# Exploring Digitalization Health: A Bibliometric Analysis Using R

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**Abstract:** In recent years, there has been a marked acceleration in studies focusing on digitalization in healthcare. These studies are increasingly recognized for their strong associations with key concepts such as efficiency, quality, financial sustainability, and cost-effectiveness. The present research conducts a bibliometric analysis of the literature on digital health to identify the thematic focus of existing studies and explore the trends that have emerged over time. Using the Web of Science database, a sample of 2,513 publications from the period 1992 to August 2024 was analyzed through bibliometric approaches. The keywords "efficiency," "quality," "finance," and "sustainability" were used to categorize and assess the relationships between these themes and the broader digitalization trends in healthcare. Bibliometric analyses were conducted using the R package, which facilitated the evaluation of publication performance and the scientific mapping of the literature. In addition, VOSviewer was employed to visually map the analyzed data, providing a clearer picture of the research landscape. The results of this study reveal a significant increase in the number of publications on digitalization in healthcare over the analyzed period, indicating a growing interest among researchers in this field. Furthermore, the findings suggest that digitalization in healthcare offers substantial benefits in terms of cost efficiency, service quality, and sustainability. These factors have emerged as central themes in digital health research and are expected to continue shaping future investigations in this rapidly evolving domain.

**Keywords:** health informatics, digital transformation, digitalization, bibliometric analysis

## 1. Introduction

Digitalization in healthcare refers to the use of digital technologies in the delivery of healthcare services. This process aims to make healthcare services more effective, accessible, personalized and efficient (Gonzalez Lopez-Valcarcel and Ortun 2022; Liu et al. 2023; Lobont et al. 2023; Odone et al. 2019) . Digitalization enables patients, physicians, hospitals and other healthcare providers to communicate better, increase their interactions and exchange via digital solutions in the healthcare sector data (Choplin, Boebme Ii, and Maynard 1992; Passanante et al. 2023; Salaschek and Bonfadelli 2020) .

Digitalization in healthcare services gained momentum with the introduction of computers in healthcare in the 1960s. The spread of digitalization in the modern sense was largely made possible by the rapid development of the internet and digital technologies in the late 1990s and early 2000s (Fernando, Bernard; Kalra, Dipak; Morrison, Zoe; Byrne, Emma; Sheikh 2012; Lorsbach et al. 2020). The development of systems such as Electronic Health Records (EHR) made significant contributions to the widespread use of digitalization in the healthcare sector. In the 2010s, a radical transformation took place globally in digital healthcare services with the integration of mobile health applications, telemedicine , artificial intelligence and big data analytics (Nastasa, Dumitra, and Grigorescu 2024).

The main objectives of digitalization in healthcare services are to provide patient-centered healthcare services, increase efficiency, reduce costs, facilitate disease management and provide personalized treatment opportunities. Using digitalization as a tool provides faster and easier access to healthcare services for patients; it is aimed to make healthcare services more efficient by automating administrative processes (Haynes, Lovett, and Sünnenberg 2003). At the same time, unnecessary tests and procedures are prevented and healthcare resources are used more effectively, and this effect contributes to reducing costs. The monitoring and management of chronic diseases are facilitated through digital tools, and it is possible for patients to continuously monitor their health status thanks to wearable technologies and mobile health applications. Personalized treatment, on the other hand, provides patient-specific solutions by enabling the creation of individual treatment plans based on individuals' health and genetic data and proposes to make treatment processes more effective (Wang et al. 2023; Zarakovitis et al. 2018).

The benefits of digitalization in healthcare include the fact that patients and healthcare professionals can access medical data quickly and more easily through electronic health records and digital platforms, which offers great advantages especially in emergency situations. By the help of the digitalization of administrative and clinical processes, workflows in hospitals are accelerated and efficiency is increased. Time-consuming processes are completed in a shorter time thanks to automated systems; this increases the speed and efficiency of healthcare services (Gonzalez Lopez-Valcarcel and Ortun 2022; Pattanaik et al. 2024; Zhong et al. 2024). Digital health tools let the patients to watch their health status from their homes and stay in constant communication with their physicians through wearable devices and mobile applications in the follow-up of chronic diseases. In addition, it allows for personalized treatment opportunities and the creation of treatment plans based on individuals' genetic and medical data, and this process increases treatment efficiency (Berlet et al. 2022; Zarakovitis et al. 2018). Digitalization ensures more efficient use of healthcare resources and reduces costs by preventing unnecessary tests and procedures. While electronic health records allow for the reduction of medical errors and closer monitoring of treatment processes, digital health data provides valuable resources for research and contributes to major advances in medical research and education. Digital tools, especially virtual reality (VR) and augmented reality (AR), are strengthening the training of healthcare professionals (Pisniak 2023).

On the other hand, cybersecurity and data privacy risks have significant place among the disadvantages of digitalization in healthcare. Patient data stored in a digital environment can be subject to cyber attacks due to the fact that it contains personal and sensitive information, and data breaches can lead to serious security problems. In addition, access to digital healthcare services is not possible for every individual; especially elderly individuals, those living in rural areas or those with low digital literacy cannot benefit sufficiently from these services (Wuelfing 2022). Another important disadvantage of digitalization is the high initial investment costs; the installation of electronic health records and telemedicine infrastructure requires large investments. The complex structure and user-friendliness of some digital systems can increase the workload of healthcare professionals. Data errors and incompatibilities that may occur in digital healthcare systems can lead to medical errors and endanger patient safety. In addition, with the increase in digitalization, face-to-face interaction between doctor and patient decreases, and this can negatively affect patient satisfaction and trust (Palumbo, Casprini, and Montera 2022a). Excessive dependence on technology can lead to interruptions in healthcare services when technical disruptions occur. Storing and sharing digital health data brings with it legal and ethical issues. Therefore, while taking advantage of digitalization, it is of great importance to pay attention to issues such as cybersecurity, user-friendly systems, equal access and data management (Gonzalez-Colom et al. 2024; Palumbo, Casprini, and Montera 2022b).

It is known that studies on digitalization in healthcare are now popular worldwide today. It is impossible to limit digitalization to a single area; this process manifests itself in many areas. Digitalization is constantly developing in areas such as the transition from paper-based systems to electronic systems, artificial intelligence applications, machine learning and teleradiology (Kremers 2020). Literature studies on digitalization in healthcare services generally address the use of digital technologies to increase the efficiency of healthcare services, improve patient safety, reduce costs and monitor the health of individuals. The main topics these studies focus on are gathered under the following headings:

Electronic Health Records (EHR): Electronic Health Records (EHR) enable patients to store and share their health data in a digital environment. Studies on EHR in the literature focus on issues such as increasing patient safety, integrating with clinical decision support systems, and ensuring data privacy and security (Kose et al. 2023).

Telemedicine: Telemedicine is about technologies that enable patients to access healthcare services remotely. Research in this area examines benefits such as increasing access to healthcare, facilitating patient follow-up, and managing chronic diseases, especially in rural and (Kremers 2020)disadvantaged areas .

Wearable Technologies and Mobile Health (m-Health): Wearable devices and mobile health applications allow individuals to monitor their health status. Studies in this area focus on early diagnosis of diseases,

continuous health monitoring and individual health management (Tandon, Dhir, and Islam 2023).
Artificial Intelligence (AI) and Machine Learning: Artificial intelligence and machine learning are technologies used to make data-based decisions in healthcare. Studies on the integration of artificial intelligence into healthcare in the literature are particularly concentrated in areas such as imaging, disease diagnosis, treatment planning and clinical decision support systems (Armand et al. 2024).
Big Data and Data Analytics: Big data analytics includes studies on the analysis of health data and its use in areas such as public health management, personalized medicine and epidemiological research. Big data enables health services to be made more predictable and specific to the individual (Khan and Javaid 2021).
Blockchain Technology in Healthcare: Blockchain technology enables health data to be stored securely and traceably. Literature focuses on the role of this technology in data security, patient privacy, data sharing, and transparency in healthcare services (Abbas et al. 2022).
Robotics and Automation: Robotics and automation technologies are used to increase precision in surgical interventions and to increase efficiency in healthcare services. There are studies in the literature on robotic surgery, automation of patient care processes and the use of robots in rehabilitation services (Shah and Agarwal 2019).
Virtual Reality (VR) and Augmented Reality (AR): Virtual and augmented reality technologies are used in medical education for simulations, treatment of psychological disorders and rehabilitation processes. There are various studies on the role of these technologies in the education of health professionals and patient treatment (Talwar et al. 2023).
Personalized Medicine: Personalized medicine aims to create treatment plans based on an individual's genetic data and other personal information. Studies in this field specifically address treatment strategies and individualized healthcare services supported by genomic data (Prem et al. 2021).
Cybersecurity and Data Privacy: Cybersecurity, patient data privacy, and protection against cyber threats in digital health systems are of great importance in the literature. Studies in this area focus on the protection and secure sharing of health data (Calik, Kaya, and Celebi 2022).
Digitalization in healthcare facilitates the accessibility of healthcare services, especially for individuals living in rural and remote areas, and contributes to health equity. Electronic health records and automated systems enable faster and more efficient provision of healthcare services, simplify patient information management, and use healthcare professionals' time more effectively (Beckmann et al. 2021; Cordova Gonzalez 2022). In addition, digital health technologies enable the creation of personalized treatment plans, making treatment processes more targeted and effective. Health data stored in a digital environment provides access to fast and accurate information that is vital in emergencies, helps reduce costs, and enables more efficient use of resources by preventing unnecessary tests. While digital health tools facilitate the monitoring and management of chronic diseases, technologies such as big data analytics and artificial intelligence make major contributions to medical research and innovation (Taran, Noja, and Pirtea 2023). In addition, digital health solutions increase patient satisfaction by giving patients more control over their health and encouraging their active participation in treatment processes.Thus, digitalization in healthcare makes healthcare more effective, accessible and personalized, while increasing the efficiency and sustainability of healthcare systems and improving overall health outcomes (Prem et al. 2021).
Research questions; Which journals are most preferred on this subject? Which countries publish the most? What are the subjects of studies conducted in this field by year? With the answers sought to these questions, a road map for the research was drawn.
It is seen that the studies on digitalization in health have a very wide perspective. However, in this study, only the relationship between the studies carried out in this field and quality, efficiency, finance and sustainability is discussed. No bibliometric analysis addressing these four concepts has been found in the literature before. The study with the closest similarity to this study was conducted by Tunçsiper in 2023. In this study, digital transformation and health economics are discussed. In our study, the keywords were determined as quality, efficiency, finance and sustainability.
The contribution of this study to the literature is to clearly demonstrate the relationship between

digitalization in health and the concepts of efficiency, quality, finance and sustainability. It is to raise awareness on how digitalization affects these four key focal points. The objective of this study to explore the field of healthcare digitalization through a comprehensive bibliometric analysis. The published research is reviewed to address the core issues in healthcare digitalization studies. These core issues are analyzed by dividing them into four focal points (efficiency, quality, sustainability, and finance). It also addresses the main themes and research focuses that shape the future of healthcare. This analysis hopes to provide valuable insights into the current state of healthcare digitalization research and its potential impact on healthcare systems worldwide.

## 2. Method

In the bibliometric analysis carried out in this study, various tools and techniques are used to examine the brief view of the research conducted in the field of digitalization in health. The bibliometrix package in the R program was used for data analysis and visualisation. Scientific publications were analysed and the relationships between the subjects were revealed. Vosviewer programme was used to visualise and reveal the meaning relationship between the data.It transforms bibliometric data into information by applying numerical methods to perform quantitative analysis of scientific documents. This approach includes two main procedures: performance analysis and science mapping. Performance analysis is a method used to evaluate the productivity and impact of scientific research. In this analysis, metrics such as number of publications, number of citations, h-index, annual distribution of publications and journal impact factor are generally taken into account. In this study, the distribution of publications by years is analyzed. Science mapping helps to understand the structure and evolution of scientific fields by visualizing the relationships between academic research. This mapping is done with tools such as citation networks, co-author maps, keyword maps and concept maps. In this study, keyword maps are used to show how topics and themes in a particular field are related.

Web of Science database was used during the data collection phase. The research covers publications on digitalization in health between August 1992-2024. The studies are examined within the scope of four main focuses. These are; efficiency, quality, sustainability and financial management. In the analysis, the main keywords were determined as “digitalization” and “health”. Then, the keywords “quality”, “finance”, “sustainability” and “efficiency” were added to the keywords “digitalization” and “health” respectively and separate searches were performed.

A retrospective study was conducted by downloading the data from the database in ‘BibTex’ format and analysing them through R programming language. In addition, the data were downloaded from WoS in ‘tabdelimited’ format and imported into Vosviewer for mapping the data.

R package Bibliometrix are the tools that used for analysis. These tools allowed the examination of factors such as the number of publications, the number of citations per article, collaborative research outputs, h-index and main research areas (Li, Li, and Tang 2023; Lwin, Punnakitikashem, and Thananusak 2023).

In visualizing the data, VOSviewer software was preferred due to its accuracy in information mining, network density and cluster visualization features.

## 3. Findings

This study examines how research in the field of digitalization in health is covered in terms of major countries, publications, journal types and themes. As a result of the filtering with the keywords " digitalization " and " health ", 2513 publications were accessed. Of these publications, only " article " and " review article " were included in the scope and 2147 publications were accessed. The 2147 publications obtained were analyzed and visualized using the " biblioshiny " package program in the R program for bibliometric analysis. In addition, the academic studies included in the analysis were examined by dividing them into the categories of "sustainability", "productivity", "quality", and "finance" (Figure 1).

The 2147 publications obtained as a result of the analysis are examined bibliometrically to find answers to the following study questions: Which journals are most preferred on this subject? Which countries

publish the most? What are the subjects of studies conducted in this field by year? Thus, the research topic is analyzed comprehensively.

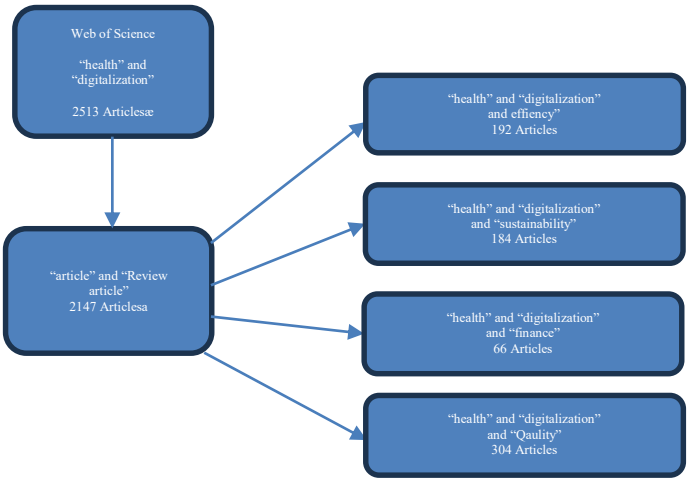


**Figure 1.** Flow diagram of the Article selection process

Figure 2 provides the distribution of studies conducted in the field of digitalization in health by year. What is striking here is that there has been a high increase in the number of publications since 2019 compared to previous years. This may be due to the rapid advances in digital health technologies, especially the increase in research and development activities in areas such as artificial intelligence, big data, wearable technologies and telemedicine. In addition, the fact that the COVID-19 pandemic has increased the interest in digital health solutions due to the need for remote provision of health services may have increased the number of studies in this field. Government policies and strategies encouraging the digitalization of health systems may have influenced the increase in research funds and the emergence of more studies. Digitally collected health data and information provide large data sets for researchers. Increased public awareness and the potential of digital health solutions to improve health services are effective in the growth of academic and industrial interest. In addition, investments in digital health technologies and collaborations in the private sector support innovations and research in this field (Angjeli 2022; Sanirs, Liguori, and Garvey 2023; Sendur 2022).

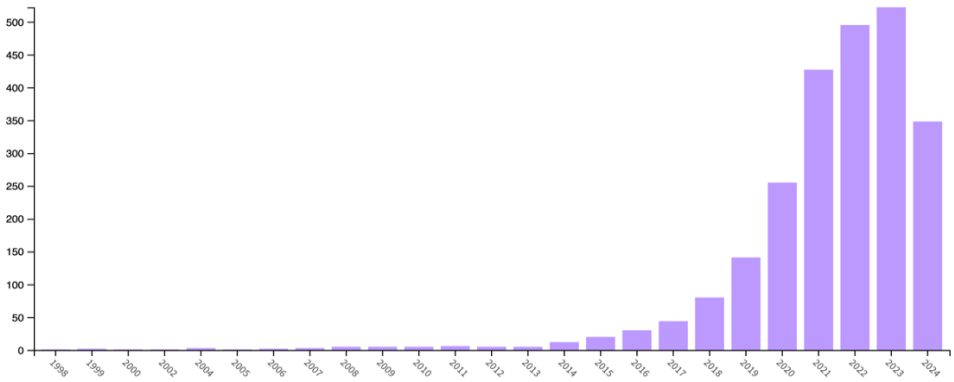


**Figure 2.** Number of Studies Conducted in the Field of Digitalization in Healthcare by Year

Figure 3 shows the categories of studies conducted in the field of digitalization in healthcare. When the studies conducted are scrutinized, the most seen themes are Environmental Occupational Health (360), Health Resort Sciences Services (218), Medical Informatics (171), Environmental Sciences (170), Management (95). The concentration of studies in these categories shows that digital health technologies have significant impacts in these basic areas. Wheares, research in the fields of public health, environmental health and occupational health reveals that there is an increasing interest in how digital health solutions are applied in these areas; studies on the delivery and management of health services emphasize the potential of digitalization to increase service quality and optimize health systems. While studies in the field of medical informatics show the importance of integrating technologies such as electronic health records, artificial intelligence and big data analysis into health systems; studies in the environmental sciences category indicate that the effects of environmental factors on health can be monitored and managed more effectively with digital technologies. This demonstrates that digital health research provides significant transformations not only in individual health but also in wide-ranging areas such as community health, environment and management of health services (Gonzalez Lopez-Valcarcel and Ortun 2022; Rodriguez-Modrono 2024; Zhong et al. 2024).

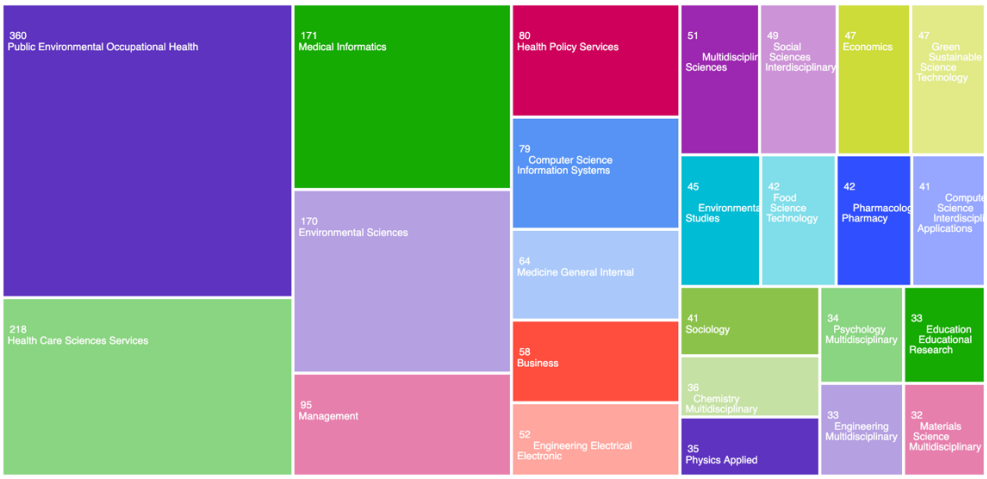


**Figure 3.** WOS Categories

In this study, it was also analyzed how much of the work done in the field of digitalization in health is in the fields of efficiency, finance, sustainability and quality. The reason for choosing these four main focal points is related to their direct relationship with digitalization. Digitalization in health can significantly affect the efficiency, financial management, quality and sustainability of health services. In terms of efficiency, health services are automated and processes are accelerated thanks to digital tools and electronic health records (EHR). This allows doctors and health personnel to use their time more efficiently and enables patients to access their past health data quickly. In addition, digital systems facilitate data sharing and prevent unnecessary tests (Kuebler 2017). In addition, the governance approach known as the twin transformation focuses on technological transformation as well as climate and sustainability transformation.

In financial management, digitalization reduces printing, storage and data processing costs by replacing paper-based systems. Automated processes can reduce the cost of malpractice by minimizing human errors. Digital systems allow healthcare institutions to monitor their financial status instantly and make more effective financial planning. This makes budgeting and financial reporting processes more transparent and effective (Boria-Reverter et al. 2021).

In terms of quality, digital health applications support personalized medical practices, allowing the creation of patient-specific treatment plans. Advanced analytics and artificial intelligence increase the quality of healthcare services, while digital decision support systems and electronic prescriptions reduce

medical errors. It also contributes to the standardization of healthcare services (Rodriguez-Modrono 2024).

In terms of sustainability, digitalization reduces energy and resource consumption by reducing paper use and the need for physical archives. The use of environmentally friendly technologies reduces the carbon footprint of the healthcare sector. Digital solutions such as telehealth and remote monitoring allow patients to access healthcare from their homes, allowing healthcare services to be provided in a more sustainable way. This holistic approach helps healthcare systems become more effective, economical and environmentally friendly (Brown et al. 2023).

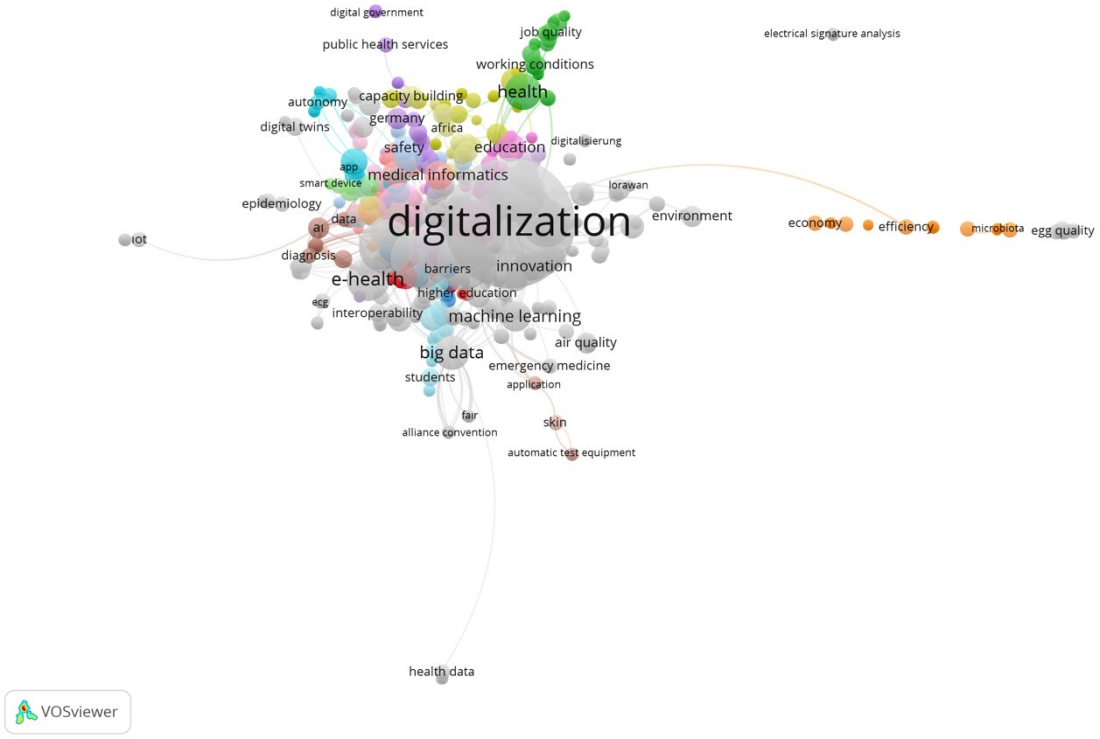


**Figure 4.** Keyword Distribution

In Figure 4, keywords used in studies on digitalization in health in the fields of efficiency, quality, sustainability and finance are analyzed. It is seen that the most frequently used keyword in the studies is “ digitalization ”. “ Health ”, “e- health ”, “ bigdata ” are among the other most frequently used keywords. The fact that the most frequently used keyword is digitalization shows that these four main focal points cover digitalization and reflects their effects on digitalization in health. In the map, digitalisation occupies a central position, with different keywords related to this topic clustered around it. For example, concepts such as e-health, big data and machine learning show strong links with digitalisation. In addition, concepts such as health and education are also closely related to digitalisation and important scientific studies are being conducted in these fields. Further afield, concepts such as economy, efficiency and microbiota show more specific links with digitalisation. This type of analysis provides valuable insight into which topics digitalisation is associated with in scientific research and which areas are at the forefront.

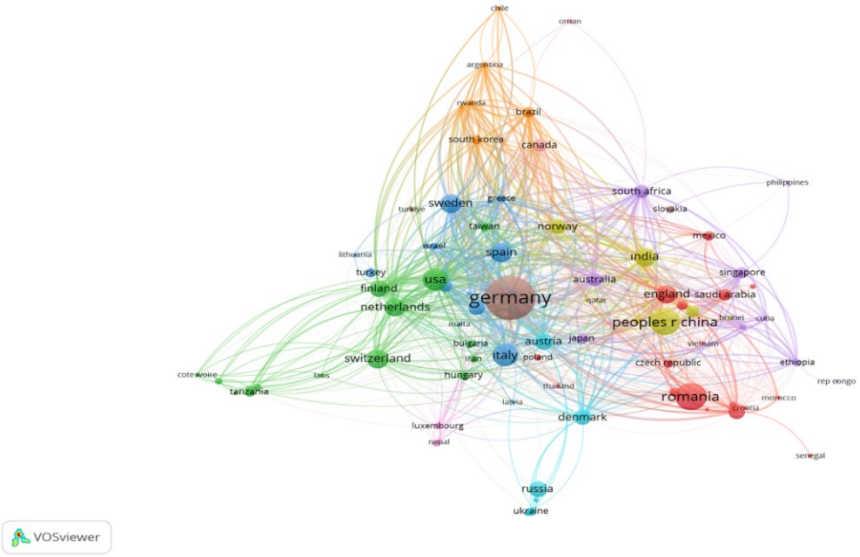


**Figure 5.** Country Distribution

Figure 5 shows the distribution of studies on efficiency, quality, finance and sustainability in the field of digitalization in healthcare by country. Germany is seen as the pioneer in studies conducted in these areas. There may be many reasons why studies in the field of digitalization in healthcare are concentrated in Germany. Germany stands out as a country with an advanced technology infrastructure and advanced digital health solutions. The country's active steps in digitalizing its healthcare system, especially its investments in areas such as electronic health records and digital health applications, ensure that research in this field is at the forefront. In addition, Germany encourages the development of innovative solutions by providing significant financial support for health informatics research. Comprehensive health informatics programs in educational institutions and international collaborations also increase Germany's knowledge and experience in this field (Eckert et al. 2019; Henzler et al. 2023; Wahl et al. 2024; Weitzel et al. 2021).

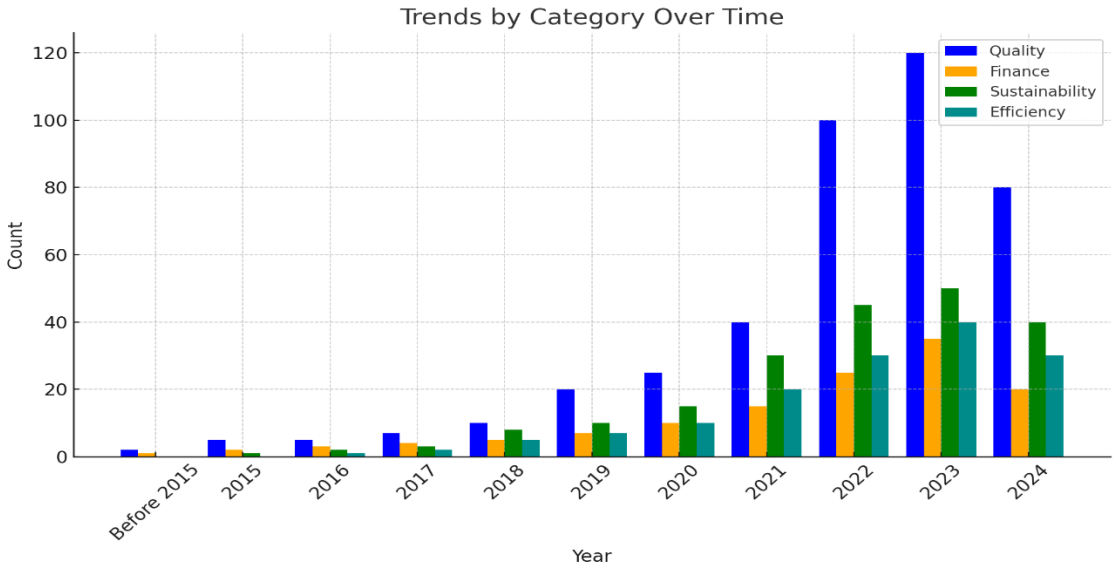


**Figure 6.** Distribution of Work Conducted in the Fields of Quality, Productivity, Finance and Sustainability by Year

Figure 6 shows the distribution graph of studies conducted in the field of digitalization in healthcare on quality, efficiency, finance and sustainability over the years. It is seen that studies conducted in 2015 and before are quite rare. However, the number of studies, especially in the field of quality, has increased considerably as of 2021. It is thought that this increase covering the COVID-19 period is not a coincidence. Many studies conducted during the COVID-19 period show that digitalization in healthcare directly affects quality, efficiency, sustainability and finance. The pandemic has started a period in which healthcare systems have difficulty providing adequate and timely services to patients with traditional methods. (Angjeli 2022; Schnack et al. 2023; Sendur 2022). This situation has led to the rapid adoption of digital solutions in healthcare, especially digital technologies such as telehealth, remote patient monitoring, artificial intelligence-supported diagnostic systems, and electronic health records. Telehealth services have made patient access to healthcare services sustainable during the pandemic, while also helping hospitals prevent overcrowding. Thus, the quality of healthcare services has improved by allowing patients to receive fast and effective treatment without physically going to healthcare centers. At the same time, digitalization plays a critical role in monitoring the spread of the disease and making more efficient use of resources by facilitating patient monitoring and data analysis. From a quality perspective, digitalization in healthcare increases patient safety while enabling faster diagnosis and treatment processes. In addition, thanks to data management and sharing, healthcare professionals have access to more comprehensive and accurate information, improving the quality of patient care. It is thought that the increase in studies in the field of digitalization in healthcare after 2019 is due to both the necessities brought about by the pandemic and the goal of providing permanent improvements in healthcare services (Cichosz, Udsen, and Hejlesen 2020; Ekman et al. 2022; Elsner 2021).

It is seen that digitalization in healthcare has given increasing momentum to studies in the fields of finance, sustainability, efficiency and quality. Digital health technologies support financial sustainability by helping to reduce costs and increase efficiency in operational processes. Resource usage is reduced thanks to electronic health records and remote patient monitoring systems, thus creating an environmentally friendly and sustainable healthcare system. Digital solutions increase the quality of healthcare services with faster diagnosis and treatment processes and make patient care safer and more accessible. At the same time, digital tools such as artificial intelligence and automation contribute to more accurate and effective decisions by minimizing human errors. The increase in awareness of digitalization in healthcare, especially after the pandemic, and the critical importance of its relationship with these 4 basic issues have contributed to the increase in studies in this field.

## 4. Discussion and Conclusion

Digital transformation in healthcare is changing traditional models and fundamentally affecting consumer expectations and behaviors. This transformation is expected to be a major driver for initiatives that improve clinical outcomes and reduce costs. Due to the vastness of the healthcare ecosystem, transformations in healthcare are spread over a longer period of time.

Bibliometric analysis of digital health research reveals a rapidly growing field with far-reaching implications for healthcare delivery and management. The increase in publications over the last decade points to the increasing interest in digital health solutions, with mobile health technologies and remote healthcare delivery gaining prominence. This growth is also reflected in the expanding global digital health market, driven by the increased adoption of these technologies and supportive government initiatives worldwide.

In particular, this study examines the relationship between digitalization in healthcare and studies on efficiency, sustainability, finance and quality. It is not possible to separate digitalization in healthcare from these four main focal points. Innovations and studies carried out in the name of digitalization affect quality and efficiency and also create a financial opportunity window. One of the misconceptions regarding investment expenditures in the healthcare field is that the amounts spent are seen as very high. However, the expenditures made over time show their effect and affect lower costs. Thus, the studies carried out become financially sustainable. Therefore, studies carried out in the field of digitalization in

healthcare in particular are not independent of these four main focal points.
Looking ahead, digital health continues to reshape the healthcare landscape by creating new patient expectations and disrupting traditional models. While the healthcare industry has been more thorough in embracing digital transformation than other industries, there is still a long way to go in terms of its potential to improve clinical outcomes and reduce costs. To fully realize this benefit, continued research and strategic implementation will be crucial, paving the way for a more efficient, accessible, and patient-centered healthcare system in the future.

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## References

Abbas, A. F., Qureshi, N. A., Khan, N., Chandio, R., & Ali, J. (2022). The blockchain technologies in healthcare: Prospects, obstacles, and future recommendations; lessons learned from digitalisation. *International Journal of Online and Biomedical Engineering*, *18*(9), 144–159. https://doi.org/10.3991/ijoe.v18i09.32253

Angjeli, G. (2022). COVID-19 and the economic challenges. *International Journal of Ecosystems and Ecology Science-IJEES*, *12*(4), 367–372.

Armand, T. P. T., Nfor, K. A., Kim, J.-I., & Kim, H.-C. (2024). Applications of artificial intelligence, machine learning, and deep learning in nutrition: A systematic review. *Nutrients*, *16*(7). https://doi.org/10.3390/nu16071073

Beckmann, M., Dittmer, K., Jaschke, J., Karbach, U., Koeberlein-Neu, J., Nocon, M., Rusniok, C., Wurster, F., & Pfaff, H. (2021). Electronic patient record and its effects on social aspects of interprofessional collaboration and clinical workflows in hospitals (ECoCo): A mixed methods study protocol. *BMC Health Services Research*, *21*(1). https://doi.org/10.1186/s12913-021-06377-5

Berlet, M., Vogel, T., Gharba, M., Eichinger, J., Schulz, E., Friess, H., Wilhelm, D., Ostler, D., & Kranzfelder, M. (2022). Emergency telemedicine mobile ultrasounds using a 5G-enabled device: Development and usability study. *JMIR Formative Research*, *6*(5). https://doi.org/10.2196/36824

Boria-Reverter, S., Romeo, M., Yepes-Baldo, M., & Rayon-Valpuesta, M. L. (2021). Financial system challenges and opportunities: Sustainability and financial stability. *Cuadernos Del CIMBAGE*, *23*(2), 18–32.

Brown, M. R. D., Knight, M., Peters, C. J., Maleki, S., Motavalli, A., & Nedjat-Shokouhi, B. (2023). Digital outpatient health solutions as a vehicle to improve healthcare: A United Kingdom focused politics and practice perspective. *Frontiers in Digital Health*, *5*. https://doi.org/10.3389/fdgth.2023.1242896

Calik, E., Kaya, H., & Celebi, F. V. (2022). A novel method to ensure the security of the shared medical data using contracts: Organ transplantation sample. *Concurrency and Computation-Practice & Experience*, *34*(9, SI). https://doi.org/10.1002/cpe.6752

Choplin, R. H., Boebme II, J. M., & Maynard, C. D. (1992). Picture archiving and communication systems: An overview. *RadioGraphics*, *12*, 127–129.

Cichosz, S. L., Udsen, F. W., & Hejlesen, O. (2020). The impact of telehealth care on health-related quality of life of patients with heart failure: Results from the Danish TeleCare North Heart Failure Trial. *Journal of Telemedicine and Telecare*, *26*(7–8), 452–461. https://doi.org/10.1177/1357633X19832713

Cordova Gonzalez, G. A. (2022). Electronic health records: Its effects on the doctor-patient relationship and the role of the computer in the clinical setting. *Health and Technology*, *12*(2), 305–311. https://doi.org/10.1007/s12553-021-00634-7

Eckert, O., Kuehl, L., Vogel, U., & Weber, S. (2019). Development of an electronic death certificate for Germany. *Bundesgesundheitsblatt-Gesundheitsforschung-Gesundheitsschutz*, *62*(12, SI), 1493–1499. https://doi.org/10.1007/s00103-019-03055-0

Ekman, B., Thulesius, H., Wilkens, J., & Arvidsson, E. (2022). Digitalization of health care: Findings from key informant interviews in Sweden on technical, regulatory, and patient safety aspects. *Journal of Medical Internet Research, 24*(9). https://doi.org/10.2196/38746

Elsner, P. (2021). Patient safety in dermatology: Options for optimization. *Aktuelle Dermatologie, 47*(07), 323–330. https://doi.org/10.1055/a-1385-3215

Fernando, B., Kalra, D., Morrison, Z., Byrne, E., & Sheikh, S. (2012). Benefits and risks of structuring and/or coding the presenting patient history in the electronic health record: Systematic review. *BMJ Quality & Safety, 21*(4), 337–346.

Gonzalez Lopez-Valcarcel, B., & Ortun, V. (2022). Rebuilding the healthcare system: Governance, organization, and digitalisation. SESPAS Report 2022. *Gaceta Sanitaria, 36*(1), 44–50. https://doi.org/10.1016/j.gaceta.2022.02.010

Gonzalez-Colom, R., Mitra, K., Vela, E., Gezsi, A., Paajanen, T., Gal, Z., Hullam, G., Machinen, H., Nagy, T., Kuokkanen, M., Piera-Jimenez, J., Roca, J., Antal, P., Juhasz, G., & Cano, I. (2024). Multicentric assessment of a multimorbidity-adjusted disability scores to stratify depression-related risks using temporal disease maps: Instrument validation study. *Journal of Medical Internet Research, 26.* https://doi.org/10.2196/53162

Haynes, R., Lovett, A., & Sunnenberg, G. (2003). Potential accessibility, travel time, and consumer choice: Geographical variations in general medicine practice registrations in Eastern England. *Environment and Planning A, 35*(10), 1733–1750.

Henzler, T., Dieterle, S., Duerkop, D., & Nahrung, G. C. (2023). Private practice groups and medical resort centers in Germany: A fact of the current situation. *Urologie, 62*(9, SI), 889–897. https://doi.org/10.1007/s00120-023-02150-0

Khan, I. H., & Javaid, M. (2021). Big data applications in medical field: A literature review. *Journal of Industrial Integration and Management-Innovation and, 6*(1), 53–69. https://doi.org/10.1142/S242486222030001X

Kose, I., Cece, S., Yener, S., Seyhan, S., Elmas, B. Ö., Rayner, J., Birinci, S., Ulgu, M. M., Zehir, E., & Gundogdu, B. (2023). Basic electronic health record (EHR) adoption in Turkey is nearly complete but challenges persist. *BMC Health Services Research, 23*(1). https://doi.org/10.1186/s12913-023-09859-w

Kremers, M. (2020). Teleradiology and telemedicine. *MKG-Chirurg, 13*(4, SI), 248–259. https://doi.org/10.1007/s12285-020-00270-6

Kuebler, W. F. (2017). Efficiency in the hospital: A matter of course, reality, and challenge. *Therapeutische Umschau, 74*(1), 796–804. https://doi.org/10.1024/0040-5930/a000866

Li, G., Li, D., & Tang, T. (2023). Bibliometric review of design for digital inclusion. *Sustainability, 15*(14). https://doi.org/10.3390/su151410962

Liu, S., Lu, Y., Wang, D., He, X., Ren, W., Kong, D., & Luo, Y. (2023). Impact of digital health literacy on health-related quality of life in China community-dwelling older adults: The mediating effect of health-promoting lifestyle. *Frontiers in Public Health, 11.* https://doi.org/10.3389/fpubh.2023.1200722

Lobont, O.-R., Taran, A.-M., Vatavu, S., & Para, J. (2023). Scientific radiography of healthcare system process efficiency. *Zagreb International Review of Economics & Business, 26*(2), 113–136. https://doi.org/10.2478/zireb-2023-0017

Lorsbach, M., Gillessen, A., Revering, K., & Juhra, C. (2020). Information on medicine history in the emergency department: Influence on therapy and diagnostic decisions. *Medical Clinic - Intensivmedicine Under Notfallmedizin.* https://doi.org/10.1007/s00063-020-00661-8

Lwin, H. N. N., Punnakitikashem, P., & Thananusak, T. (2023). E-health research in Southeast Asia: A bibliometric review. *Sustainability, 15*(3). https://doi.org/10.3390/su15032559

Nastasa, A., Dumitra, T.-C., & Grigorescu, A. (2024). Artificial intelligence and sustainable development during the pandemic: An overview of the scientific debates. *Heliyon, 10*(9). https://doi.org/10.1016/j.heliyon.2024.e30412

Odone, A., Buttigieg, S., Ricciardi, W., Azzopardi-Muscat, N., & Staines, A. (2019). Public health digitalization in Europe: EUPHA vision, action and role in digital public health. *European Journal of Public Health, 29*(3), 28–35. https://doi.org/10.1093/eurpub/ckz161

Palumbo, R., Casprini, E., & Montera, R. (2022a). Making digitalization work: Unveiling digitalization's implications on psycho-social risks at work. *Total Quality Management & Business Excellence.* https://doi.org/10.1080/14783363.2022.2055458

Palumbo, R., Casprini, E., & Montera, R. (2022b). Making digitalization work: Unveiling digitalization's implications on psycho-social risks at work. *Total Quality Management & Business Excellence.* https://doi.org/10.1080/14783363.2022.2055458

Passanante, A., Pertwee, E., Lin, L., Lee, J. T., Wu, K. Y., & Larson, H. J. (2023). Conversational AI and vaccine communication: Systematic review. *Journal of Medical Internet Research, 25.* https://doi.org/10.2196/42758

Pattanaik, P. K., Gupta, S., Pani, A. K., Himanshu, U., & Pappas, I. O. (2024). Impact of inter and intra-organizational factors in healthcare: A conditional mediation analysis. *Information Systems Frontiers.* https://doi.org/10.1007/s10796-024-10522-w

Pisniak, V. S. (2023). Application of digital technologies in the training of future primary teachers for the formation of labor competences of pupils with health disabilities. *Information Technologies and Learning Tools, 94*(2), 38–53. https://doi.org/10.33407/itlt.v94i2.5031

Prem, B., Boerner-Zobel, F., Bias, H., & Voelter-Mahlknecht, S. (2021). Start moving - Benefits of an onsite workplace health program in the age of digitalization. *Journal of Occupational Medicine and Toxicology, 16*(1). https://doi.org/10.1186/s12995-021-00338-8

Rodríguez-Modrono, P. (2024). Digitalization, flexibilization and job quality: An intersectional analysis. *Cuadernos de Relaciones Laborales, 42*(1), 21–40. https://doi.org/10.5209/crla.89119

Salaschek, M., & Bonfadelli, H. (2020). Digital health communication and factors of influence. *Bundesgesundheitsblatt-Gesundheitsforschung-Gesundheitsschutz, 63*(2), 160–165. https://doi.org/10.1007/s00103-019-03086-7

Sanirs, S. C., Liguori, E. W., & Garvey, E. (2023). How digitalization reinvented entrepreneurial resilience during COVID-19. *Technological Forecasting and Social Change, 189.* https://doi.org/10.1016/j.techfore.2023.122398

Schnack, H., Lubasch, J. S., Zinkevich, A., Pawel, A., Uthoff, S. A. K., Ansmann, L., & von Kutzleben, M. (2023). Health services research in Germany in times of COVID-19: How does the pandemic influence research processes, methods, and researcher personnel? An online survey. *Gesundheitswesen, 85*(06), 495–504. https://doi.org/10.1055/a-2055-0904

Sendur, Y. (2022). The COVID-19 pandemic and digitalization in financial markets. *İstanbul İktisat Dergisi-İstanbul Journal of Economics, 72*(2), 1025–1038. https://doi.org/10.26650/ISTJECON2022-1127590

Shah, S. S. H., & Agarwal, A. (2019). Evaluation of clinicians' awareness regarding the impact of robotics on patient care in the near future. *Pakistan Journal of Medical & Health Sciences, 13*(4), 1033–1036.

Talwar, S., Kaur, P., Nunkoo, R., & Dhir, A. (2023). Digitalization and sustainability: Virtual reality tourism in a post-pandemic world. *Journal of Sustainable Tourism, 31*(11), 2564–2591. https://doi.org/10.1080/09669582.2022.2029870

Tandon, A., Dhir, A., & Islam, N. (2023). Mobile health interventions for cancer resort and support: The next level of digitalization in healthcare? *IEEE Transactions on Engineering Management.* https://doi.org/10.1109/JUL.2023.3243724

Taran, A.-M., Noja, G.-G., & Pirtea, M.-G. (2023). Is the quality of public governance beneficial for the European Union systems? The mediating role of health financing. *Transformations in Business & Economics, 22*(3A), 751–766.

Tunçsiper, Ç. (2023). Dijital dönüşüm ve sağlık ekonomisi: Dijital sağlık üzerine bibliyometrik bir analiz. *Gümüşhane Üniversitesi Sağlık Bilimleri Dergisi, 12*(1), 21–31. https://doi.org/10.37989/gumussagbil.1240687

Wahl, S., Osmann, B., Renger, F., & Czirfusz, A. (2024). The digital transformation of pharmacy services in Germany. *Clinical Social Work and Health Intervention, 15*(3). https://doi.org/10.22359/cswhi_15_3_09

Wang, X. L., Shi, Y., Xin, W. B., Wang, T. C., Yang, G. L., & Jiang, Z. Y. (2023). Channel prediction with time-varying Doppler spectrum in high-mobility scenarios: A polynomial Fourier transform-based approach and field measurements. *IEEE Transactions on Wireless Communications, 22*(11), 7116–7129. https://doi.org/10.1109/TWC.2023.3247825

Weitzel, E. C., Quittschalle, J., Wellzel, F. D., Loebner, M., Hauth, I., & Riedel-Heller, S. G. (2021). E-mental health and healthcare apps in Germany. *Nervenarzt, 92*(11), 1121–1129. https://doi.org/10.1007/s00115-021-01196-9

Wuelfing, C. (2022). Opportunities and risks of telemedicine in urology. *Urology, 61*(2), 117–124. https://doi.org/10.1007/s00120-022-01759-x

Zarakovitis, D., Tsoromocus, D., Tsaloukidis, N., & Lazakidou, A. (2018). Mobile application for patients' waiting time control and management of diagnostic imaging examinations. *International Journal of Reliable and Quality E-Healthcare, 7*(4), 20–33. https://doi.org/10.4018/IJRQEH.2018100102

Zhong, M., Qiang, D., Wang, J., & Sun, W. (2024). Improving health and reducing health inequality: An innovation of? *Social Science & Medicine, 348.* https://doi.org/10.1016/j.socscimed.2024.116847