

Current Trends And Challenges In Health Informatics: A Systematic Review

Muhannad Abdulrahman Mohsen Hurayb¹, Abdullah Ali Alazzmi², Wejdan Amein Abdullah³, Ibrahim Awad Saad Alahmari⁴, Hamoud Turki Almutairi⁵, Yasser Al-Quwaifel⁶, Abdulrahman Ati Althgfi⁷, Bader Mahlan Albogami⁸, Bakr Siddiq Bakr Fallatah⁹, Mutab Salem Auid Al Baqami¹⁰, Khalid Aayed Thawab Albogami¹⁰, Abdullah Aziz Almalky¹¹, Abdulmajeed Safar Alosaimi¹²

Abstract

Health informatics is a fast-developing field that includes the use of technology to improve healthcare delivery and patient outcomes. This systematic review aims to identify current trends and challenges in health informatics by analyzing secondary data from several sources. The study reviews recent literature on health informatics and synthesizes key findings to deliver a complete overview of the field. The analysis reveals several important trends in health informatics, including the widespread adoption of electronic health records, the increasing use¹ of telehealth and mobile health technologies, and the growing significance of data analytics and artificial intelligence in healthcare. These trends have the potential to improve patient care, increase effectiveness, and reduce costs in the healthcare system. However, the study also highlights several challenges facing the field, such as data privacy and security concerns, interoperability issues, and the need for improved training and education for healthcare professionals. In conclusion, this systematic review provides valuable insights into the current state of health informatics and highlights both the opportunities and challenges facing the field. By identifying key trends and issues, this study aims to inform future research and policy efforts to advance the field of health informatics and improve healthcare delivery.

Keywords: Health informatics, Artificial intelligence, Healthcare system, Data privacy, Patient outcomes.

1. Introduction

Delivering high-quality healthcare services depends heavily on the quickly expanding subject of health informatics. Significant improvements in patient care, health outcomes, and operational efficiency have resulted from the integration of technology with healthcare (Dixon,

¹specialist -Health Informatics,Al-Laith General Hospital, Saudi Arabia.

²health Informatics Technician ,Nafi General Hospital - Third Health Cluster In Riyadh, Saudi Arabia.

³health Informatics Technician, National Guard Hospital, Saudi Arabia.

⁴health Informatics Technician, Almaseef Primary Health Care Center, Saudi Arabia.

⁵senior Health Informatics Specialis, Health Affairs In Hafr Al-Batin, Saudi Arabia.

⁶health Information Management Specialist,Al Muthanna Hospital In Qassim, Saudi Arabia.

⁷health Information Technician, King Faisal Complex, Taif, Saudi Arabia.

⁸health Informatics Technician, Rumah General Hospital, Saudi Arabia.

⁹health Informatics ,King Salman Bin Abdulaziz Medical City, Saudi Arabia.

¹⁰health Information, Ministry Of Health, Saudi Arabia.

¹¹health Informatics Technician,Comprehensive Medical Examination Administration, Saudi Arabia.

¹²health Informatics Technician, Dawadmi General Hospital - Third Health Cluster In Riyadh, Saudi Arabia.

2025). As technology continues to change, it is significant to understand the current trends and challenges in health informatics to ensure that healthcare organizations are at the forefront of innovation and improvement.

In this systematic review, we aim to explore the current trends in health informatics and identify the challenges that healthcare organizations are facing in implementing and utilizing health informatics technologies (Goldberg, 2011). By analyzing the existing literature and studies in the field, we hope to provide valuable insights that can help inform decision-making and resource distribution in healthcare surroundings.

The growing use of electronic health records (EHRs) for patient data management and storage is one of the major developments in health informatics. EHRs have revolutionized the way patient data is collected, organized, and accessed, making it easier for healthcare providers to coordinate care and make informed treatment decisions (Kim, 2018). To fully reap the rewards of this technology, however, a number of obstacles, including data security and interoperability problems, have also been brought about by the growing use of EHRs.

The use of telemedicine and remote monitoring technology to provide healthcare services to patients outside of conventional clinical settings is another important development in health informatics (Marc, 2019). Particularly in rural and isolated locations with limited access to healthcare services, telemedicine has grown in popularity. While telemedicine offers numerous advantages, including improved access to care and cost savings, there are challenges related to regulatory issues, reimbursement policies, and technological barriers that need to be overcome to fully integrate telemedicine into mainstream healthcare delivery (Panayides, 2020).

Furthermore, the growing availability of health data from various sources, such as wearable devices, mobile apps, and social media, presents both opportunities and challenges for healthcare organizations. Big data analytics and AI have the potential to revolutionize patient care by providing personalized treatment options, predicting disease outbreaks, and optimizing healthcare delivery processes (Saranummi, 2012). However, ensuring the confidentiality and safety of patient data, as well as developing the necessary infrastructure and expertise to harness the power of big data, remain major challenges for healthcare organizations.

In summary, the field of health informatics is constantly developing and is driven by technological improvements and changing healthcare needs. By understanding the current trends and challenges in health informatics, healthcare organizations can better prepare for the future and leverage technology to improve patient outcomes and operational efficiencies. This review aims to give a wide overview of the state of health informatics and offer insights that can guide strategic decision-making in healthcare settings.

2. Literature Review

Health informatics is a fast-developing field that includes the intersection of healthcare, information technology, and data science. Numerous studies have been conducted to investigate the current trends and challenges in health informatics. This literature review summarizes a selection of these studies to provide a comprehensive overview of the field.

A study by Nelson et al. (2013) examined the use of EHRs in healthcare delivery. The authors highlighted the benefits of EHRs, such as improved clinical decision-making and more efficient care delivery. However, they also identified challenges related to data security, interoperability,

and user acceptance. The study emphasized the need for standardization and integration of EHR systems to maximize their potential benefits.

Similarly, a study by Lai et al. (2017) explored the role of health information exchange (HIE) in refining care management and patient outcomes. The authors discussed the importance of HIE in facilitating the seamless sharing of patient information across different healthcare surroundings. However, they outlined challenges related to privacy concerns, data quality, and regulatory barriers. The study highlighted the need for stronger governance structures and guidelines to support the effective implementation of HIE initiatives.

Other studies have focused on emerging technologies in health informatics, such as AI and machine learning. For example, a study by Haux (2010) investigated the potential applications of AI in healthcare, including diagnostic support, personalized medicine, and predictive analytics. The authors discussed the benefits of AI in improving the accuracy and efficiency of clinical decision-making. However, they also raised concerns about issues related to data bias, explainability, and ethical considerations. The study underscored the importance of developing robust governance frameworks and transparency measures to address these challenges.

In addition to technology-driven trends, research has also explored the impact of sociocultural factors on health informatics. A study by Esmailzadeh et al. (2010) examined the influence of organizational culture on the adoption and use of health information systems. The authors found that organizational culture can shape user behaviors, attitudes, and perceptions towards technology. They emphasized the importance of fostering a supportive culture that promotes collaboration, communication, and innovation in healthcare organizations.

Cresswell (2015) examined the implementation of EHRs in healthcare organizations and found that while EHRs offer numerous benefits, such as improved data accessibility and accuracy, their implementation can be challenging and time-consuming. The study highlighted the importance of proper training and support for healthcare professionals to effectively utilize EHR systems and maximize their potential benefits.

The utilization of mobile health (mHealth) technology to enhance chronic disease self-management and patient participation was the main emphasis of the study by Schwartz et al. (2020). According to the study, mHealth applications can be useful resources for patients to monitor their health indicators, get tailored suggestions for medical treatment, and connect with medical professionals. However, the study also pointed out the need for rigorous evaluation of mHealth informatics research by Narasimhamurthy (2017), who explored the use of AI and machine learning algorithms in healthcare policymaking. The study highlighted the potential of AI to automate data analysis, predict patient outcomes, and identify patterns in healthcare data. The study does, however, also bring up ethical issues related to data protection and algorithmic decision-making when utilizing AI in healthcare.

3. Methodology

The methodology of this systematic review involved conducting a comprehensive search of the literature to identify relevant studies on current trends and challenges in health informatics. The search was conducted in online databases, including PubMed, Scopus, and Web of Science, using search terms related to health informatics, trends, challenges, and key concepts such as electronic health records, telemedicine, mHealth, big data, artificial intelligence, and precision medicine.

After identifying the relevant studies, a screening process was conducted to include only those studies that met the inclusion criteria, which included being published in the last eleven years and focusing on trends and challenges in health informatics. After removing duplicate research, the titles and abstracts of the remaining papers were used to determine their relevance.

The selected studies were then reviewed in detail, and data were extracted on the key trends and challenges identified in each study. These data were synthesized and scrutinized to identify common themes and arrangements across the studies. The findings were then summarized, and implications for future research and practice were discussed.

The methodology used in this systematic review allowed for a comprehensive examination of the current trends and challenges in health informatics, providing valuable insights and recommendations for researchers, practitioners, and policymakers in the field.

4. Results and Discussion

4.1 Overview of Health Informatics

4.1.1 Definition and Scope

Health informatics is an interdisciplinary field that utilizes information technology, data analytics, and communication systems to improve healthcare delivery, patient outcomes, and overall healthcare management (Massoudi, 2017). It covers a wide range of tools and approaches, including EHRs, telemedicine, health apps, data analytics, and artificial intelligence. The scope of health informatics is vast, covering areas such as clinical informatics, public health informatics, nursing informatics, and bioinformatics.

4.1.2 Evolution and Growth

Recent technological breakthroughs, shifting healthcare demands, and a greater focus on data-driven decision-making have all contributed to the rapid rise and growth of health informatics (Holzinger, 2016). Healthcare practitioners used to rely on manual procedures and paper-based records, which resulted in mistakes and inefficiencies. The delivery and administration of healthcare have changed dramatically with the advent of EHRs and other digital health technologies.

The adoption of health informatics technologies has been steadily increasing across healthcare settings, from hospitals and clinics to research institutions and public health organizations (Fang, 2016). The market for health informatics solutions is projected to continue growing, with a wide range of new technologies and applications emerging to meet the evolving needs of the healthcare industry.

4.1.3 Importance in Healthcare

The field of health informatics is essential to raising the standard, security, and effectiveness of healthcare. Healthcare professionals are able to analyze patient outcomes over time, tailor treatment approaches, and make better educated judgments by collecting, storing, and analyzing massive volumes of patient data (Damaj, 2020). Predictive analytics, for instance, can assist in identifying individuals who may be more susceptible to specific ailments or consequences, allowing for preemptive measures and preventive therapy.

Moreover, health informatics helps healthcare teams collaborate and communicate more easily, which improves care coordination and lowers medical mistakes (Gülkesen, 2019). Patients can obtain healthcare services from any location with the use of telemedicine and remote

monitoring technology, which enhances accessibility to care and lowers treatment-related obstacles.

Research has shown that the adoption of health informatics tools and strategies can result in improved patient outcomes, increased patient engagement, and cost savings for healthcare organizations (Luna et al., 2014). Studies have also demonstrated the potential of artificial intelligence in diagnosing diseases, predicting treatment responses, and streamlining administrative processes.

4.2 Current Trends in Health Informatics

4.2.1 Electronic Health Records (EHR)

HER have transformed healthcare delivery by enabling healthcare workers to store and share patient data digitally. EHR systems offer benefits such as increased efficiency, improved data accuracy, and better care coordination (Masic, 2013). However, challenges like interoperability, data security, and usability still exist in EHR implementation.

One study by Ravì et al. (2016) found that healthcare organizations faced difficulties in exchanging EHR data due to a lack of standardization and varying EHR systems. Additionally, concerns about data breaches and patient privacy have been raised, highlighting the importance of robust security measures in EHR platforms.

4.2.2 Telemedicine and Telehealth

Telemedicine and telehealth technologies have gained popularity, especially in the wake of the COVID-19 pandemic, enabling remote consultations and monitoring of patients. These technologies have been shown to improve access to healthcare services, reduce healthcare costs, and increase patient satisfaction (Alsulame, 2015). However, challenges such as reimbursement issues, regulatory barriers, and the digital divide still hinder the widespread adoption of telemedicine.

A study by Demiris (2016) highlighted the regulatory complexities associated with telemedicine practice across different states, limiting its scalability. Moreover, disparities in internet connectivity and access to digital devices pose challenges for underserved populations in accessing telehealth services.

4.2.3 Artificial Intelligence in Healthcare

With its ability to analyze vast volumes of data, forecast patient outcomes, and support clinical decision-making, artificial intelligence (AI) holds the potential to revolutionize the delivery of healthcare. AI applications in image identification, natural language processing, and predictive analytics have demonstrated encouraging effects in terms of increasing treatment outcomes and diagnostic accuracy (Demiris, 2016). Nonetheless, worries about algorithmic bias, data privacy, and the moral implications of AI in healthcare continue.

A study by Gülkesen et al. (2019) demonstrated the effectiveness of AI algorithms in diagnosing skin cancer with accuracy comparable to dermatologists. While AI has shown great potential in augmenting healthcare delivery, ensuring transparency and ethical use of AI algorithms remains a critical challenge.

4.2.4 Wearable Technology

Wearable technology devices, such as smartwatches and fitness trackers, have gained popularity for monitoring health metrics, promoting physical activity, and tracking chronic

conditions. These devices offer real-time data collection, personalized feedback, and continuous monitoring, empowering individuals to take control of their health (Luna, 2014). However, challenges related to data accuracy, data privacy, and data integration into healthcare systems need to be addressed for the widespread adoption of wearable technology in healthcare.

A study by Masic (2013) found that wearable devices could accurately measure heart rate but showed discrepancies in tracking calorie expenditure. Moreover, concerns about data security and sharing wearable device data with healthcare providers raise issues around trust and privacy.

4.2.5 Internet of Things (IoT) in Healthcare

The Internet of Things (IoT) has enabled the connectivity of medical devices, sensors, and healthcare systems to gather real-time data, monitor patient health, and automate healthcare processes (Ravi, 2016). IoT applications in healthcare, such as remote patient monitoring, medication adherence tracking, and smart hospitals, offer opportunities for personalized and efficient healthcare delivery. However, in order to guarantee the secure and efficient use of IoT in healthcare, issues with cybersecurity, interoperability, and regulatory compliance must be resolved.

A study by Narasimhamurthy (2017) highlighted the potential of IoT-enabled remote patient monitoring devices in improving chronic disease management and reducing healthcare costs. Despite the benefits of IoT in healthcare, concerns about data privacy and security vulnerabilities in IoT devices underscore the need for robust cybersecurity measures.

4.3 Challenges in Health Informatics

4.3.1 Data Security and Privacy Concerns

One of the most pressing challenges in health informatics is ensuring the security and privacy of patient data. Healthcare organizations collect a vast amount of sensitive information, including medical histories, test results, and insurance details, which must be protected from unauthorized access and data breaches (Massoudi, 2017). Recent studies have shown that healthcare data breaches are on the rise, with cyber-attacks and insider threats posing significant risks to patient privacy. For example, the 2017 WannaCry ransomware attack targeted healthcare organizations worldwide, compromising patient records and causing significant disruptions to healthcare services (Damaj, 2020).

Healthcare companies must put strong cybersecurity safeguards in place, such as encryption, access limits, and frequent security audits, to allay these worries. To guarantee that patient data is always safeguarded, healthcare personnel also need to be taught the best practices for data security and privacy (Fang, 2016). Organizations can reduce the risks associated with illegal access and data breaches by investing in safe health informatics systems and highlighting the significance of data security.

4.3.2 Interoperability Issues

Interoperability, or the capacity of various healthcare systems and applications to interchange and utilize data, is another significant difficulty in the field of health informatics. Laboratory information systems, EHRs and billing software are just a few of the many systems that healthcare companies frequently utilize. These systems might not be compatible with one another (Holzinger, 2016). This lack of interoperability can result in fragmented patient data, duplication of efforts, and errors in clinical decision-making.

To improve interoperability, healthcare organizations need to adopt homogenous data formats and procedures, such as Fast Healthcare Interoperability Resources (FHIR) (Saranummi, 2012). By implementing interoperable systems and promoting data sharing among healthcare providers, organizations can improve the continuity of care and enhance the overall efficiency of healthcare delivery.

4.3.3 Regulatory Compliance

To preserve patient privacy and guarantee data security, health informatics systems need to go by a number of legal standards, including HIPAA. Healthcare firms that violate these standards risk serious fines and harm to their reputation (Marc, 2019). The significance of regulatory compliance in health informatics has also increased with the adoption of new legislation, such as the General Data Protection Regulation (GDPR), in Europe. To make sure that their procedures and systems comply with all applicable laws and guidelines, healthcare institutions need to spend money on resources and training (Goldberg, 2011).

4.3.4 Adoption and Implementation Challenges

The adoption and implementation of health informatics systems can be difficult because of several issues, including resistance to alteration, lack of training, and financial constraints. Healthcare professionals may be reluctant to embrace new technologies or workflows, leading to inefficiencies and resistance to system adoption (Alsulame, 2015). Furthermore, the high costs associated with implementing health informatics systems can be a barrier for many organizations, particularly small healthcare providers.

To overcome these challenges, healthcare organizations should provide wide-ranging training and backing to staff members to ensure a smooth changeover to new structures (Esmaeilzadeh, 2010). Additionally, organizations can explore funding opportunities and cost-saving strategies, such as cloud-based solutions and software as a service (SaaS) models, to reduce the financial burden of system implementation.

4.3.5 Ethical Considerations

Health informatics raises important ethical considerations related to patient autonomy, confidentiality, and equity in healthcare delivery (Panayides, 2020). For example, the use of AI algorithms in clinical decision-making may raise concerns about biases, transparency, and accountability (Cresswell et al., 2015). Healthcare administrations must ensure that AI systems are developed and deployed ethically and responsibly to avoid potential harm to patients.

Furthermore, the collection and use of patient data in health informatics systems raise ethical questions about consent, control, and data ownership. According to Haut (2010), patients have the right to know how their data is being used and to decide who can access it. In order to safeguard patient rights and foster confidence in health informatics systems, healthcare institutions are required to comply with ethical rules and best practices.

In summary, the current trends and challenges in health informatics stress the significance of addressing data safety and confidentiality concerns, improving interoperability, ensuring regulatory compliance, overcoming adoption and implementation challenges, and addressing ethical considerations (Masic, 2013). By addressing these challenges proactively and collaboratively, healthcare administrations can harness the full potential of health informatics to improve patient outcomes, enhance care coordination, and drive innovation in healthcare delivery.

4.4 Future Directions

4.4.1 Emerging Technologies in Health Informatics

Health informatics is witnessing a rapid evolution due to the emergence of various technologies that have the potential to transform healthcare delivery (Lai, 2017). The application of ML and AI algorithms is one of the major technologies driving major advancements in health informatics. In fields like clinical decision support systems, personalized medicine, and predictive analytics, these technologies have demonstrated a lot of potential (Panayides, 2020). AI and ML systems, for instance, may evaluate enormous datasets to find trends and forecast patient outcomes, enabling medical professionals to make better choices.

Another emerging technology in health informatics is the Internet of Things (IoT), which involves interconnected devices and sensors that can collect real-time data and transmit it to healthcare systems (Schwartz, 2020). IoT devices may measure medication adherence, keep an eye on patient vitals, and offer remote patient monitoring, all of which can enhance population health management and patient outcomes.

Blockchain technology is also gaining traction in health informatics, particularly in areas such as secure data sharing, interoperability, and ensuring data integrity (Nelson, 2013). Blockchain offers a decentralized and transparent way to store and share healthcare data securely while also ensuring data privacy and security compliance.

4.4.2 Potential Solutions to Address Challenges

Despite the advancements in health informatics, there are still challenges that need to be addressed, such as interoperability issues, data privacy concerns, and the need for standardized data formats (Kim, 2018). To address these challenges, collaborations between stakeholders in the healthcare industry, including healthcare providers, technology vendors, and policymakers, are essential. Better data sharing and exchange can result in improved care coordination and patient outcomes. This can be achieved by standardizing data formats and guaranteeing interoperability across various healthcare systems (Dixon, 2015).

Moreover, implementing strong data security measures, including access limits and encryption, can assist in addressing data privacy issues and guaranteeing patient confidentiality (Cresswell, 2015). Building confidence between patients and healthcare professionals about the use of health informatics tools may also be facilitated by establishing clear policies and procedures around data sharing and privacy.

4.4.3 Opportunities for Research and Innovation

There are numerous opportunities for research and innovation in the field of health informatics. One area of research that holds great promise is the use of genomics and precision medicine to personalize patient care (Demiris, 2016). Healthcare professionals may customise treatment strategies for each patient based on their genetic composition by utilising genomics data and sophisticated analytics, which will result in more efficient and focused therapy.

Additionally, research into the integration of wearable devices and mobile health applications into healthcare delivery can lead to improved patient engagement and outcomes (Gülkesen, 2019). Wearable devices can track patient activity, monitor vital signs, and provide real-time feedback to healthcare providers, enabling proactive interventions and more personalized care.

Additionally, investigating the possibilities of telemedicine and telehealth technology might increase access to medical treatment, particularly in disadvantaged rural areas (Luna, 2014). By enabling remote monitoring, telemedicine, and virtual consultations, telehealth systems can lower barriers to treatment and increase access to healthcare.

5. Conclusion

In conclusion, this review highlights the current trends and challenges in health informatics. The study has identified a variety of trends, including the increasing use of electronic health records, big data analytics, artificial intelligence, and telemedicine in healthcare. These trends are shaping the way healthcare providers deliver care and manage patient information.

However, these developments also bring with them a number of issues that need to be resolved. These difficulties include worker training, regulatory compliance, data privacy and security concerns, and interoperability problems. It is crucial for healthcare organizations to invest in solutions that address these challenges and optimize the use of health informatics technologies.

Overall, health informatics has the potential to transform healthcare delivery and improve patient results. By staying abreast of current trends and addressing the challenges associated with health informatics, healthcare organizations can leverage technology to provide better patient care and enhance operational efficiency.

References

- Alsulame, K., Khalifa, M., & Househ, M. S. (2015). eHealth in Saudi Arabia: Current Trends, Challenges and Recommendations. *ICIMTH*, 213, 233-236.
- Cresswell, K. M., & Sheikh, A. (2015). Health information technology in hospitals: current issues and future trends. *Future Hospital Journal*, 2(1), 50.
- Damaj, I. W., Iraqi, Y., & Mouftah, H. T. (2020). Modern development technologies and health informatics: Area transformation and future trends. *IEEE Internet of Things Magazine*, 3(4), 88-94.
- Dixon, B. E., Kharrazi, H., & Lehmann, H. P. (2015). Public health and epidemiology informatics: recent research and trends in the United States. *Yearbook of medical informatics*, 24(01), 199-206.
- Demiris, G. (2016). Consumer health informatics: past, present, and future of a rapidly evolving domain. *Yearbook of medical informatics*, 25(S 01), S42-S47.
- Esmaeilzadeh, P., Sambasivan, M., & Kumar, N. (2010, September). The challenges and issues regarding e-health and health information technology trends in the healthcare sector. In *International Conference on E-business Technology and Strategy* (pp. 23-37). Berlin, Heidelberg: Springer Berlin Heidelberg.
- Fang, R., Pouyanfar, S., Yang, Y., Chen, S. C., & Iyengar, S. S. (2016). Computational health informatics in the big data age: a survey. *ACM Computing Surveys (CSUR)*, 49(1), 1-36.
- Goldberg, L., Lide, B., Lowry, S., Massett, H. A., O'Connell, T., Preece, J., ... & Shneiderman, B. (2011). Usability and accessibility in consumer health informatics: current trends and future challenges. *American journal of preventive medicine*, 40(5), S187-S197.
- Gülkesen, K. H., & Haux, R. (2019). Research subjects and research trends in medical informatics. *Methods of Information in Medicine*, 58(S 01), e1-e13.
- Haux, R. (2010). Medical informatics: past, present, future. *International journal of medical informatics*, 79(9), 599-610.
- Holzinger, A. (2016). *Machine learning for health informatics* (pp. 1-24). Springer International Publishing.
- Kim, Y. M., & Delen, D. (2018). Medical informatics research trend analysis: a text mining approach. *Health informatics journal*, 24(4), 432-452.
- Luna, D., Almerares, A., Mayan, J. C., de Quirós, F. G. B., & Otero, C. (2014). Health informatics in developing countries: going beyond pilot practices to sustainable implementations: a review of the current challenges. *Healthcare informatics research*, 20(1), 3-10.
- Lai, A. M., Hsueh, P. Y., Choi, Y. K., & Austin, R. R. (2017). Present and future trends in consumer health informatics and patient-generated health data. *Yearbook of medical informatics*, 26(01), 152-159.
- Massoudi, B. L., & Chester, K. G. (2017). Public health, population health, and epidemiology informatics: recent research and trends in the United States. *Yearbook of medical informatics*, 26(01), 241-247.

- Marc, D., Butler-Henderson, K., Dua, P., Lalani, K., & Fenton, S. H. (2019). Global workforce trends in health informatics & information management. In MEDINFO 2019: Health and Wellbeing e-Networks for All (pp. 1273-1277). IOS Press.
- Masic, I. (2013). The history and new trends of medical informatics. *Donald School J Ultrasound Obstet Gynecol*, 7(3), 301-302.
- Nelson, R., & Staggers, N. (2013). *Health informatics: An interprofessional approach*. Elsevier Health Sciences.
- Narasimhamurthy, A. (2017). An overview of machine learning in medical image analysis: Trends in health informatics. *Medical imaging: Concepts, methodologies, tools, and applications*, 36-58.
- Panayides, A. S., Amini, A., Filipovic, N. D., Sharma, A., Tsiftaris, S. A., Young, A., ... & Pattichis, C. S. (2020). AI in medical imaging informatics: current challenges and future directions. *IEEE journal of biomedical and health informatics*, 24(7), 1837-1857.
- Ravi, D., Wong, C., Deligianni, F., Berthelot, M., Andreu-Perez, J., Lo, B., & Yang, G. Z. (2016). Deep learning for health informatics. *IEEE journal of biomedical and health informatics*, 21(1), 4-21.
- Schwartz, D. G., McGrath, S. P., Monsen, K. A., & Dixon, B. E. (2020). Current approaches and trends in graduate public health informatics education in the United States: four case studies from the field. *Online Journal of Public Health Informatics*, 12(1).
- Saranummi, N. (2012). World Trends in Health Informatics: 'Case Europe'. *Transactions of Japanese Society for Medical and Biological Engineering*, 50(6), 504-509.