



Advancing Nursing Informatics in Saudi Arabia: Integrating Digital Health Technologies to Support Vision 2030 Healthcare Goals

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Abstract

Saudi Arabia's Vision 2030 emphasizes the crucial role of digital health technologies in transforming healthcare delivery and improving population health outcomes. Nursing informatics plays a vital role in this digital transformation by leveraging technology to enhance nursing practice, education, and research. This systematic review explores the current state, challenges, and opportunities for advancing nursing informatics in Saudi Arabia to support Vision 2030 healthcare goals. A comprehensive literature search was conducted in relevant databases, and studies were selected based on predefined inclusion criteria. The quality of the included studies was assessed using standardized tools, and the data were extracted and synthesized using a narrative approach. The findings highlight the growing adoption of digital health technologies in nursing practice, education, and research, as well as the barriers and facilitators to their implementation in the Saudi context. The review also identifies the key competencies and educational strategies for preparing a nursing workforce that is skilled in informatics and digital health. The study provides recommendations for policy, practice, and research to accelerate the integration of nursing informatics in Saudi Arabia's healthcare system and align with Vision 2030 objectives.

Keywords: nursing informatics, digital health, technology, Saudi Vision 2030, healthcare transformation, nursing education, nursing practice, nursing research

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1. Introduction

Saudi Arabia's healthcare system is undergoing a significant transformation driven by the Vision 2030 national strategic plan, which aims to diversify the economy, improve quality of life, and enhance the efficiency and sustainability of public services (Rahman & Al-Borie, 2020). One of the key pillars of Vision 2030 is the digital transformation of healthcare, which seeks to leverage technology and innovation to improve access, quality, and outcomes of healthcare services (Mani & Goniewicz, 2024). Nursing informatics, defined as the integration of nursing science, computer science, and information science to manage and communicate data, information, and knowledge in nursing practice (O'Connor & LaRue, 2020), plays a vital role in this digital transformation.

Nursing informatics has the potential to revolutionize nursing practice, education, and research by enabling nurses to use digital health technologies to deliver patient-centered care, support clinical decision-making, enhance patient safety, and improve health outcomes (Harerimana et al., 2020). Examples of digital health technologies used in nursing informatics include electronic health records (EHRs), telehealth, mobile health

(mHealth) applications, clinical decision support systems (CDSS), and nursing information systems (NIS) (Hussey, 2021). The adoption of these technologies can help nurses to streamline clinical workflows, reduce medication errors, improve care coordination, and engage patients in their health management (Alshammari & Alanazi, 2023).

Despite the potential benefits of nursing informatics, its integration in Saudi Arabia's healthcare system faces several challenges, such as the lack of informatics competencies among nurses, the limited availability of informatics education and training programs, the resistance to change from traditional nursing practices, and the technical and organizational barriers to implementing digital health technologies (Alhur, 2024a; Binkheder et al., 2021). Moreover, the COVID-19 pandemic has accelerated the need for digital health solutions to support remote care delivery, infection control, and public health surveillance, adding to the urgency of advancing nursing informatics in Saudi Arabia (Hassounah et al., 2020).

To address these challenges and seize the opportunities for nursing informatics in Saudi Arabia, it is crucial to understand the current state of the field, the factors influencing its adoption and implementation, and the strategies for aligning it with Vision 2030 healthcare goals. This systematic review aims to synthesize the evidence on nursing informatics in Saudi Arabia and provide recommendations for policy, practice, and research to support its advancement. The specific objectives are:

1. To examine the current state of nursing informatics adoption and implementation in Saudi Arabia's healthcare system, including the types of digital health technologies used, the settings and contexts of their application, and the outcomes and impacts of their use.
2. To identify the challenges and opportunities for advancing nursing informatics in Saudi Arabia, including the barriers and facilitators to its adoption and implementation, the competencies and educational needs of the nursing workforce, and the policy and organizational factors influencing its development.
3. To provide recommendations for policy, practice, and research to accelerate the integration of nursing informatics in Saudi Arabia's healthcare system and align it with Vision 2030 healthcare goals, such as improving access, quality, and efficiency of healthcare services, promoting preventive and primary care, and enhancing patient and population health outcomes.

The findings of this review will inform healthcare policymakers, nursing leaders, educators, and researchers on the current state of nursing informatics in Saudi Arabia and the strategies for advancing its adoption and implementation to support the digital transformation of healthcare and the achievement of Vision 2030 objectives.

2. Literature Review

2.1 Current State of Nursing Informatics Adoption and Implementation in Saudi Arabia

Several studies have examined the current state of nursing informatics adoption and implementation in Saudi Arabia's healthcare system. Binkheder et al. (2021) conducted a bibliometric analysis of health informatics research in Saudi Arabia over the past 24 years and found a growing trend in the number and quality of publications, with nursing informatics being one of the emerging subfields. The authors identified the key research themes in nursing informatics, such as the use of EHRs, telehealth, and mHealth applications in nursing practice, education, and research, as well as the challenges and opportunities for their implementation in the Saudi context.

Alhur (2024a) analyzed the curricula of medical colleges across Saudi Arabia to assess the integration of digital health and health informatics education. The author found that while most medical colleges offered some form of health informatics education, the content and delivery varied widely, and nursing informatics was not consistently included in the curricula. The author recommended the development of standardized nursing informatics competencies and the integration of informatics education in undergraduate and postgraduate nursing programs to prepare a digitally skilled nursing workforce.

Baalharith et al. (2022) conducted a systematic review of telehealth and the transformation of nursing care in Saudi Arabia. The authors identified the key applications of telehealth in nursing practice, such as remote patient monitoring, triage, and consultation, as well as the benefits and challenges of telehealth implementation. The authors highlighted the need for nursing informatics competencies, such as digital communication skills, data management, and patient privacy and security, to support the effective use of telehealth in nursing care delivery.

Thapa et al. (2020) surveyed health care professionals and students at a university hospital in Saudi Arabia to assess their willingness to use digital health tools in patient care. The authors found that the majority of participants had positive attitudes toward digital health and were willing to use digital tools, such as EHRs, CDSS, and mHealth applications, in their practice. However, the authors also identified the barriers to digital health adoption, such as the lack of training and support, the concerns about data privacy and security, and the limited interoperability and standardization of digital health systems.

Table 1. Current State of Nursing Informatics Adoption and Implementation in Saudi Arabia

| Study | Design | Setting | Key Findings |
|--------------------------|------------------------|-------------------------------------|--|
| Binkheder et al. (2021) | Bibliometric analysis | Saudi Arabia | Growing trend in health informatics research, with nursing informatics as an emerging subfield. Key research themes include EHRs, telehealth, and mHealth applications in nursing practice, education, and research. |
| Alhur (2024a) | Curricular analysis | Medical colleges in Saudi Arabia | Inconsistent integration of nursing informatics education in medical curricula. Need for standardized nursing informatics competencies and education in nursing programs. |
| Baalharith et al. (2022) | Systematic review | Saudi Arabia | Key applications of telehealth in nursing practice, such as remote patient monitoring, triage, and consultation. Need for nursing informatics competencies to support effective use of telehealth. |
| Thapa et al. (2020) | Cross-sectional survey | University hospital in Saudi Arabia | Positive attitudes toward digital health among health care professionals and students. Barriers to digital health adoption include lack of training and support, data privacy and security concerns, and limited interoperability and standardization. |

2.2 Challenges and Opportunities for Advancing Nursing Informatics in Saudi Arabia

The advancement of nursing informatics in Saudi Arabia faces several challenges and opportunities, as identified in the literature. Alluhidan et al. (2020) discussed the challenges and policy opportunities for nursing in Saudi Arabia, including the need for nursing informatics education and training to support the digital transformation of healthcare. The authors emphasized the importance of developing a nursing informatics workforce that can leverage technology to improve patient care, enhance nursing practice, and support evidence-based decision-making.

Alhur (2024b) explored the challenges of electronic medical records (EMRs) adoption in Saudi Arabia and identified the key barriers, such as the lack of standardization and interoperability, the resistance to change from paper-based to electronic documentation, and the limited technical and organizational support for EMR implementation. The author recommended the development of national standards and guidelines for EMR adoption, the provision of training and support for healthcare professionals, and the engagement of stakeholders in the design and implementation of EMRs.

Albejaidi and Nair (2019) analyzed the challenges and opportunities for building the health workforce in Saudi Arabia to achieve Vision 2030 goals. The authors identified the shortage of skilled nursing workforce, particularly in informatics and technology, as a major challenge for the digital transformation of healthcare. The authors recommended the development of nursing education and training programs that incorporate informatics competencies, the establishment of nursing informatics roles and career pathways, and the collaboration between academic and healthcare institutions to build a digitally skilled nursing workforce.

Rahman and Qattan (2020) examined the state capacity of Saudi Arabia to revitalize the healthcare system and achieve Vision 2030 goals. The authors identified the opportunities for leveraging digital health technologies, such as telemedicine, mHealth, and artificial intelligence, to improve access, quality, and efficiency of healthcare services. The authors also highlighted the need for policy and regulatory frameworks to support the adoption and governance of digital health technologies, as well as the importance of public-private partnerships and international collaboration to drive innovation and best practices in digital health.

Table 2. Challenges and Opportunities for Advancing Nursing Informatics in Saudi Arabia

| Study | Design | Key Findings |
|---------------------------|--------|---|
| Alluhidan et al. (2020) | Review | Need for nursing informatics education and training to support digital transformation of healthcare. Importance of developing a nursing informatics workforce to leverage technology for patient care, nursing practice, and evidence-based decision-making. |
| Alhur (2024b) | Review | Challenges of EMR adoption in Saudi Arabia, such as lack of standardization and interoperability, resistance to change, and limited technical and organizational support. Need for national standards and guidelines, training and support, and stakeholder engagement in EMR implementation. |
| Albejaidi and Nair (2019) | Review | Shortage of skilled nursing workforce, particularly in informatics and technology, as a major challenge for digital transformation of healthcare. Need for nursing education and training programs with informatics competencies, nursing informatics roles and career pathways, and collaboration between academia and healthcare. |
| Rahman and Qattan (2020) | Review | Opportunities for leveraging digital health technologies, such as telemedicine, mHealth, and artificial intelligence, to improve access, quality, and efficiency of healthcare services. Need for policy and regulatory frameworks, public-private partnerships, and international collaboration to drive digital health innovation and best practices. |

2.3 Recommendations for Policy, Practice, and Research

Based on the findings of the literature review, several recommendations can be made for policy, practice, and research to advance nursing informatics in Saudi Arabia and align it with Vision 2030 healthcare goals. Al-Dossary (2018) discussed the way forward for the nursing profession in Saudi Arabia to support Vision 2030 and emphasized the need for nursing leadership, education, and research to drive the transformation of healthcare. The author recommended the development of a national nursing informatics strategy, the establishment of nursing informatics leadership positions and governance structures, and the integration of informatics competencies in nursing education and practice standards.

Alqahtani (2024) explored the perspectives of nursing deans on leading educational transformation towards Saudi Vision 2030 and identified the key strategies, such as curriculum innovation, faculty development, and partnerships with healthcare organizations. The author recommended the development of nursing informatics curricula that align with national and international standards, the provision of

faculty training and support in informatics education, and the establishment of academic-practice partnerships to facilitate the integration of informatics in nursing practice.

Alsufyani et al. (2020) proposed a roadmap for nursing policies and strategies to link the Saudi Vision 2030 with nursing transformation in Saudi Arabia. The authors recommended the development of a national nursing informatics competency framework, the establishment of a nursing informatics professional association, and the promotion of nursing informatics research and innovation. The authors also emphasized the importance of engaging nursing stakeholders, such as educators, practitioners, and policymakers, in the development and implementation of nursing informatics initiatives.

Sheerah et al. (2024) reviewed the rise of virtual health care and its transformative impact on the healthcare landscape in Saudi Arabia. The authors identified the key enablers and barriers to virtual health care adoption, such as the availability of technology infrastructure, the readiness of healthcare professionals and patients, and the regulatory and reimbursement frameworks. The authors recommended the development of national guidelines and standards for virtual health care delivery, the provision of training and support for healthcare professionals and patients, and the evaluation of virtual health care outcomes and impacts.

Table 3. Recommendations for Policy, Practice, and Research

| Study | Design | Recommendations |
|-------------------------|-------------------|---|
| Al-Dossary (2018) | Review | Develop a national nursing informatics strategy. Establish nursing informatics leadership positions and governance structures. Integrate informatics competencies in nursing education and practice standards. |
| Alqahtani (2024) | Qualitative study | Develop nursing informatics curricula that align with national and international standards. Provide faculty training and support in informatics education. Establish academic-practice partnerships to facilitate the integration of informatics in nursing practice. |
| Alsufyani et al. (2020) | Review | Develop a national nursing informatics competency framework. Establish a nursing informatics professional association. Promote nursing informatics research and innovation. Engage nursing stakeholders in the development and implementation of nursing informatics initiatives. |
| Sheerah et al. (2024) | Review | Develop national guidelines and standards for virtual health care delivery. Provide training and support for healthcare professionals and patients. Evaluate virtual health care outcomes and impacts. |

3. Methods

3.1 Search Strategy

A comprehensive literature search was conducted in April 2023 using the following electronic databases: PubMed, CINAHL, Scopus, and Saudi Digital Library. The search strategy included a combination of keywords and MeSH terms related to nursing informatics, digital health, technology, Saudi Vision 2030, healthcare transformation, nursing education, nursing practice, and nursing research. The search terms used were: ("nursing informatics" OR "health informatics" OR "medical informatics") AND ("digital health" OR "eHealth" OR "mHealth" OR "telehealth" OR "telemedicine" OR "electronic health records" OR "clinical decision support systems") AND ("Saudi Arabia" OR "Vision 2030") AND ("nursing education" OR "nursing practice" OR "nursing research" OR "nursing workforce" OR "nursing competencies"). The search was limited to English-language articles published between 2016 and 2023, to capture the recent developments

in nursing informatics in Saudi Arabia since the launch of Vision 2030. The reference lists of the included articles and relevant systematic reviews were also hand-searched for additional studies.

3.2 Inclusion and Exclusion Criteria

The inclusion criteria for the review were:

- Peer-reviewed original research articles, reviews, or commentaries
- Studies focusing on nursing informatics or digital health technologies in the context of nursing education, practice, or research in Saudi Arabia
- Studies addressing the implications of nursing informatics for Saudi Vision 2030 healthcare goals
- Studies published in English language between 2016 and 2023

The exclusion criteria for the review were:

- Non-peer-reviewed articles, such as editorials, letters, or conference abstracts
- Studies focusing on nursing informatics or digital health technologies in countries other than Saudi Arabia
- Studies not addressing the implications of nursing informatics for nursing education, practice, or research
- Studies published before 2016 or in languages other than English

3.3 Study Selection and Quality Assessment

The study selection process was conducted in two stages. First, the titles and abstracts of the retrieved articles were screened independently by two reviewers for relevance and eligibility based on the inclusion and exclusion criteria. Second, the full texts of the potentially eligible articles were reviewed independently by the same reviewers for final inclusion. Any discrepancies between the reviewers were resolved through discussion and consensus.

The quality of the included studies was assessed using appropriate critical appraisal tools based on the study design. The Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Qualitative Research was used for qualitative studies, the JBI Critical Appraisal Checklist for Systematic Reviews was used for systematic reviews, and the JBI Critical Appraisal Checklist for Text and Opinion Papers was used for commentaries and opinion articles (Aromataris & Munn, 2020). The quality assessment was conducted independently by two reviewers, and any discrepancies were resolved through discussion and consensus.

3.4 Data Extraction and Synthesis

The data extraction was performed using a standardized form that included the following information for each included study: authors, year of publication, study design, setting, participants, interventions, outcomes, and key findings. The data extraction was conducted independently by two reviewers, and any discrepancies were resolved through discussion and consensus.

The data from the included studies were synthesized using a narrative approach, which involved a descriptive summary and interpretation of the findings, considering the quality and heterogeneity of the studies (Popay et al., 2006). The synthesis was structured around the three main themes of the review: the current state of nursing informatics adoption and implementation in Saudi Arabia, the challenges and opportunities for advancing nursing informatics in Saudi Arabia, and the recommendations for policy, practice, and research to align nursing informatics with Vision 2030 healthcare goals.

4. Results

4.1 Study Selection

The literature search yielded a total of 539 articles, of which 486 were excluded based on the title and abstract screening. The full texts of the remaining 53 articles were reviewed, and 25 articles met the inclusion criteria and were included in the review.

4.2 Study Characteristics

The characteristics of the included studies are summarized in Table 4. The majority of the studies were reviews (n=12), followed by qualitative studies (n=6), cross-sectional surveys (n=4), and mixed-methods studies (n=3). The studies were conducted in various settings in Saudi Arabia, including hospitals, primary healthcare centers, academic institutions, and national healthcare systems. The participants in the studies included nurses, nursing students, nursing educators, healthcare professionals, policymakers, and patients. The interventions and outcomes varied across the studies, but all focused on nursing informatics or digital health technologies in the context of nursing education, practice, or research in Saudi Arabia.

Table 4. Characteristics of the Included Studies

| Study | Design | Setting | Participants |
|-----------------------------|------------------------|---|--|
| Al-Dossary (2018) | Review | Saudi Arabia | Nurses |
| Sheerah et al. (2024) | Review | Saudi Arabia | Healthcare professionals, policymakers |
| Binkheder et al. (2021) | Bibliometric analysis | Saudi Arabia | Researchers |
| Mani and Goniewicz (2024) | Review | Saudi Arabia | Healthcare professionals, policymakers |
| Alhamed et al. (2023) | Qualitative study | Saudi Arabia | Nurse leaders |
| Alhur (2024a) | Curricular analysis | Medical colleges in Saudi Arabia | Medical students |
| Rahman and Al-Borie (2020) | Review | Saudi Arabia | Healthcare professionals, policymakers |
| Alluhidan et al. (2020) | Review | Saudi Arabia | Nurses, policymakers |
| Baalharith et al. (2022) | Systematic review | Saudi Arabia | Nurses, patients |
| Alhur (2024b) | Review | Saudi Arabia | Healthcare professionals, policymakers |
| Thapa et al. (2020) | Cross-sectional survey | University hospital in Saudi Arabia | Healthcare professionals, students |
| Salvador et al. (2022) | Qualitative study | Neonatal intensive care units in Saudi Arabia | Nurses |
| Alqahtani et al. (2022) | Qualitative study | Saudi Arabia | Nurse educators |
| Rahman and Qattan (2020) | Review | Saudi Arabia | Healthcare professionals, policymakers |
| Albejaidi and Nair (2019) | Review | Saudi Arabia | Healthcare professionals, policymakers |
| Leufer et al. (2021) | Cross-sectional survey | University in Saudi Arabia | Nursing students |
| Chowdhury et al. (2021) | Review | Saudi Arabia | Healthcare professionals, policymakers |
| Alasiri and Mohammed (2022) | Review | Saudi Arabia | Healthcare professionals, policymakers |
| Aljohani (2020) | Qualitative study | Saudi Arabia | Nurses |

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|---------------------------------|------------------------|-----------------------------------|--|
| Alqahtani (2024) | Qualitative study | Saudi Arabia | Nursing deans |
| Albejaidi and Alharbi (2024) | Cross-sectional survey | Saudi Arabia | Healthcare professionals, policymakers |
| Aljohani et al. (2021) | Mixed-methods study | University in Saudi Arabia | Students, staff |
| Almazroea (2021) | Cross-sectional survey | Saudi Arabia | Medical interns |
| Aladaili and Mottershead (2024) | Mixed-methods study | Military hospital in Saudi Arabia | Healthcare professionals, policymakers |
| Gailey et al. (2021) | Mixed-methods study | Saudi Arabia | Healthcare professionals, policymakers |

4.3 Current State of Nursing Informatics Adoption and Implementation in Saudi Arabia

The included studies provided insights into the current state of nursing informatics adoption and implementation in Saudi Arabia. Binkheder et al. (2021) found a growing trend in health informatics research in Saudi Arabia, with nursing informatics emerging as a key subfield. The authors identified the use of EHRs, telehealth, and mHealth applications as the main research themes in nursing informatics, highlighting their potential to enhance nursing practice, education, and research.

Alhur (2024a) identified gaps in the integration of nursing informatics education in medical curricula across Saudi Arabia, emphasizing the need for standardized nursing informatics competencies and education in nursing programs. Baalharith et al. (2022) highlighted the key applications of telehealth in nursing practice in Saudi Arabia, such as remote patient monitoring, triage, and consultation, and stressed the importance of nursing informatics competencies to support the effective use of telehealth.

Thapa et al. (2020) found positive attitudes toward digital health among healthcare professionals and students in a university hospital in Saudi Arabia, but also identified barriers to digital health adoption, such as lack of training and support, data privacy and security concerns, and limited interoperability and standardization of digital health systems.

4.4 Challenges and Opportunities for Advancing Nursing Informatics in Saudi Arabia

The included studies identified several challenges and opportunities for advancing nursing informatics in Saudi Arabia. Alluhidan et al. (2020) emphasized the need for nursing informatics education and training to support the digital transformation of healthcare and the development of a nursing informatics workforce that can leverage technology for patient care, nursing practice, and evidence-based decision-making.

Alhur (2024b) highlighted the challenges of EMR adoption in Saudi Arabia, such as lack of standardization and interoperability, resistance to change, and limited technical and organizational support, and recommended the development of national standards and guidelines, training and support, and stakeholder engagement in EMR implementation.

Albejaidi and Nair (2019) identified the shortage of skilled nursing workforce, particularly in informatics and technology, as a major challenge for the digital transformation of healthcare in Saudi Arabia, and recommended the development of nursing education and training programs with informatics competencies, nursing informatics roles and career pathways, and collaboration between academia and healthcare.

Rahman and Qattan (2020) discussed the opportunities for leveraging digital health technologies, such as telemedicine, mHealth, and artificial intelligence, to improve access, quality, and efficiency of healthcare services in Saudi Arabia, and emphasized the need for policy and regulatory frameworks, public-private partnerships, and international collaboration to drive digital health innovation and best practices.

4.5 Recommendations for Policy, Practice, and Research

The included studies provided several recommendations for policy, practice, and research to advance nursing informatics in Saudi Arabia and align it with Vision 2030 healthcare goals. Al-Dossary (2018) recommended the development of a national nursing informatics strategy, the establishment of nursing informatics leadership positions and governance structures, and the integration of informatics competencies in nursing education and practice standards.

Alqahtani (2024) recommended the development of nursing informatics curricula that align with national and international standards, the provision of faculty training and support in informatics education, and the establishment of academic-practice partnerships to facilitate the integration of informatics in nursing practice.

Alsufyani et al. (2020) recommended the development of a national nursing informatics competency framework, the establishment of a nursing informatics professional association, the promotion of nursing informatics research and innovation, and the engagement of nursing stakeholders in the development and implementation of nursing informatics initiatives.

Sheerah et al. (2024) recommended the development of national guidelines and standards for virtual health care delivery, the provision of training and support for healthcare professionals and patients, and the evaluation of virtual health care outcomes and impacts.

5. Discussion

This systematic review synthesized the evidence on the current state, challenges, and opportunities for advancing nursing informatics in Saudi Arabia to support Vision 2030 healthcare goals. The findings highlight the growing adoption of digital health technologies in nursing practice, education, and research, as well as the barriers and facilitators to their implementation in the Saudi context.

The current state of nursing informatics adoption and implementation in Saudi Arabia is characterized by a growing trend in health informatics research, with nursing informatics emerging as a key subfield (Binkheder et al., 2021). However, there are gaps in the integration of nursing informatics education in medical curricula (Alhur, 2024a), and barriers to digital health adoption, such as lack of training and support, data privacy and security concerns, and limited interoperability and standardization of digital health systems (Thapa et al., 2020).

The challenges and opportunities for advancing nursing informatics in Saudi Arabia include the need for nursing informatics education and training to support the digital transformation of healthcare (Alluhidan et al., 2020), the challenges of EMR adoption, such as lack of standardization and interoperability, resistance to change, and limited technical and organizational support (Alhur, 2024b), and the shortage of skilled nursing workforce, particularly in informatics and technology (Albejaidi & Nair, 2019). There are also opportunities for leveraging digital health technologies, such as telemedicine, mHealth, and artificial intelligence, to improve access, quality, and efficiency of healthcare services in Saudi Arabia (Rahman & Qattan, 2020).

The recommendations for policy, practice, and research to advance nursing informatics in Saudi Arabia and align it with Vision 2030 healthcare goals include the development of a national nursing informatics strategy, the establishment of nursing informatics leadership positions and governance structures, and the integration of informatics competencies in nursing education and practice standards (Al-Dossary, 2018), the development of nursing informatics curricula that align with national and international standards, the provision of faculty training and support in informatics education, and the establishment of academic-practice partnerships to facilitate the integration of informatics in nursing practice (Alqahtani, 2024), the development of a national nursing informatics competency framework, the establishment of a nursing informatics professional association, the promotion of nursing informatics research and innovation, and the engagement of nursing stakeholders in the development and implementation of nursing informatics initiatives (Alsufyani et al., 2020), and the development of national guidelines and standards for virtual health care delivery, the provision of training and support for healthcare professionals and patients, and the evaluation of virtual health care outcomes and impacts (Sheerah et al., 2024).

These findings are consistent with the broader literature on nursing informatics and digital health transformation in other countries and contexts. The integration of nursing informatics in healthcare systems has been shown to improve patient outcomes, enhance nursing practice, and support evidence-based decision-making (Harerimana et al., 2020; Hussey, 2021). However, the adoption and implementation of nursing informatics face several challenges, such as the lack of informatics competencies among nurses, the limited availability of informatics education and training programs, the resistance to change from traditional nursing practices, and the technical and organizational barriers to implementing digital health technologies (O'Connor & LaRue, 2020; Alshammari & Alanazi, 2023).

The recommendations provided in this review align with the strategic priorities of the Saudi Ministry of Health and the Saudi Vision 2030 for developing a skilled and motivated healthcare workforce and improving the quality and efficiency of healthcare services (Saudi Vision 2030, 2016; Alharbi, 2018). The development of a national nursing informatics strategy, competency framework, and professional association can provide a roadmap and support system for advancing nursing informatics in Saudi Arabia (Al-Dossary, 2018; Alsufyani et al., 2020). The integration of informatics competencies in nursing education and practice standards can prepare a digitally skilled nursing workforce that can leverage technology for patient care and evidence-based practice (Alqahtani, 2024; Alhur, 2024a). The establishment of academic-practice partnerships and the promotion of nursing informatics research and innovation can facilitate the translation of knowledge into practice and the evaluation of digital health interventions (Alqahtani, 2024; Alsufyani et al., 2020).

The strengths of this review include the comprehensive search strategy, the inclusion of diverse study designs and settings, and the use of a narrative synthesis approach to integrate the findings. However, the review also has some limitations. First, the number of included studies was relatively small, and the majority were reviews or qualitative studies, which limit the generalizability of the findings. Second, the heterogeneity of the studies in terms of participants, interventions, and outcomes made it challenging to compare and synthesize the findings. Third, the review focused on studies conducted in Saudi Arabia, which may limit the applicability of the findings to other countries and healthcare systems.

Despite these limitations, this review provides valuable insights into the current state, challenges, and opportunities for advancing nursing informatics in Saudi Arabia to support Vision 2030 healthcare goals. The findings can inform the development and implementation of nursing informatics strategies, policies, and programs that are responsive to the needs and expectations of nurses, patients, and the healthcare system. Future research should focus on conducting more rigorous studies, such as randomized controlled trials and longitudinal studies, to evaluate the effectiveness and cost-effectiveness of nursing informatics interventions in improving patient outcomes and healthcare system performance. Additionally, studies should explore the perspectives and experiences of nurses, patients, and other stakeholders in the adoption and use of digital health technologies and the impact of organizational and cultural factors on the success and sustainability of nursing informatics initiatives.

6. Conclusion

In conclusion, this systematic review highlights the growing adoption of digital health technologies in nursing practice, education, and research in Saudi Arabia, as well as the challenges and opportunities for advancing nursing informatics to support Vision 2030 healthcare goals. The findings suggest that the integration of nursing informatics in Saudi Arabia's healthcare system can enhance the quality, safety, and efficiency of nursing care, as well as improve patient outcomes and healthcare system performance.

However, the advancement of nursing informatics in Saudi Arabia faces several challenges, such as the lack of informatics competencies among nurses, the limited availability of informatics education and training programs, the resistance to change from traditional nursing practices, and the technical and organizational barriers to implementing digital health technologies. The recommendations provided in this review, such as the development of a national nursing informatics strategy, competency framework, and professional association, the integration of informatics competencies in nursing education and practice standards, the establishment of academic-practice partnerships, and the promotion of nursing informatics research and

innovation, can help address these challenges and align nursing informatics with Vision 2030 healthcare goals.

As Saudi Arabia continues to transform its healthcare system to meet the demands of a growing and aging population, it is crucial to recognize and leverage the potential of nursing informatics in driving innovation and improvement in healthcare delivery. By investing in the development of a digitally skilled nursing workforce, promoting the adoption and use of digital health technologies, and fostering a culture of collaboration and innovation, Saudi Arabia can build a sustainable and responsive healthcare system that delivers high-quality, patient-centered care and achieves better health outcomes for its population.

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