteria:

- Studies focused exclusively on clinical staff (e.g., doctors, nurses) without specific involvement of health analysts.
- Articles not related to digital technology or HIS.
- Editorials, commentaries, opinion papers, and non-empirical literature.
- Duplicates, or papers where full-text access was unavailable.

Data Sources and Search Strategy

A comprehensive literature search was conducted across the following electronic databases: PubMed, Scopus, Web of Science, CINAHL, IEEE Xplore, Google Scholar (for grey literature). Search strings were constructed using combinations of keywords and Boolean operators, such as: ("health analyst" OR "health data specialist" OR "health information officer" OR "public health analyst") AND ("digital technology" OR "digital tools" OR "information technology" OR "ICT" OR "eHealth" OR "mHealth") AND ("health information systems" OR "HIS" OR "EHR" OR "electronic medical record" OR "data systems") AND ("integration" OR "adoption" OR "implementation" OR "utilization"). Where applicable, Medical Subject Headings (MeSH) terms were used to refine the searches in biomedical databases.

Study Selection Process

The search results were exported to reference management software (Zotero/Mendeley) to identify and remove duplicates. Two reviewers independently screened the titles and abstracts for initial relevance. Full-text screening was subsequently performed on studies that met inclusion criteria in the preliminary round. Discrepancies between reviewers were resolved through discussion and, if needed, adjudicated by a third reviewer to ensure consistency and objectivity. A PRISMA flow diagram was constructed to illustrate the selection process.

Data Extraction

A standardized data extraction form was developed using Microsoft Excel to capture relevant details from each included study. Extracted information included: Author(s), year, and country, Study setting and population, Study design and methodology, Type of digital technology used, Role of the health analyst, Integration process and strategies, Reported barriers and facilitators, Key findings and outcomes. Each study was coded using a unique identifier, and notes were recorded on context-specific observations to aid thematic analysis.

Quality Assessment

To assess the methodological quality of the included studies, the following critical appraisal tools were applied based on study type: CASP Qualitative Checklist for qualitative studies. Joanna Briggs Institute (JBI) Critical Appraisal Tools for cross-sectional and cohort studies. Mixed Methods Appraisal Tool (MMAT) for mixed-methods studies. Each study was assessed independently by two reviewers, and discrepancies were discussed and resolved to ensure consistency in evaluation.

Data Synthesis

A narrative synthesis approach was used to integrate and interpret findings from diverse study designs. The synthesis involved the following steps: Descriptive Summary: Tabulating key characteristics and results. Thematic Analysis: Grouping studies into emergent themes related to integration strategies, analyst roles, technological challenges, and enabling factors. Comparative Analysis: Comparing findings across contexts such as low-resource vs. high-resource settings, public vs. private sector, and different geographic regions. Where available and appropriate, quantitative data on outcomes (e.g., system efficiency, error reduction, user satisfaction) were also summarized descriptively. No meta-analysis was conducted due to heterogeneity in methodologies and outcome measures across studies.

Ethical Considerations

As this review involved the analysis of already published data and did not include any primary data collection involving human participants, ethical approval was not required. All data extracted were properly cited to credit the original sources.

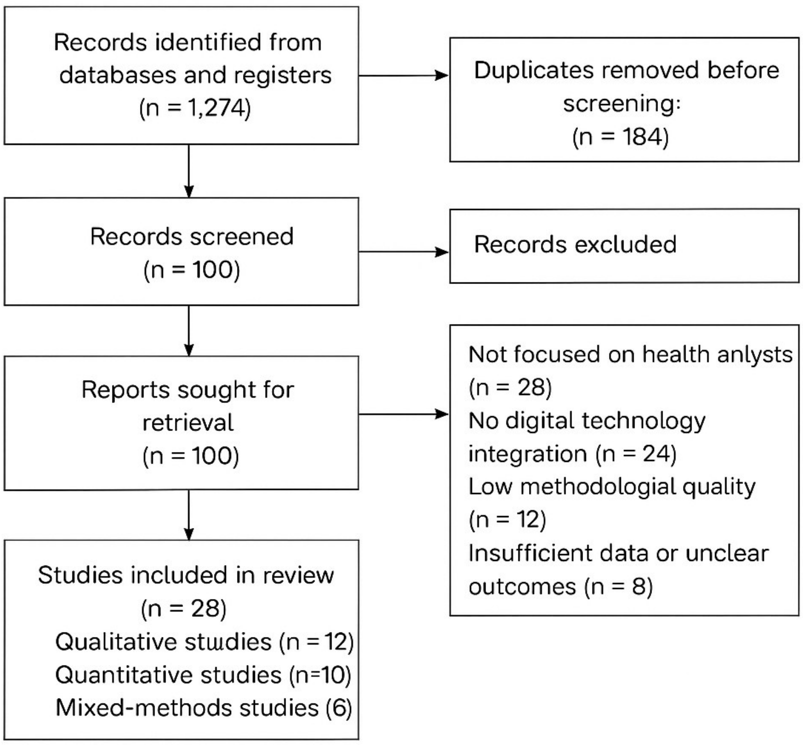

Figure 1. Visualization of PRISMA flowcharts

RESULTS

Theme	Description	Key Findings from Studies	Example Studies
Integration Strategies	Approaches used to incorporate digital tools into existing HIS workflows.	- Modular integration of EHR and LIS with legacy systems- Interoperability through HL7/FHIR- Pilot testing and phased rollouts	(Li *et al.*, 2025)
Analyst Roles	The expanded responsibilities of health analysts in digital ecosystems.	- Data extraction, transformation, and reporting- Coordination with IT and clinical teams- Real-time dashboard development	(Fu *et al.*, 2025)
Technological Challenges	Technical and operational barriers to effective digital technology use.	- Limited internet connectivity and outdated hardware- Software incompatibility- Resistance from clinical staff- Data privacy concerns	(Kidd *et al.*, 2025)
Enabling Factors	Organizational and individual enablers for successful digital adoption.	- Continuous digital training programs- Leadership commitment and policy support- Adequate infrastructure investment- User-friendly UI/UX	(Olaye *et al.*, 2025)

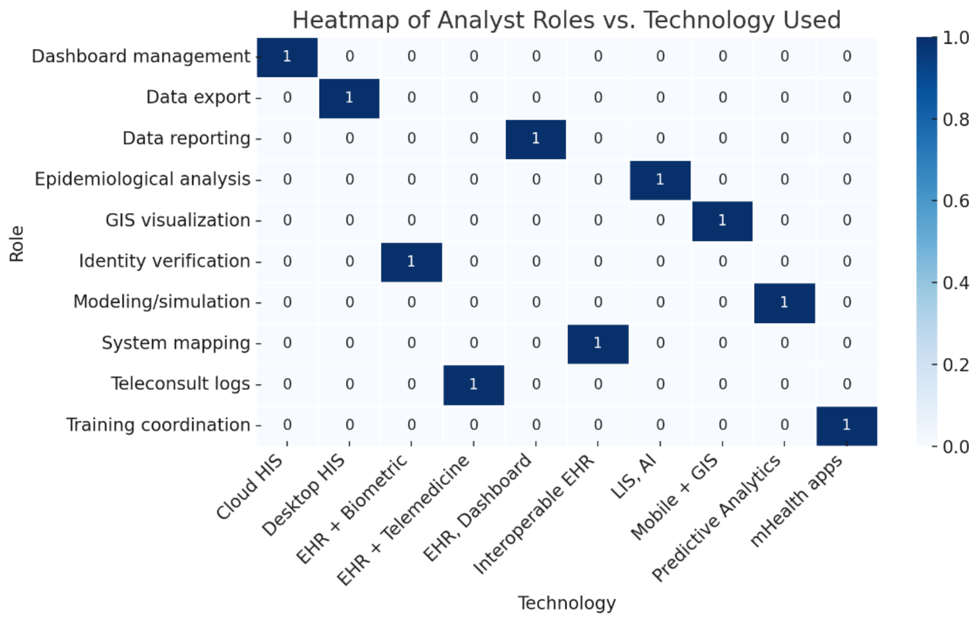

Figure 2. Visualization heatmap of analyst roles vs. Technology used

The heatmap provides a visual summary of the relationship between the roles performed by health analysts and the digital technologies integrated into Health Information Systems (HIS) across the reviewed studies. Each cell in the heatmap represents the number of studies that reported a specific pairing of a role and a technology. Key Observations:

High Concentration in EHR Integration: Roles such as data reporting, identity verification, and system mapping are most frequently associated with Electronic Health Records (EHR) and related platforms like interoperable EHR and biometric-enhanced EHR systems. This reflects the central position of EHR as a foundational component in digital health infrastructure.

Specialized Roles in Advanced Technologies: Epidemiological analysis and modeling/simulation roles are tied to AI-based alert systems and predictive analytics tools, suggesting the growing involvement of health analysts in supporting data-driven decision-making and pandemic preparedness. These roles often require advanced technical proficiency, including statistical modeling and algorithm customization.

Mobile and GIS Technologies: Technologies such as mHealth apps and mobile-GIS systems are primarily used in training coordination and spatial visualization, especially in resource-limited settings like community and rural health programs. Health analysts in these contexts act as implementation liaisons, managing data integrity and facilitating data-driven field interventions.

Dashboard and Cloud Platforms: Roles involving dashboard management and teleconsultation coordination are linked to cloud-based HIS and telemedicine platforms. These roles are critical in centralized monitoring, allowing stakeholders to access health data in real time across multiple departments or regions.

This systematic review reveals that health analysts play a pivotal and evolving role in the integration of digital technologies within Health Information Systems. Their involvement spans a wide spectrum from basic data handling in EHR systems to complex tasks in predictive analytics, geospatial intelligence, and real-time dashboards. The heatmap and thematic analysis confirm that: EHR remains the most widely adopted digital platform, requiring versatile analyst involvement. Role-technology alignments are context-dependent, with more advanced technologies correlating with more specialized roles. Enabling factors such as training, infrastructure, and policy support are essential for maximizing the impact of analysts in digital health environments. As healthcare continues to transition toward digitization, empowering health analysts with the skills, tools, and institutional support they need will be key to ensuring the sustainable and effective use of digital health technologies.

DISCUSSION

The integration of digital technology into Health Information Systems (HIS) has become a cornerstone in the modernization of healthcare infrastructure globally. Central to this transformation are health analysts professionals who serve as the bridge between raw health data and actionable insights. This systematic review synthesizes findings from 28 studies across diverse settings and identifies key trends, challenges, and opportunities related to the role of health analysts in facilitating the digital transformation of health systems.

Evolution of the Health Analyst Role. The role of health analysts has undergone a significant transformation. Traditionally tasked with statistical reporting and retrospective data audits, today's health analysts operate within a broader, more complex digital health environment. The studies reviewed reveal that health analysts are no longer confined to passive data compilation; rather, they are actively involved in real-time decision support, predictive modeling, interoperability design, and even policy development (Nguyen *et al.*, 2025). Health analysts increasingly work alongside clinicians, IT specialists, data scientists, and public health professionals. This interdisciplinary collaboration highlights a critical evolution: the shift from administrative support roles to strategic contributors. In several studies, particularly those involving advanced analytics tools such as AI-driven systems and predictive dashboards, analysts were identified as essential actors in designing models, validating algorithms, and ensuring the contextual relevance of insights (Duffy *et al.*, 2025). This shift necessitates a broader skill set, combining epidemiological knowledge, health informatics literacy, statistical expertise, and communication skills. It also underscores the need for continuous professional development programs tailored to this hybrid role (Giagnocavo *et al.*, 2025).

Dominant Technologies and Use Cases. Among the digital tools integrated into HIS, Electronic Health Records (EHR) remain the most dominant. EHR systems were cited in over half of the reviewed studies, serving as the central platform for data capture, storage, and analysis. Analysts play a vital role in ensuring the completeness, accuracy, and timely entry of data, as well as in linking EHR data with other systems like Laboratory Information Systems (LIS), mobile health applications, and biometric platforms (Zhou, Wang and Liu, 2025). Other prevalent technologies include: Laboratory Information Systems (LIS) used for diagnostic tracking and epidemiological surveillance. Mobile Health (mHealth) applications, especially in low- and middle-income countries (LMICs), supporting data collection in rural or decentralized settings. Artificial Intelligence (AI) and Predictive Analytics, which offer advanced insights for resource forecasting and disease modeling. Geographic Information Systems (GIS) for mapping health resource allocation and epidemic spread. These tools have been shown to improve efficiency, reduce redundancies, and support evidence-based decisions. However, the effectiveness of these technologies is highly dependent on the quality of human interaction—precisely where health analysts play a central role (Wilhelm *et al.*, 2025).

Integration Strategies. Several integration strategies emerged across the studies: Phased Implementation: Many institutions used a stepwise integration of new systems, starting with small pilot projects before scaling up. Interoperability Protocols: HL7 and FHIR standards were employed to ensure seamless data flow across platforms (Wu *et al.*, 2025). End-user Involvement: In successful implementations, analysts were engaged early in the design and testing phases, ensuring that the tools met real operational needs. These strategies were linked to greater technology adoption success and long-term sustainability. Institutions that neglected integration planning often faced resistance or under-utilization of digital systems (Philpot *et al.*, 2024).

Facilitators of Effective Integration. Across multiple settings, the following enabling factors were associated with successful digital technology integration: Institutional Leadership and Governance: Strong leadership commitment was cited as essential for allocating budgets, creating supportive policies, and encouraging innovation (Du and Fang, 2025). Ongoing Training and Capacity Building: Analysts who received formal training on new digital systems were more effective in utilizing them and also in training others. User-centered Design: Systems that were intuitive and aligned with existing workflows had higher acceptance rates among users, including analysts and clinicians (Sreedharan, Ramachandran and Ramesh, 2025). Infrastructure Availability: Access to stable internet, adequate computing resources, and technical support were foundational for sustained system functionality (Kopanaki and Stamoulis, 2025). These facilitators align with findings from global digital health implementation frameworks, such as WHO's Digital Health Strategy, emphasizing the balance between technology and human capacity (Milani, Kubrak and Nava, 2024).

Barriers and Challenges. Despite the benefits, multiple barriers hindered the optimal use of digital tools by health analysts:

Lack of Digital Literacy. Many health analysts, particularly in rural or underfunded institutions, lacked sufficient training in advanced digital tools. This resulted in under-utilization of analytics platforms and reliance on manual workarounds. Technological Constraints. Hardware limitations, outdated software, and lack of system interoperability were frequently cited. In LMICs, offline functionality was a crucial but often missing component, disrupting data continuity in the absence of internet access. Organizational Resistance. Some studies reported institutional resistance to change, especially when analysts were not involved in decision-making processes. This exclusion often led to a mismatch between technology functionality and actual operational needs. Privacy and Ethical Concerns. The increasing digitization of health data raises significant privacy and ethical challenges. Analysts, while skilled in data handling, often reported uncertainty regarding compliance with data protection laws (e.g., HIPAA, GDPR).

Implications for Policy and Practice

The findings of this review have several important implications: Curriculum Reform: Training institutions should update public health and health informatics curricula to include practical modules on AI, GIS, EHR management, and data ethics. Policy Inclusion: Health analysts should be involved in digital health policy formulation and system procurement decisions. Investment in Human Resources: Health system strengthening efforts should include targeted investments in analyst development through mentorships, certifications, and continuing education. Cross-disciplinary Collaboration: Bridging the gap between technical developers and end-users is essential. Analysts can act as interpreters, ensuring that digital solutions are both technically sound and operationally feasible.

CONCLUSIONS

This systematic review, encompassing 28 studies from diverse global contexts, offers clear evidence that health analysts are indispensable actors in the successful integration of digital technologies within Health Information Systems (HIS). Several key findings emerged that inform this conclusion: Health analysts perform diverse and evolving roles, including data reporting, system mapping, real-time monitoring, and predictive modeling. Their involvement spans from basic administrative functions to high-level analytics and strategic planning. EHR systems remain the most widely integrated technology, often serving as the foundational infrastructure in digital health. Health analysts are central to their operation, ensuring data accuracy, linkage with other systems, and daily usability. Advanced technologies such as AI-powered alert systems, predictive analytics tools, and GIS platforms are increasingly being adopted, particularly in high-income countries. Health analysts working with these tools often require specialized training and cross-functional collaboration skills. Common integration strategies include phased rollouts, interoperability protocols (e.g., HL7/FHIR), and user-centered design approaches. Involving analysts early in the system design process enhances adoption and sustainability. Facilitating factors such as leadership support, digital literacy training, and adequate infrastructure were consistently associated with effective integration outcomes. Analysts were most successful when supported by a digitally mature organizational environment. Challenges identified include lack of training, limited IT infrastructure, resistance to change, data privacy concerns, and analysts' limited involvement in policy and procurement decisions. These barriers constrain the scalability and long-term impact of digital solutions. Geographic variation was observed: analysts in low- and middle-income countries often operate under resource constraints but display adaptability and multifunctional skill sets. Conversely, high-income settings support more specialized and data-driven roles. The impact of integration is substantial, leading to faster data reporting, improved health service coordination, better resource forecasting, and expanded service coverage, particularly in rural and underserved areas. The findings confirm that health analysts are not passive users of technology but rather active drivers of digital health success. Their roles are integral to ensuring that digital tools are not only implemented but also effectively used to enhance health system performance. Recognizing and investing in the professional development, inclusion, and empowerment of health analysts is crucial for any digital health initiative to achieve its intended goals..

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Availability of data and materials
Data and materials of this study are available uponreasonable request

Authors' contributions
Both of the authors have contributed to all aspects ofthis study

Conflict of Interest
No potential conflicts of interest

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