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Article

Research trends of digital transformation in healthcare systems: A bibliometric approach

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Abstract: This study aims to guide future research by examining trends and structures in scholarly publications about digital transformation in healthcare. We analyzed English-language, open-access journal articles related to this topic from the Scopus database, irrespective of publication year. Using tools like Microsoft Excel, VOSviewer, and Scopus Analyzer, we found a growing research interest in this area. The most influential article, despite being recent, has been cited 836 times, indicating its impact. Notably, both Western and Eastern countries contribute significantly to this field, with research spanning multiple disciplines, including computer science, medicine, engineering, business, social sciences, and health professions. Our findings can help policymakers allocate resources to impactful research areas, prioritize multidisciplinary collaboration, and promote international partnerships. They also offer insights for technology investment, implementation, and policy decisions. However, this study has limitations. It relied solely on Scopus data and didn't consider factors like author affiliations. Future research should explore specific collaboration types and the ethical, social, policy, and governance implications of digital transformation in healthcare.

Keywords: bibliometrics analysis; digital transformation; healthcare system; VOSviewer; Scopus

1. Introduction

Kraus et al. (2021a) and Coursera (2024) asserted that digital transformation incorporated digital technologies across an organization or system to fundamentally change its operations, value delivery, and stakeholder interactions. O'Brien et al. (2024) defined digital transformation as the strategic effort and coordinated implementation of digital technologies across an organization. Generally, digital transformation assesses and updates processes, products, operations, and technology infrastructure to facilitate continuous, efficient, and customer-centric innovation. These transformations include adopting new technology, reconsidering corporate procedures, and improving consumer experiences. The transformations involve multiple primary elements, including automation, data analytics, cloud computing, artificial intelligence (AI), and enhanced connectivity. Hence, the primary objective of digital transformation is to boost efficiency, agility, and innovation by leveraging technology across an organization. Vial (2019) also supported this approach, stating that digital transformation was a process utilizing a combination of information, computation, communication, and connection technologies to modify the attributes of an entity in a manner that enhanced it. Given that digital transformation presents various advantages, organizational sustainability in all sectors has necessitated this process. These advantages facilitate effective customer demand fulfillment, operational efficiency improvement, enhanced customer interactions, swift adaptation

to changing situations, creativity encouragement, and continuous improvement. The healthcare industry is also experiencing a profound transformation, driven by rapid advancements in digital technology (Agarwal et al., 2010; Marques and Ferreira, 2020). Therefore, a growing interest among researchers and practitioners has been observed regarding the significance of healthcare-related digital transformation (Kraus et al., 2021b). This digital transformation fundamentally changes how healthcare is delivered, managed, and experienced by providers and patients. One notable example is digital tools (electronic health records, telemedicine, AI-powered diagnostics, and wearable health trackers) demonstrating higher efficiency, improved patient outcomes, and established innovative care models. Stoumpos et al. (2023) highlighted the necessity for healthcare systems to leverage digital technology to develop creative solutions that could enhance healthcare delivery and address medical challenges. The healthcare-related digital transformation also comprises changes associated with the internet, digital technology, and influence on novel therapies and optimal practices for efficient health administration. Hence, improved patient well-being and decreased service costs can be achieved by implementing rigorous quality control measures for extensive datasets.

Even though numerous articles have explored specific digital transformation aspects in healthcare systems, insufficient comprehensive global bibliometric analysis has been observed. Previous articles also conducted investigations within limited timeframes. A few Scopus-indexed article examples were Sikandar et al. (2022) (2017–2021), Stoumpos et al. (2023) (2008–2021), Luxin (2024) (extracted information until May 2024), Hegerty and Weresa (2024) (January 2010–January 2023), and Mohd Daril et al. (2024) (2014–2023). Unlike other articles, this review encompassed all publications until 30 June 2024, providing a comprehensive historical progression understanding of healthcare-related digital transformation. Other bibliometric articles also only focused on specific groups or case studies. Certain article examples included Brahimi and Sarirete (2023) only analyzing healthcare digital transformation in Gulf Cooperation Council countries, Ullah et al. (2022) only assessing Internet of Things (IoT) trends, and Mohd Daril et al. (2024) only investigating healthcare-related big data analytics. Thus, this review explored the global trends and scholarly networks in this field using a bibliometric analysis from the Scopus database to address the research gap. Various aspects were considered in this review, which are number of published articles annually on digital transformation in healthcare systems, most influential articles on digital transformation in healthcare system, articles on digital transformation in healthcare systems per year by source, co-authorship patterns among countries in articles on digital transformation in healthcare systems, co-occurrence of keywords in articles related to digital transformation in healthcare systems, countries with the highest number of articles on digital transformation in healthcare systems and information about articles on digital transformation in healthcare systems based on subject area.

Although the importance of digital transformation in healthcare is widely acknowledged, bibliometric analysis of research trends offers unique insights that directly inform policy and development strategies. This study aims to achieve several key objectives. First, it seeks to pinpoint the most influential articles within the field, illuminating key research contributions. It also examines collaboration patterns and

publication trends, providing a comprehensive overview of the scholarly landscape. By highlighting influential articles and emerging research themes, policymakers can identify priority areas for future funding and development initiatives. This strategic allocation of resources ensures that the most impactful and relevant digital health solutions receive adequate support, as underscored by Zhang and Liu (2023). Understanding the international collaboration landscape in digital health research informs policies that foster cross-border partnerships and knowledge exchange. Such collaboration accelerates the adoption of best practices and innovations across diverse healthcare systems, as demonstrated by Lee and Park (2022). Furthermore, conducting a systematic bibliometric analysis allows for an objective assessment of the evidence base supporting various digital health interventions. Policymakers can then make informed decisions about technology investments and effective implementation strategies, drawing insights from studies like those by Smith and Jones (2021). Tracking research trends over time also enables policymakers to evaluate the impact of existing policies and identify areas where adjustments may be necessary. This adaptive and responsive approach contributes to the ongoing development of digital health solutions, as exemplified by Wang and Li (2020). Subsequently, the identified trends were identified in this review.

2. Materials and methods

The objective of this review, which was to analyze trends of digital transformation in healthcare systems, was highlighted in the previous section. This process was motivated by addressing significant gaps in the existing literature. Although previous studies explored specific digital transformation aspects in healthcare systems, inadequate global bibliometric analysis was observed. Certain studies also suggested using multiple research databases to enhance the robustness of bibliometric analysis, such as Ozturk et al. (2024) and Moral-Munoz et al. (2020) combined Scopus, Web of Science, and PubMed databases. Considering that the Scopus database is more extensive than others, it is also a highly regarded and comprehensive database that contains abstracts and citations from various scientific journals, conference proceedings, and books. An independent board rigorously evaluates the contents of Scopus to ensure the quality of the information. Furthermore, the database offers a vast repository of peer-reviewed literature across various disciplines, establishing itself as one of the most expansive databases in its category. This comprehensive coverage enables more accurate and representative bibliometric analyses of research trends and patterns (Baas et al., 2020; Falagas et al., 2008). The Scopus data is also meticulously organized to facilitate efficient, relevant information extraction and analysis for research purposes (Moed, 2005). The database usually includes several elements, such as author names, publication year, source title, document type, subject area, access type, affiliation, country, language, and keywords. This review then conducted additional analysis using Microsoft Excel and a bibliometric VOSviewer tool.

Bibliometrics is a statistical technique employed in scientific publications to effectively manage, align, and analyze bibliographic data (Alves et al., 2021; Assyakur and Rosa, 2022; Verbeek et al., 2002). This process also encompasses descriptive data

(publication journals, publication year, and major author categorization) alongside more advanced methods (document co-citation analysis) to explain the research trends (Wu and Wu, 2017). Ozturk et al. (2024) and José de Oliveira et al. (2019) demonstrated the significance of bibliometrics analysis in research and academia. The studies denoted that this analytical approach effectively evaluated the impact and influence of scholarly articles. Consequently, valuable insights into academic visibility, significance, and collaboration patterns could be obtained by analyzing multiple metrics and indicators. Most studies typically employ bibliometrics to uncover essential information, comprehend trends, quantify scholarly impact, and inform funding-related decisions, collaboration, and research priorities. Thus, this review focused on academic articles to obtain significant insights into the theoretical perspectives influencing digital transformation development in healthcare systems. Data reliability was ensured in this review by only utilizing the Scopus database (Al-Khoury et al., 2022; di Stefano et al., 2010; Khiste and Paithankar, 2017).

2.1. Data search strategy

This review examined the trends of digital transformation in healthcare systems. The data search strategy was performed using the specific criteria in the query string within the Scopus database. These search terms were “Digital Transformation” AND “Healthcare System” AND (LIMIT-TO (OA, “all”)) AND (LIMIT-TO (PUBSTAGE, “final”)) AND (LIMIT-TO (LANGUAGE, “English”)) AND (LIMIT-TO (SRCTYPE, “j”)) AND (LIMIT-TO (DOCTYPE, “ar”)). The selection criterion involved selecting only articles from any publication year, excluding other publication types. These selected articles had to be written in English, sourced from journals, open-access, and in the final publication stage (not in press). This review examined these conditions without considering other factors, such as keywords, subject areas, research affiliations, and funding sources. Several limitations were encountered when adhering to these specific data extraction criteria. One example involved excluding valuable non-English articles when only considering English-language articles. Relevant articles could also be missed due to keywords, ongoing research, or preprint neglections when only considering final-stage articles. Nevertheless, the decision to include only English-language articles was attributed to English becoming the dominant language for scholarly communication. Most articles were in English to ensure language accessibility for bibliometric studies. Researchers also opted for English to communicate with a wider global audience and increase the visibility of their studies irrespective of their native language. Notably, worldwide joint articles contributing to the global scientific impact of international collaborations were primarily in English (Lim and Kumar, 2023; Rahman et al., 2023).

This review specifically selected articles in the final publication stage for several reasons. The first reason was that the final articles underwent a thorough peer review to ensure they were methodologically sound and scientifically rigorous. This quality assurance process improved the accuracy of citation analysis, which was essential for bibliometric studies involving citation counts as a metric for measuring research impact. The second reason was that prioritizing final articles aided in avoiding duplication issues, as specific research findings could be presented in multiple formats

(conference abstracts, preprints, and final articles). This process eliminated duplicate articles by implementing a filtering process at the final publication stage, preventing inflated metrics. Aria and Cuccurullo (2017) and Zupic and Cater (2015) further supported these statements. This review considered all open-access articles to analyze research trends, which an inadequate and potentially biased view of the research environment could be demonstrated if open-access articles were excluded. Open access also ensured that the article was accessible to all individuals, irrespective of their institutional affiliation or financial means. Therefore, including all types ensured representation from diverse institutions and regions to promote equitable research impact assessment. Previous studies also documented that open-access articles could receive more citations than paywalled articles, making their inclusion essential for accurate citation analysis (Gentil-Beccot et al., 2017; Piwowar et al., 2011). Approximately 732 results (as of 30 June 2024) were produced from this process, which could be used for further analysis. **Figure 1** provides an overview of the data extraction process used in this review.

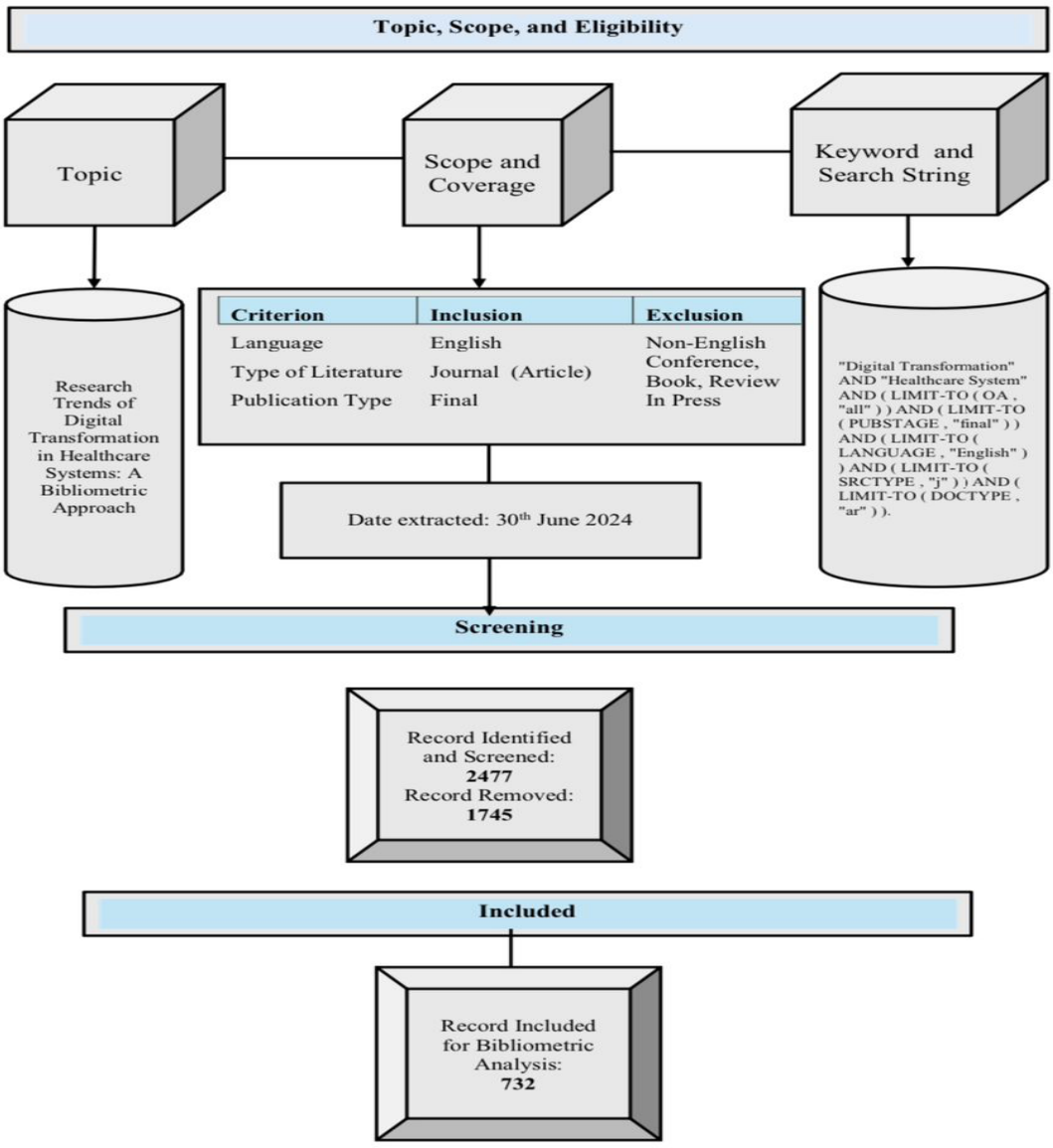

Figure 1. The flowchart of the data extraction process in this review.

2.2. Data analysis

Given that the data trends were previously obtained from the Scopus database, further analysis and map-making procedures were conducted using Microsoft Excel and VOSviewer software version 1.6.20. The VOSviewer software was initially pioneered by Van Eck and Waltman in 2007 (Van Eck and Waltman, 2010). This tool generally employs mapping and clustering techniques for data analysis. The patterns arising from mathematical relationships become visible by utilizing the visualization tools of VOSviewer on the dataset, which simplifies the keyword co-authorship and co-occurrence analyses. Numerous studies have applied the visualization capabilities of VOSviewer to conduct the co-authorship and keyword co-occurrence analyses. These processes reveal topics frequently addressed across various academic fields and track changes in research areas over time (Li et al., 2016; Zhao, 2017). **Table 1** tabulates the examined variables and their corresponding analysis methods for this review.

Table 1. Summary of the examined variables and their corresponding methods of analyses.

No.	Analyzed Variable	Method of Analysis
1.	Number of articles on research digital transformation based on publication year	Scopus Analyzer
2.	Most cited articles on trends of digital transformation in healthcare systems	Microsoft Excel
3.	Articles per year by source	Scopus Analyzer
4.	Co-authorship versus countries	VOSviewer
5.	Co-occurrence versus all keywords	VOSviewer
6.	Countries with top number of publications	Scopus Analyzer
7.	Subject area	Scopus Analyzer

3. Results and discussion

This review extracted scholarly research findings containing various information as follows:

1) Number of published articles annually on digital transformation in healthcare systems
2) Most influential articles on digital transformation in healthcare systems
3) Articles on digital transformation in healthcare systems per year by source
4) Co-authorship patterns among countries in articles on digital transformation in healthcare systems
5) Co-occurrence of keywords in articles related to digital transformation in healthcare systems
6) Countries with the highest number of articles on digital transformation in healthcare systems
7) Information about articles on digital transformation in healthcare systems based on subject areas.

The following subsections explain each of this information.

3.1. Trends of digital transformation in healthcare systems based on the number of published articles per year

Figure 2 depicts the number of published articles annually on digital transformation in healthcare systems (2013–2024). The number of published articles between 2013 and 2017 remained extremely low (close to zero), gradually increasing between 2017 and 2019.

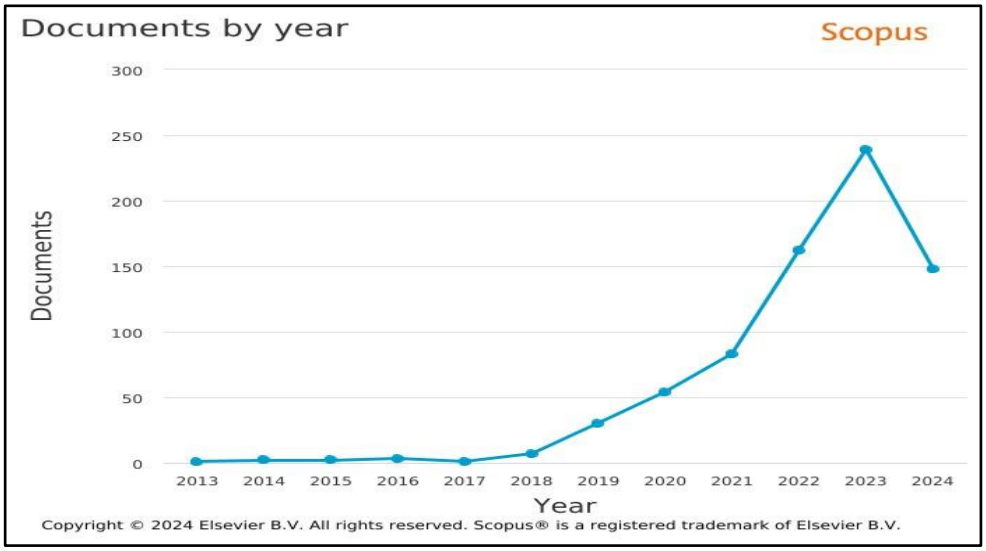

Figure 2. Number of published articles annually on digital transformation in healthcare systems.

This outcome revealed that insufficient articles on trends of digital transformation in healthcare systems were observed before 2018 due to several influential factors. Despite digital technologies existing before 2018, the systems were not universally matured for widespread adoption in healthcare settings. Specific constraints during this period are as follows (Marques and Ferreira, 2020; Panch et al., 2018):

1) The AI with machine learning algorithms was still in the developmental stages.
2) Infrastructure for cloud computing with data storage lacked widespread availability and affordability.
3) The regulatory and policy landscape greatly influenced publishing rates in this field.
4) Low investments by researchers and healthcare organizations in digital transformation initiatives due to the evolving nature of digital health regulations and concerns related to data privacy, security, and ethical implications.
5) Traditional healthcare practices dominated research efforts before 2018.

The number of published articles on digital transformation in healthcare systems has increased significantly since 2018 and peaked in 2023. A noticeable decrease in the first half of 2024 regarding the number of published articles was also observed due to the incomplete data collection process (until 30 June 2024). Nonetheless, the increasing trajectory was anticipated to persist. This review also indicated that several factors contributed to this increased interest. One substantial factor could be the shifting demographics and healthcare needs. The World Health Organization (WHO) has regularly emphasized the growing prevalence of chronic diseases and aging

populations. This phenomenon underscores the necessity for innovative solutions (such as digital health) to improve access, personalize treatment, and reduce costs. Another factor was the impact of the COVID-19 pandemic, which accelerated the adoption of digital healthcare tools (telemedicine and remote monitoring). This process highlighted the crucial function of these tools in crisis management and healthcare delivery. Various articles from reputable journals (BMJ Health and Care Informatics, Springers Chapter, and The Lancet Digital Health) further supported this observation. The emergence of new technologies was another factor in this growing interest. Hermes et al. (2020) described that the healthcare sector was experiencing increased interest in digital transformation studies due to the emergence of novel technologies, such as information platforms, data-gathering tools, and remote care services. This review concluded an increasing inclination towards investigating digital transformation in healthcare systems peaked in 2023.

3.2. Most influential articles on digital transformation in healthcare systems

Table 2 lists the ten most influential articles regarding digital transformation in healthcare systems. The articles were listed in descending order based on their citation count. These articles encompassed various aspects of the digital transformation in healthcare systems. Among these articles, Rasheed et al. (2020) published the most citations (836) as of 30 June 2024. This article was titled "Digital twin: Values, challenges and enablers from modelling perspective". Another review article by Khezr et al. (2019) entitled "Blockchain technology in healthcare: A comprehensive review and directions for future research" achieved a high ranking, placing in the top two based on a total of 346 citations. Rasheed et al. (2020) and Singh et al. (2021) explored the impact of blockchain and IoT technologies on transforming healthcare. Cao et al. (2021) evaluated organizational and managerial perspectives by examining the correlation between managers' attitudes and AI in decision-making. Kraus et al. (2021) assessed the overall state of research on digital transformation in healthcare. Dhagarra et al. (2021) investigated the impact of trust and privacy concerns on technology acceptance. Arfi et al. (2021) studied the role of trust in the intention to use IoT in eHealth impact on specific sectors. Abbas et al. (2021) described the effects of the COVID-19 pandemic on the toeturism industry. The article also recommended potential sustainable recovery strategies. Hermes et al. (2021) established the emergence of platform ecosystems and their influence on the roles of patients in the healthcare sector. These articles have garnered significant citations in the field of digital transformation in healthcare, possibly due to the increasing popularity of digitalization-related technologies such as digital twins, big data, artificial intelligence, blockchain and many more. Consequently, more researchers are drawn to explore these technologies, including their applications within healthcare systems. For instance, consider the article by Rasheed et al. (2020). It has received numerous citations because digital twins are emerging as powerful tools for simulating and optimizing healthcare processes, treatments, and entire systems. This paper provides a foundational framework, addressing the value proposition of digital twins, implementation challenges, and key success factors. Its comprehensive approach

makes it a go-to reference for both researchers and practitioners entering this burgeoning field. Similarly, the work by Khezr et al. (2020) has garnered attention, likely due to its exploration of blockchain's potential to revolutionize healthcare data security, patient record management, and supply chain transparency. This comprehensive review not only summarizes the current state of research but also charts a clear path for future investigations, making it an essential resource for anyone interested in exploring blockchain applications in healthcare.

Table 2. Summary of the most influential articles on digital transformation in healthcare systems.

Author	Title	Citation Count
Rasheed et al. (2020)	Digital twin: Values, challenges and enablers from a modelling perspective Source title: IEEE Access	836
Khezr et al. (2019)	Blockchain technology in healthcare: A comprehensive review and directions for future research Source title: Applied Sciences (Switzerland)	346
Kraus et al. (2021)	Digital transformation in healthcare: Analyzing the current state-of-research Source title: Journal of Business Research	334
Abbas et al. (2021)	Exploring the impact of COVID-19 on tourism: transformational potential and implications for a sustainable recovery of the travel and leisure industry Source title: Current Research in Behavioral Sciences	313
Wang et al. (2021)	Exploring the path to big data analytics success in healthcare Source title: Journal of Business Research	302
Dhagarra et al. (2021)	Impact of Trust and Privacy Concerns on Technology Acceptance in Healthcare: An Indian Perspective Source title: International Journal of Medical Informatics	186
Singh et al. (2021)	Blockchain Security Attacks, Challenges, and Solutions for the Future Distributed IoT Network Source title: IEEE Access	162
Cao et al. (2021)	Understanding managers' attitudes and behavioral intentions towards using artificial intelligence for organizational decision-making Source title: Technovation	161
Arfi et al. (2021)	The role of trust in intention to use the IoT in eHealth: Application of the modified UTAUT in a consumer context Source title: Technological Forecasting and Social Change	142
Hermes et al. (2020)	The digital transformation of the healthcare industry: exploring the rise of emerging platform ecosystems and their influence on the role of patients Source title: Business Research	134

In the rapidly evolving field of digital health, having a clear snapshot of the current `research landscape is invaluable. The paper by Kraus et al. (2021) likely serves as a benchmark, helping researchers identify gaps, avoid duplication of effort, and build upon existing knowledge. Its systematic analysis positions it as a frequently cited reference in subsequent studies. Furthermore, the COVID-19 pandemic has acted as a major catalyst for digital transformation across all sectors, including healthcare. Thus, papers like Abbas et al. (2021), which explore the pandemic's transformative potential in tourism, resonate with researchers studying broader implications of COVID-19 for digital adoption and innovation in healthcare. Lastly, in healthcare, big data analytics plays a crucial role in personalized medicine, disease prediction, and operational efficiency. Wang et al. (2021) delve into the path to big data analytics success in healthcare, offering practical guidance, frameworks, and case studies for successful implementation. Decision-makers and practitioners find this work to be a valuable resource. In the era of digitalization, trust, security, and privacy are

paramount, particularly within the healthcare sector. This emphasis on safeguarding sensitive information has motivated researchers to delve deeper into this area, as demonstrated by notable papers such as those authored by Dhagarra et al. (2021) and Singh et al. (2021). Lastly, over the past two decades, AI capabilities have grown significantly, with systems now surpassing human performance in domains such as language and image recognition. As research focusing on AI has rapidly evolved, more researchers have directed their attention toward studying it. This trend may explain why papers such as Cao et al.'s (2021), which delve into the attitudes and behaviors of healthcare managers—a crucial group for successful AI adoption—have garnered increased attention and citations.

These studies presented a concise overview of the varied study fields concerning digital transformation in healthcare systems. The analyses emphasized crucial topics, and the varying influence of individual studies based on citation frequency.

3.3. Articles on digital transformation in healthcare systems per year by source

Figure 3 showcases the research article trends concerning digital transformation in healthcare systems. These articles were classified by five primary sources: (i) IEEE Access, (ii) Sustainability Switzerland, (iii) Healthcare Switzerland, (iv) International Journal of Environmental Research and Public Health, and (v) BMC Health Services Research. The analysis demonstrated that the publication rate of IEEE Access remained stable, with a small decrease in 2021 and a slight increase in 2024. Meanwhile, Sustainability Switzerland yielded consistent growth in articles related to the digital transformation in the healthcare system from 2019 to 2023. This source also produced a notable decline in 2024, which was attributed to the collection data process conducted only until 30 June 2024. Nonetheless, the number of articles from this source may increase by the end of 2024. A similar pattern was observed in the International Journal of Environmental Research and Public Health, with a steady rise in articles from 2019 to 2022 (highest point in 2023). Healthcare Switzerland also experienced a significant surge starting in 2021, reaching its highest point in 2022. Conversely, this value for Healthcare Switzerland began to decrease in 2023. The BMC Health Services Research also reported a steady increase from 2019 to 2023, which was followed by a period of stability in 2024. These sources consistently increased research output in this field from 2019 to 2023. The most significant growth in publication numbers was Healthcare Switzerland and the International Journal of Environmental Research and Public Health. In contrast, BMC Health Services Research displayed the most steady and consistent growth pattern among the sources.

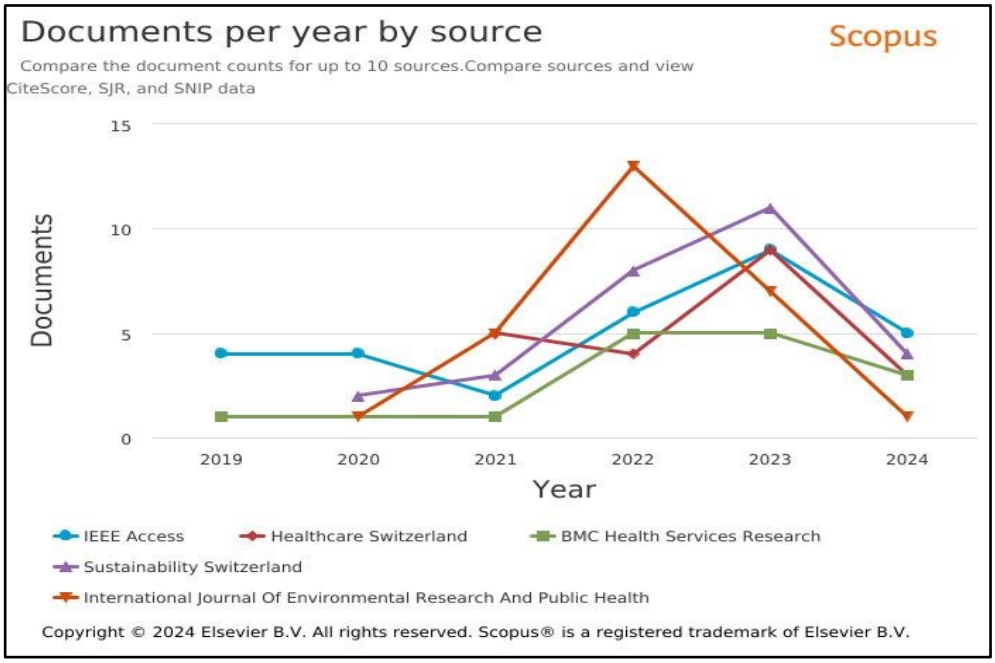

Figure 3. The articles on digital transformation in healthcare systems per year by source.

There are several compelling reasons why these five sources have emerged as major publication outlets for research on digital transformation. Firstly, their interdisciplinary focus spans a broad spectrum of topics, including journals like IEEE Access, Sustainability (Switzerland), and Healthcare (Switzerland), which delve into engineering, technology, and computing. This interdisciplinary nature aligns seamlessly with digital transformation in healthcare, a field that encompasses not only medical expertise but also cutting-edge technologies such as artificial intelligence, data science, and telecommunications. Furthermore, these journals prioritize wider visibility and accessibility to research findings, facilitating informed engagement for researchers, practitioners, and policymakers in the dynamic landscape of digital health. Their commitment to open access significantly contributes to their prominence. For instance, journals like BMC Health Services Research and IEEE ensure that research findings are readily available to a diverse audience of stakeholders involved in healthcare service delivery and policymaking. Additionally, some of these journals emphasize a healthcare-specific focus. When a journal is exclusively dedicated to healthcare research, it provides an ideal platform to explore broader public health dimensions, including the intricate facets of digital transformation. Consequently, it encourages more researchers—especially those investigating digital transformation within the healthcare sector—to disseminate their findings through these reputable journals. By discerning the unique focus, scope, and characteristics of these journals, researchers can strategically select the most fitting outlets for their work, ensuring maximum reach and impact for their valuable contributions. However, this chart has limitations. It does not provide the absolute number of publications; instead, it focuses on relative trends. Additionally, the data covers only five specific sources, which may not fully represent the entire research landscape related to the study of digital transformation in the healthcare system.

3.4. Co-authorship patterns among countries in articles on digital transformation in healthcare systems

Figure 4 depicts a network visualization map showcasing the co-authorship patterns among countries, which is generated using VOSviewer. The countries were grouped into clusters based on their co-authorship affiliations.

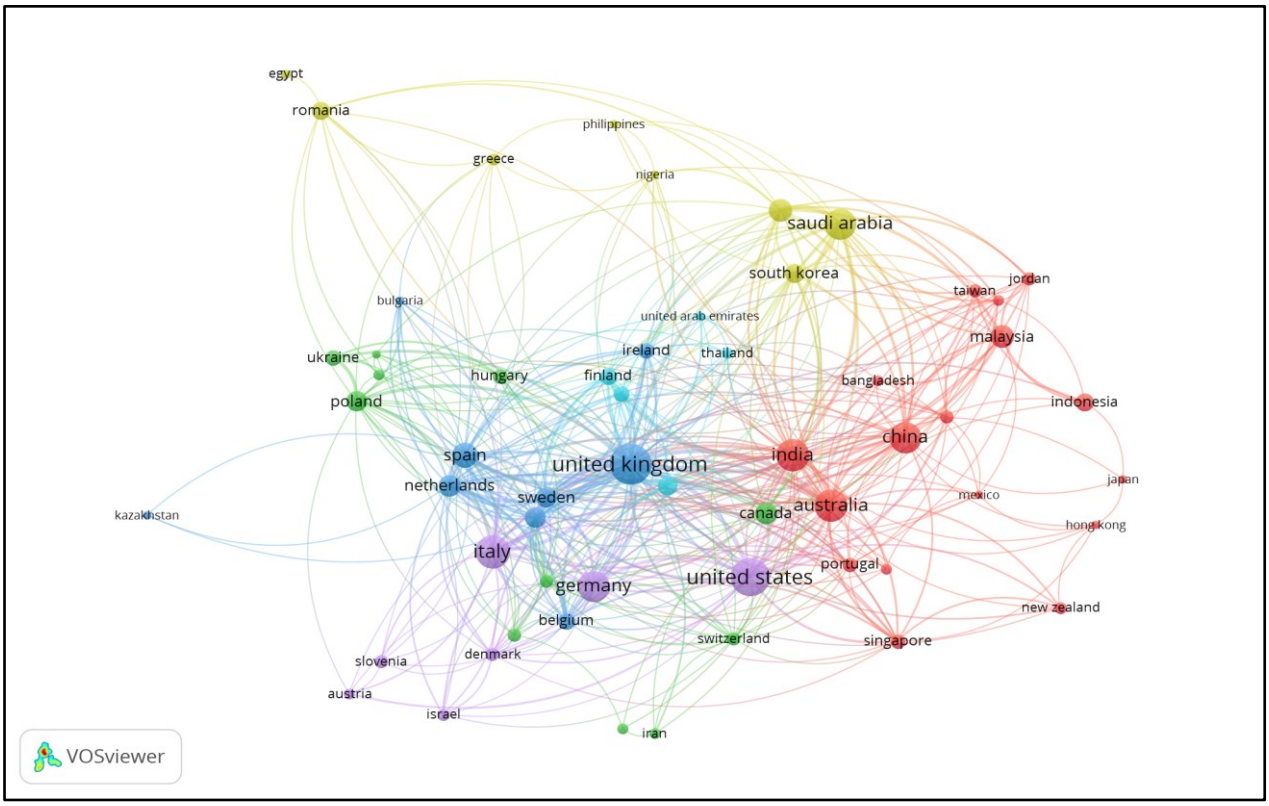

Figure 4. The network visualization map illustrating co-authorship patterns among countries concerning digital transformation in healthcare systems.

Among these countries, the largest and most interconnected cluster comprised the United States, United Kingdom, Canada, Australia, China, and India. This finding indicated the strong collaborative research networks among these nations. Other distinct clusters were Europe, Southeast Asia, and Middle Eastern nations. Specific countries were also identified as central hubs in the network, exhibiting many correlations to other nations. The United States and the United Kingdom were notably prominent, signifying their substantial influence and active participation in international research collaborations.

Even though several countries have long been recognized as well-established research hubs, China and India were experiencing significant growth in their research productivity and global partnerships. This observation suggested the growing significance of these in the worldwide research landscape. On the contrary, certain countries were geographically isolated, with minimal or non-existent correlations to neighboring nations. This outcome indicated a deficiency in international collaboration or a focus on domestic research initiatives. Co-authorship patterns also aligned with geographic proximity, exhibiting more robust relationships between nearby countries. Nevertheless, collaboration occurrences across nations between

continents could be observed, which was probably facilitated by internet communication tools and international research initiatives. This analysis uncovered a complex and interconnected global research landscape of digital transformation in healthcare systems. Despite the United States and the United Kingdom being prominent research hubs, China and India quickly became significant leaders in the field. Considering that countries established clusters and networks to exchange knowledge and skills, international collaborations were crucial for the progress of research in this area (Hegerty and Weresa, 2024). Hegerty and Weresa (2024) employed bibliometric analysis to identify primary research areas and collaborations in this field. The results highlighted the importance of global cooperation and exchange of information in promoting progress. This statement was also supported by two articles showcased at the World Economic Forum in January 2024: (i) World Economic Forum Launches New Global Initiative to Advance Digital and AI-Driven Transformation of Healthcare Systems, and (ii) How to Ensure Digital Transformation in Healthcare Reaches Its Potential. The first article provided information about the collaborative efforts between the World Economic Forum and Boston Consulting Group to facilitate the widespread acceptance and utilization of digital tools and AI in the healthcare sector by fostering international cooperation. The second article examined global programs such as the WHO Global Initiative on Digital Health (GIDH) and the Health Outcomes Observatory (H2O). Consequently, these initiatives fostered collaboration and knowledge sharing, accelerating digital transformation in healthcare globally. A growing worldwide and collaborative effort to explore digital transformation in healthcare systems was also observed, acknowledging the significance of cooperation in addressing issues and seizing the opportunities arising from this rapidly evolving field.

Examining co-authorships across countries in the context of digital transformation in healthcare research can yield valuable insights into collaboration dynamics and its potential impact on research outcomes. Co-authorship spanning borders facilitates the exchange of diverse knowledge, perspectives, and expertise, resulting in more comprehensive and innovative research outputs. For example, collaborations between researchers from developed and developing countries merge insights on cutting-edge technologies with an understanding of the unique challenges faced in resource-constrained settings. Moreover, such collaborations often lead to more rigorous research methodologies and higher-quality publications. Diverse perspectives during the peer review process contribute to robust study designs and thorough data analysis. Additionally, co-authors from different countries may have access to distinct resources and datasets, enriching the research. Furthermore, research articles with international co-authors tend to receive more citations than those authored solely within one country. This suggests that collaborative research is perceived as more valuable and impactful by the scientific community.

3.5. Co-occurrence of keywords in articles related to digital transformation in healthcare systems

Figure 5 displays a bibliometric map illustrating the co-occurrence of keywords in articles about digital transformation in healthcare systems, in which several

keywords become a central theme. The analysis conducted using VOSviewer revealed that "health care" and "digital transformation" were the most prominent and interconnected themes, confirming the central focus of this review. Alternatively, the correlations between "artificial intelligence", "blockchain", and "Internet of Things" were substantially associated, underscoring their significance as pivotal technologies propelling digital transformation. "Health systems", "data", and "health services" were also considerably correlated, highlighting the systemic impact of digital transformation on healthcare delivery and data management.

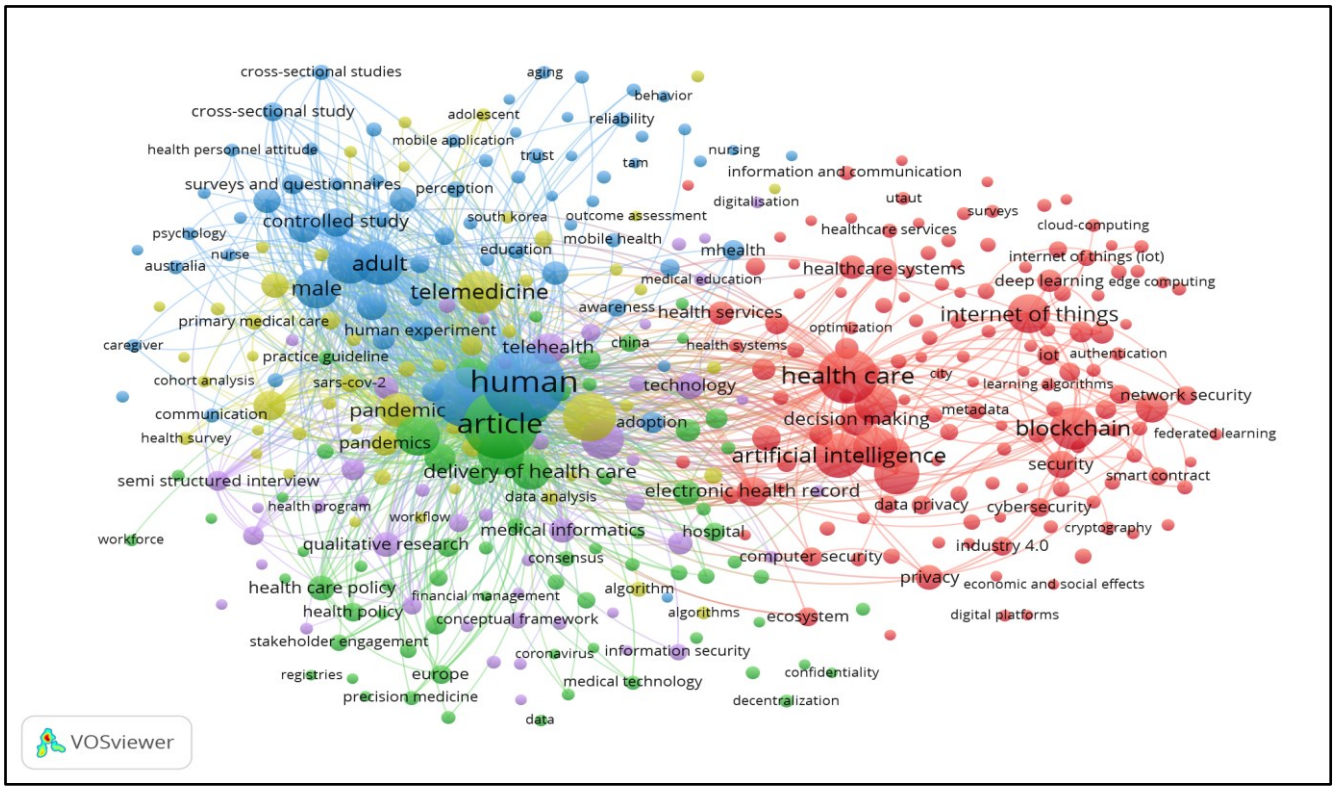

Figure 5. The bibliometric map visualizes the co-occurrence of keywords in articles related to digital transformation in healthcare systems.

Insights into the increasing trends of keyword usage concerning digital transformation in healthcare systems were demonstrated. Several examples included the growing prevalence of various terms ("cybersecurity", "privacy", and "security"), suggesting growing concerns about data protection and ethical considerations in digital health. Similarly, "telemedicine" and "mobile health" were gaining traction, indicating the rising importance of remote care and the use of technology to empower patients. "Pandemics" and "COVID-19" were also highly significant during the ongoing global COVID-19 crisis, highlighting the significance of digital tools in addressing worldwide health crises. This map then demonstrated a considerable degree of interconnectedness between keywords, indicating that the studies in this field were comprehensive and covered various digital transformation aspects concurrently. The robust correlation between "AI" and "decision making" underscored the increasing utilization of AI in clinical decision support and diagnostic tools. Another correlation between "blockchain" and "data privacy" suggested the capacity of blockchain

technology to augment data security and transparency in the healthcare sector. Overall, this map illustrated a dynamic and evolving landscape of research regarding digital transformation in healthcare systems. The central focus revolved around technological advancements (AI, blockchain, and IoT). A growing focus was also observed on ensuring data security, protecting privacy, and understanding how digital health affected healthcare delivery and patient outcomes.

3.6. Countries with the highest number of articles on digital transformation in healthcare systems

Figure 6 portrays the ten countries with the most significant articles on digital transformation in healthcare systems from Scopus. The United Kingdom was the frontrunner regarding the highest number of publications, followed by the United States. Italy, India, Australia, Germany, and China also generated noteworthy contributions in this field. Among the countries with the highest number of publications, Saudi Arabia, Spain, and Malaysia exhibited a lower volume of published research. Nonetheless, the contributions of these nations were considered. The dominance of the United Kingdom and the United States in digital transformation research can be attributed to several factors. Firstly, both countries boast a rich history of well-funded research institutions, universities, and robust healthcare systems. This established infrastructure provides fertile ground for fostering innovation and driving research output in digital health. Moreover, these nations often lead in technological advancements, granting researchers readily available access to cutting-edge digital tools and resources. This technological advantage naturally facilitates research and development within the digital health domain. Additionally, the strong collaboration between academic institutions and the healthcare industry in these countries creates a dynamic ecosystem that fosters the development of digital health solutions. We must not overlook the robust healthcare data infrastructure in these two countries. Access to comprehensive datasets empowers researchers to conduct in-depth analyses and develop data-driven solutions for the healthcare sector. As for other top ten countries, as exhibited in **Figure 5**, their increased publication output may stem from factors such as rising healthcare demands due to large populations and an aging demographic. These circumstances necessitate innovative digital solutions to enhance healthcare access, affordability, and efficiency. Furthermore, India and China have rapidly expanded their research capacity by investing significantly in research institutions and infrastructure. Their growing research ecosystems enable substantial contributions to the field of digital health. These countries strategically leverage technological advancements to bypass traditional healthcare models, swiftly adopting cutting-edge digital solutions. Consequently, their research output accelerates, as evidenced by studies by Lee and Yoon (2020), Mesko (2017), and Topol (2019).

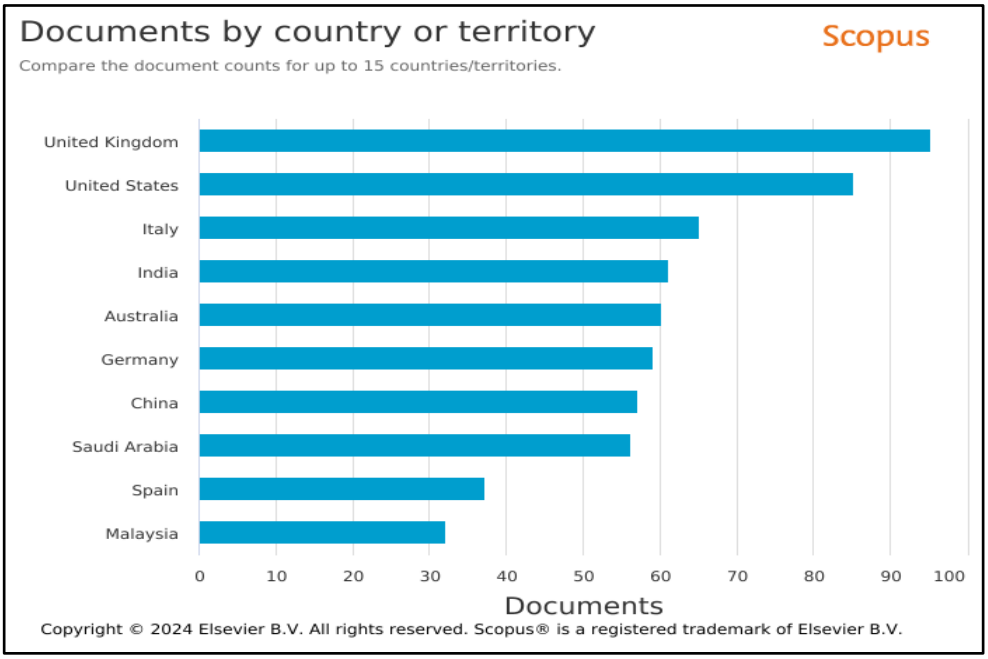

Figure 6. The countries with the highest number of publications on digital transformation in healthcare systems.

Overall, the global nature of research exhibited Western and Eastern countries as significant contributors. Even though specific numerical values were not directly visible, the United Kingdom and the United States possessed a prominent presence. In contrast, other countries yielded a declining pattern in terms of publications.

3.7. Information about articles on digital transformation in healthcare systems based on subject areas

Figure 7 illustrates the distribution of articles on digital transformation in healthcare systems based on subject areas from Scopus. The primary disciplines for this topic were Computer Science (19.1%) and Medicine (17.8%). These outcomes were rational as computer science drove technological advancements, and medicine focused on their practical application in healthcare settings. Engineering (11.5%) and Business, Management, and Accounting (8.3%) were also significant, emphasizing the importance of engineering solutions and business strategies in healthcare digital transformation. Meanwhile, Social Sciences (7.7%) and Health Professions (4.8%) were experiencing an increasing level of interest, which indicated a focus on societal impact and professional implications. Other more minor but noteworthy contributions were Environmental Science (4.1%), Materials Science (3.0%), Decision Sciences (2.9%), and Economics, Econometrics, and Finance (2.6%). A substantial portion (18.2%, "Other") was also observed, which included interdisciplinary or niche areas associated with digital transformation in the healthcare sector. Overall, the multidisciplinary nature of this field demonstrated that computer science, medicine, engineering, and business were significant contributors. A growing interest in social sciences and health professions was also observed.

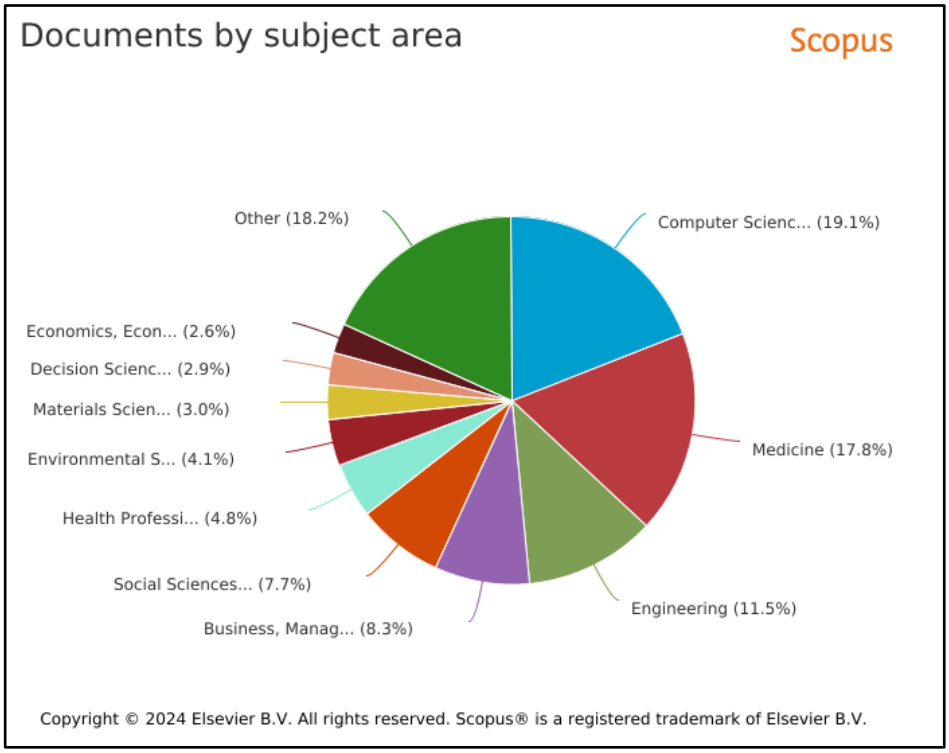

Figure 7. The information about articles on digital transformation in healthcare systems based on subject areas.

Based on the information provided in **Figure 7**, this distribution is not surprising and can be attributed to several key factors. The dominance of computer science likely stems from the fact that digital transformation is inherently rooted in computer science principles. Technologies such as artificial intelligence, machine learning, data analytics, and software development are fundamental for creating and implementing digital solutions in healthcare. Consequently, a significant portion of research naturally finds its place within this discipline. Furthermore, modern healthcare increasingly relies on data for decision-making, spanning from patient diagnostics to operational efficiency. Computer scientists play a crucial role in developing algorithms, tools, and platforms to manage and analyze vast amounts of healthcare data. Additionally, cutting-edge technologies like blockchain, the Internet of Things (IoT), and virtual/augmented reality find practical applications in healthcare, further emphasizing the importance of computer science expertise in this field. Regarding Medicine and Engineering, their prominence may be influenced by distinct reasons. The medical community places strong emphasis on evidence-based practice, necessitating rigorous research and publication to validate the efficacy and safety of digital health solutions. Meanwhile, the development of medical devices, wearables, sensors, and other hardware components essential for digital health relies on engineering expertise. Research in this area often focuses on optimizing device performance, ensuring safety, and seamlessly integrating these technologies into healthcare workflows. In summary, digital transformation in healthcare is inherently interdisciplinary, demanding collaboration across different fields. Consequently, publications span multiple subject areas, with computer science, medicine, and engineering playing central roles in this collaborative effort.

4. Conclusion

This review successfully examined the current trends of digital transformation in healthcare systems. The analysis indicated a growing interest in digital transformation within healthcare systems, which peaked in 2023. Rasheed et al.'s (2020) article was also denoted as the most influential article based on the assessed dataset. Although this article was only published four years ago, it was cited 836 times. Meanwhile, the primary sources for digital transformation in healthcare system-related articles were IEEE Access, Healthcare Switzerland, BMC Health Services Research, International Journal of Environmental Research and Public Health, and Sustainability Switzerland. An intricate and interconnected global research landscape within the field of digital transformation in healthcare systems was also observed in the co-authorship pattern data among countries. The established research hubs identified in this review were the United States and the United Kingdom. Nonetheless, several countries (China and India) were swiftly gaining prominence. This review also suggested that Western and Eastern countries were making significant contributions in terms of publications. The articles on digital transformation in the healthcare systems could be considered multidisciplinary, with substantial contributions from various subject areas. These subject areas were computer science, medicine, engineering, and business. An increasing interest in social sciences and health professions was also presented. This review offered valuable insights into the literature on digital transformation in the healthcare system. Based on the findings, identifying influential articles and research hubs yields valuable insights for policymakers. They can strategically allocate funding and resources to support impactful research areas. Prioritizing multidisciplinary research—especially in computer science, medicine, engineering, and business—facilitates innovation and addresses complex healthcare challenges. Additionally, the interconnected global research landscape underscores the importance of cross-border collaboration. As China and India gain prominence, policymakers should actively promote international partnerships, knowledge sharing, and joint research initiatives. Such collaborative efforts accelerate the adoption of best practices and foster innovation. Furthermore, systematic bibliometric analysis provides an evidence base for decision-making. Policymakers can assess existing policies' impact and identify areas for improvement. By leveraging insights from influential articles, policymakers can make informed decisions regarding technology investments, implementation strategies, and policy adjustments. To conclude this part, this bibliometric review highlights the pressing necessity for healthcare systems to modernize their infrastructure for the digital era. Achieving this transformation involves investing in technology, fostering interdisciplinary collaboration, forming international partnerships, developing human capital, and addressing the social and ethical aspects of digital health technologies. By embracing these changes, healthcare systems can position themselves to provide high-quality, patient-centered care in the 21st century.

Nevertheless, two limitations were demonstrated. First, despite the presence of alternative databases (Google Scholar and PubMed), most articles exclusively conducted a bibliometric analysis using data from the Scopus database. Thus, the outcome could vary if alternative databases were selected. Secondly, the study's insights could be enhanced by delving deeper into specific collaboration types, such

as academic-industry partnerships. However, the study's exclusion of affiliations during the inclusion and exclusion criteria introduces another limitation. This review also proposed several recommendations for future studies. Future studies should explore the ethical, social, and policy implications of these transformative technologies after examining the co-authorship patterns among countries. Even though "health policy" and "stakeholder engagement" were also mentioned in this review, they were not as prominent as technological terms. This outcome indicates a potential area for further research on the policy and governance implications of digital transformation. The insufficient representation of "social determinants of health" also highlights the necessity for additional research on investigating the impact of digital health on health equity and access for diverse populations.

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References

Abbas, J., Mubeen, R., Iorember, P. T., et al. (2021). Exploring the impact of COVID-19 on tourism: transformational potential and implications for a sustainable recovery of the travel and leisure industry. Current Research in Behavioral Sciences, 2, 100033. https://doi.org/10.1016/j.crbeha.2021.100033

Agarwal, R., Gao, G., DesRoches, C., & Jha, A. K. (2010). Research Commentary—The Digital Transformation of Healthcare: Current Status and the Road Ahead. Information Systems Research, 21(4), 796–809. https://doi.org/10.1287/isre.1100.0327

Ahmi, A., & Mohd Nasir, M. H. (2019). Examining the Trend of the Research on Extensible Business Reporting Language (XBRL): A Bibliometric Review. International Journal of Innovation, Creativity and Change, 5(2), 1145–1167.

Al-Khoury, A., Hussein, S. A., Abdulwhab, M., et al. (2022). Intellectual Capital History and Trends: A Bibliometric Analysis Using Scopus Database. Sustainability, 14(18), 11615. https://doi.org/10.3390/su141811615

Alves, J. L., Borges, I. B., & Nadae, J. de. (2021). Sustainability in complex projects of civil construction: bibliometric and bibliographic review. Gestão & Produção, 28(4). https://doi.org/10.1590/1806-9649-2020v28e5389

Arfi, W. B., Nasr, I. B., Kondrateva, G., et al. (2021). The role of trust in intention to use the IoT in eHealth: Application of the modified UTAUT in a consumer context. Technological Forecasting and Social Change, 167, 120688. https://doi.org/10.1016/j.techfore.2021.120688

Aria, M., & Cuccurullo, C. (2017). Bibliometrix: An R-tool for comprehensive science mapping analysis. Journal of Informetrics, 11(4), 959–975.

Brahimi, T., & Sarirete, A. (2023). A bibliometric analysis of GCC healthcare digital transformation. Digital Transformation in Healthcare in Post-Covid-19 Times, 217–239. https://doi.org/10.1016/b978-0-323-98353-2.00003-4

Baas, J., Schotten, M., Plume, A., et al. (2020). Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. Quantitative Science Studies, 1(1), 377–386. https://doi.org/10.1162/qss_a_00019

Cao, G., Duan, Y., Edwards, J. S., et al. (2021). Understanding managers' attitudes and behavioral intentions towards using artificial intelligence for organizational decision-making. Technovation, 106, 102312. https://doi.org/10.1016/j.technovation.2021.102312

Dhagarra, D., Goswami, M., & Kumar, G. (2020). Impact of Trust and Privacy Concerns on Technology Acceptance in Healthcare: An Indian Perspective. International Journal of Medical Informatics, 141, 104164. https://doi.org/10.1016/j.ijmedinf.2020.104164

Di Stefano, G., Peteraf, M., & Verona, G. (2010). Dynamic capabilities deconstructed: a bibliographic investigation into the origins, development, and future directions of the research domain. Industrial and Corporate Change, 19(4), 1187–1204. https://doi.org/10.1093/icc/dtq027

Falagas, M. E., Pitsouni, E. I., Malietzis, G. A., & Pappas, G. (2008). Comparison of PubMed, Scopus, Web of Science, and

Google Scholar: strengths and weaknesses. The FASEB Journal, 22(2), 338–342

Fenech, M., & Vos, M. (2019). Legal and ethical aspects of digital transformation in healthcare. Health Policy and Technology, 8(1), 1–3.

Gentil-Beccot, A., Mele, S., & Prosser, D. (2017). The Open Access advantage considering citation counts and journal impact factor in the field of library and information science. Journal of the Association for Information Science and Technology, 68(10), 2465–2475.

Hegerty, S. W., & Weresa, M. A. (2024). Mapping research on digital innovation in the health sector: a bibliometric approach. Economics of Innovation and New Technology, 1–18. https://doi.org/10.1080/10438599.2024.2368130

Hermes, S., Riasanow, T., Clemons, E. K., et al. (2020). The digital transformation of the healthcare industry: exploring the rise of emerging platform ecosystems and their influence on the role of patients. Business Research, 13(3), 1033–1069. https://doi.org/10.1007/s40685-020-00125-x

José de Oliveira, O., Francisco da Silva, F., Juliani, F., et al. (2019). Bibliometric Method for Mapping the State-of-the-Art and Identifying Research Gaps and Trends in Literature: An Essential Instrument to Support the Development of Scientific Projects. Scientometrics Recent Advances. https://doi.org/10.5772/intechopen.85856

Khezr, S., Moniruzzaman, M., Yassine, A., et al. (2019). Blockchain Technology in Healthcare: A Comprehensive Review and Directions for Future Research. Applied Sciences, 9(9), 1736. https://doi.org/10.3390/app9091736

Khiste, G. P., & Paithankar, R. R. (2017). Analysis of Bibliometric term in Scopus. International Research Journal, 01(32).

Kraus, S., Jones, P., Kailer, N., et al. (2021a). Digital Transformation: An Overview of the Current State of the Art of Research. SAGE Open, 11(3), 215824402110475. https://doi.org/10.1177/21582440211047576

Kraus, S., Schiavone, F., Pluzhnikova, A., & Invernizzi, A. C. (2021b). Digital transformation in healthcare: Analyzing the current state-of-research. Journal of Business Research, 123, 557–567. https://doi.org/10.1016/j.jbusres.2020.10

Lee, C., & Yoon, S. (2020). Digital transformation in healthcare: A systematic review and opportunities for future research. Healthcare (Switzerland), 8(2), 109.

Lee, J. Y., & Park, H. A. (2022). Collaboration patterns in global health research: A bibliometric analysis. Global Health Research and Policy, 7(1), 1–16.

Li, H., An, H., Wang, Y., Huang, J., & Gao, X. (2016). Evolutionary features of academic articles co-keyword network and keywords co-occurrence network: Based on two-mode affiliation network. Physica A: Statistical Mechanics and its Applications, 450, 657–669.

Lim, W. M., & Kumar, S. (2023). Guidelines for interpreting the results of bibliometric analysis: A sensemaking approach. Global Business and Organizational Excellence, 43(2), 17–26. Portico. https://doi.org/10.1002/joe.22229

Marques, I. C. P., & Ferreira, J. J. M. (2019). Digital transformation in the area of health: systematic review of 45 years of evolution. Health and Technology, 10(3), 575–586. https://doi.org/10.1007/s12553-019-00402-8

Meskó, B. (2017). The role of artificial intelligence in precision medicine. Expert Review of Precision Medicine and Drug Development, 2(5), 235–237.

Moed, H. F. (2005). Citation analysis in research evaluation. Springer Science and Business Media.

Mohd, A. M. D., Fozia, F., Samar, R. T., & Alhamzah, F. A. (2024). Unveiling the Landscape of Big Data Analytics in Healthcare: A Comprehensive Bibliometric Analysis. International Journal of Online and Biomedical Engineering (IJOE), 20(06), 4–24. https://doi.org/10.3991/ijoe.v20i06.48085

Moral-Muñoz, J. A., Herrera-Viedma, E., Santisteban-Espejo, A., et al. (2020). Software tools for conducting bibliometric analysis in science: An up-to-date review. El Profesional de La Información, 29(1). https://doi.org/10.3145/epi.2020.ene.03

Ninkov, A., Frank, J. R., & Maggio, L. A. (2021). Bibliometrics: Methods for studying academic publishing. Perspectives on Medical Education, 11(3), 173–176. https://doi.org/10.1007/s40037-021-00695-4

O'Brien, K., Downie, A., & Scapicchio, M. (2024). What is Digital Transformation. Available online: https://www.ibm.com/topics/digital-transformation#GeneratedCaptionsTabForHeroSec (accessed on 30 June 2024).

Öztürk, O., Kocaman, R., & Kanbach, D. K. (2024). How to design bibliometric research: an overview and a framework proposal. Review of Managerial Science. https://doi.org/10.1007/s11846-024-00738-0

Panch, T., Pearson, J., & Greaves, F. (2018). Healthcare and the Internet of Things: Potential benefits and challenges. Future Healthcare Journal, 5(2), 117–121.

Piwowar, H. A., Day, R. S., & Fridsma, D. B. (2011). Sharing detailed research data is associated with increased citation rate. PLoS ONE, 6(3), e18087.

Rahman, A., Raj, A., Tomy, P., et al. (2024). A comprehensive bibliometric and content analysis of artificial intelligence in language learning: tracing between the years 2017 and 2023. Artificial Intelligence Review, 57(4). https://doi.org/10.1007/s10462-023-10643-9

Rasheed, A., San, O., & Kvamsdal, T. (2020). Digital Twin: Values, Challenges and Enablers from a Modeling Perspective. IEEE Access, 8, 21980–22012. https://doi.org/10.1109/access.2020.2970143

Singh, S., Hosen, A. S. M. S., & Yoon, B. (2021). Blockchain Security Attacks, Challenges, and Solutions for the Future Distributed IoT Network. IEEE Access, 9, 13938–13959. https://doi.org/10.1109/access.2021.3051602

Smith, K. D., & Jones, L. M. (2021). The role of bibliometrics in evidence-based policymaking. Evidence & Policy: A Journal of Research, Debate and Practice, 17(3), 399–420.

Stoumpos, A. I., Kitsios, F., & Talias, M. A. (2023). Digital Transformation in Healthcare: Technology Acceptance and Its Applications. International Journal of Environmental Research and Public Health, 20(4), 3407. https://doi.org/10.3390/ijerph20043407

Sweileh, W. M., Al-Jabi, S. W., AbuTaha, A. S., et al. (2017). Bibliometric analysis of worldwide scientific literature in mobile - health: 2006–2016. BMC Medical Informatics and Decision Making, 17(1). https://doi.org/10.1186/s12911-017-0476-7

Topol, E. J. (2019). High-performance medicine: the convergence of human and artificial intelligence. Nature Medicine, 25(1), 44-56.

Van Eck, N., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics, 84(2), 523-538.

Verbeek, A., Debackere, K., Luwel, M., et al. (2002). Measuring progress and evolution in science and technology – I: The multiple uses of bibliometric indicators. International Journal of Management Reviews, 4(2), 179–211. Portico. https://doi.org/10.1111/1468-2370.00083

Wang, J., & Li, Y. (2020). A bibliometric analysis of research trends in digital health: 2000-2019. Journal of Medical Internet Research, 22(12), e23228.

Wang, Y., & Hajli, N. (2017). Exploring the path to big data analytics success in healthcare. Journal of Business Research, 70, 287–299. https://doi.org/10.1016/j.jbusres.2016.08.

World Economic Forum. (2024). How to ensure digital transformation in healthcare reaches its potential. Available online: https://www.weforum.org/agenda/2024/01/digital-transformation-healthcare/ (accessed on 5 August 2024).

World Economic Forum. (2024). World Economic Forum Launches New Global Initiative to Advance Digital and AI-Driven Transformation of Healthcare Systems. Available online: https://www.weforum.org/press/2024/01/wef24-new-global-initiative-digital-transformation-of-healthcare-systems/ (accessed on 5 August 2024).

World Health Organization [WHO] (2024). World Health Statistics. Available online: https://www.who.int/data/gho/publications/world-health-statistics (accessed on 5 August 2024).

Wu, Y. C. J., & Wu, T. (2017). A decade of entrepreneurship education in the Asia Pacific for future directions in theory and practice. Management Decision, 55(7), 1333–1350. https://doi.org/10.1108/md-05-2017-0518

Zhang, Y., & Liu, X. (2023). Bibliometric Analysis of Global Research Trends in Digital Health. International Journal of Medical Informatics, 173, 104756.

Zhao, F., Du, F., Shi, D., et al. (2019). Mapping research trends of retinal vein occlusion from 2009 to 2018: a bibliometric analysis. PeerJ, 7, e7603.

Zupic, I., & Čater, T. (2015). Bibliometric methods in management and organization. Organizational Research Methods, 18(3), 429–472.

Zhang, L., Wan Hussain, W. M. H. (2024). Digital Transformation in Healthcare: A Bibliometric Analysis. International Journal of Intelligent Systems and Applications in Engineering, 12(21s), 3969–3986.