

## Research Article

# Mapping of digital transformation in healthcare: Pre & post covid-19

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## Abstract

This study aims to map the literature on digital transformation in healthcare services from 2000 to 2022. The Scopus database is utilized to conduct the bibliometric analysis of 736 documents. VOS viewer software is used to analyze the extracted articles associated with 'digital transformation & healthcare services' research. Data is divided into two parts; Part 1 is based on literature before COVID-19 and Part 2 is based on the literature after Covid-19. Results revealed that there was a rapid increase in the rate of publication once Covid-19 hit the world. Medicine (subject area) has surpassed Business, Management, and Accounting in publishing articles on digital transformation and healthcare after COVID-19. The United Kingdom has taken the lead from the United States in publishing and research collaborations for publishing papers. Different themes have emerged from the data i.e., artificial intelligence, blockchain, industry 4.0, cloud computing, big data, digital healthcare, and others. Covid-19 has shaken the world. It is highly vital to know the digital transition that has taken place after the pandemic. Therefore, the current study has mapped the digital transformation literature in healthcare services to highlight the bibliometric transitions in terms of productivity and collaborations at the end of authors, countries, institutions, subject areas, and keywords..

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## 1. Introduction

The Industrial Revolution 4.0 has resulted in digital transformation (Iizuka & Ikeda, 2021) and digital transformation is a fundamental change process that aims to radically improve an entity and redefine its value proposition for its stakeholders (Gong & Ribiere, 2021). It is made possible by the innovative use of digital technologies combined with the strategic leverage of key resources and capabilities. Internal medical procedures are being impacted by electronic records, the Internet of Things, blockchain, machine learning, artificial intelligence, and other technologies because of the collection and analysis of healthcare data (Massaro, 2021). In recent decades, business environments and societies have been transformed by digital and technological developments from industrial to knowledge-based economies (Garcia-Perez et al., 2023). The sustainability of businesses of all kinds in both developing and developed countries has been jeopardized by the economic instability brought on by the COVID-19 pandemic over the past three years (Putritamara et al., 2023).

Therefore, the need for a deeper understanding of the healthcare sector's digital transition and its potentially disruptive nature for societies has motivated researchers to dig deeper into this area (Garcia-Perez et al., 2023). It is contended that the sector's digital transformation is not only necessary but also inevitable in the age of knowledge-based healthcare services. However, the pandemic presented the unusual issue of providing safe care for patients who had illnesses specifically COVID-19 infections. In this context, the digital transformation in healthcare around the globe became inevitable (Monaghesh & Hajizadeh, 2020) and other digital innovations and e-health solutions presented practical means to provide medical care remotely (Wax & Christian, 2020).

This research is motivated by the need for a deeper understanding of the healthcare services' digital transition and its potentially disruptive nature for societies. It is further contended that the service's digital transformation is not only necessary but also inevitable in the age of knowledge-based healthcare services. To understand the digital transitions in healthcare systems to suit the evolving and more demanding requirements of society, this article adds to better insights on digital transformation in healthcare by examining the body of knowledge associated with the bibliography of digital transformation and healthcare.

Bibliometric analysis is a quantitative approach that supports to identification and analysis of the data linked with keywords used and searched in the literature, their relationships, the number of articles published in a particular time frame, and their citations (Evren & Kozak, 2014; Muñoz-Leiva et al., 2015). Therefore, the current study is designed to map the literature on digital transformation and healthcare services by answering the following research objectives.

RO 1. To identify the publication output on 'digital transformation in healthcare' search before and after COVID-19.

RO 2. To highlight the most prominent authors, subject areas, and journals that contributed to the development of 'digital transformation in healthcare' research before and after COVID-19.

RO 3. To highlight the most productive institutions and countries in the 'digital transformation in healthcare' search before and after Covid-19.

RO 4. To visualize and identify the collaborations among authors, countries, and keywords related to 'digital transformation in healthcare' before and after COVID-19.

RO 5. To identify the emerging themes associated with 'digital transformation in healthcare' before and after Covid-19.

## 2. Theoretical Background

Technological change, especially the ongoing process of digitization of health services, is one of the variables influencing the performance of healthcare systems in reaching these goals (Ricciardi et al., 2019). The pandemic has had a significant effect on the pharmaceutical sector such as changes in regulations, changes in demand, and reduction in research and development (Furtner et al., 2022).

A complex situation that is challenging to identify is the adoption of e-services and digital transformation procedures in the public sector (Kitsios et al., 2021). Digital transformation, according to Ylinen, (2021), is an organization's response to changes in its environment based on the integrated use of technical and technology resources through electronic devices, creating a wide range of options for public engagement. To adapt to the views of new clients, businesses utilizing disruptive technology must abandon the patterns and routines that represent their established business processes (Henderson, 2006). In a world with limited resources, the healthcare system has undergone a digital revolution. This transition is built on disruptive technology that was adopted during the pandemic. A pandemic can significantly alter the global health system due to limited resources for vaccinations, medical personnel, and transportation concerns, in addition to the amount of contamination and mortality (Katz et al., 2020; Moazzami et al., 2020).

Many academics have investigated the opportunities, problems, and issues related to healthcare digitization. Digital technologies have grown to be essential in this process to improve healthcare and its administration (Martínez-Caro et al., 2018). While increasing healthcare costs have a significant impact on people's quality of life (particularly more so in the case of chronic conditions), ongoing aging and population expansion have an impact on healthcare needs and necessitate the development of cutting-edge and new scientific solutions (Chiuchisan et al., 2014; Garcia-Perez et al., 2023). While increasing healthcare costs have a significant impact on people's quality of life (particularly more in the case of chronic conditions), ongoing population expansion and aging have an impact on healthcare needs and thus necessitate the development of new, cutting-edge scientific solutions (Chiuchisan et al., 2014). The adoption rate of digital technological transformation in healthcare systems in developing nations has remained lower than the developed countries despite governmental commitment and considerable expenditure (Jung & Feng, 2020). However, the COVID-19 pandemic has caused an increase in adopting the digital transformation in the healthcare sector around the globe since 2020. The necessity of maintaining a physical barrier between patients and healthcare providers made it much easier for both groups to use digital technology and gave people a chance to appreciate the advantages of digital health (Manteghinejad & Javanmard, 2021).

Upon thorough analysis of the extant literature, given the magnitude of the healthcare industry, research investigating the causes of service providers' resistance to e-health advances is still rare (Baudier et al., 2023). Additionally, most of the earlier studies that looked at the resistance concentrated on healthcare and digitization, like Wearable devices in Healthcare (Ali et al., 2022), clinical decision support systems (Zakane et al., 2014), mobile healthcare (Ali et al., 2021), electronic health records (Ngafeson & Manga, 2021), Mobile Technologies and Healthcare (Ali et al., 2022), the epidemic prevention cloud (Hsieh & Lin, 2020), Electronic Service Quality in Healthcare (Ali et al., 2021a), healthcare service quality (Ali et al., 2023, 2024). This constrained coverage highlights the need for a deeper and more comprehensive understanding of digital transformational developments around the world.

### 3. Method

The search was carried out in Scopus database because it is the major database than others (Abbas et al., 2022; Alsharif et al., 2021; Khudzari et al., 2018). It also offers extensive coverage of the subjects than that of MedLine, Web of Sciences, and many others (Khudzari et al., 2018; Mongeon & Paul-Hus, 2016).

#### 3.1 Search Strategy

To screen the documents, inclusion and exclusion criteria have been used. Documents for the analysis were extracted in December 2022. The researcher applied the main keywords (central theme) of the current study i.e., digital transformation & healthcare. The search was filtered by limiting the exact keywords required for the study (Appendix II). It was further restricted to English articles from journals only, and the year 2023 was excluded from the search. The final number of documents (n=736) extracted was divided into two timelines i.e., pre Covid-19 (n=87) and post Covid-19 (n=649) (Fig. 1).

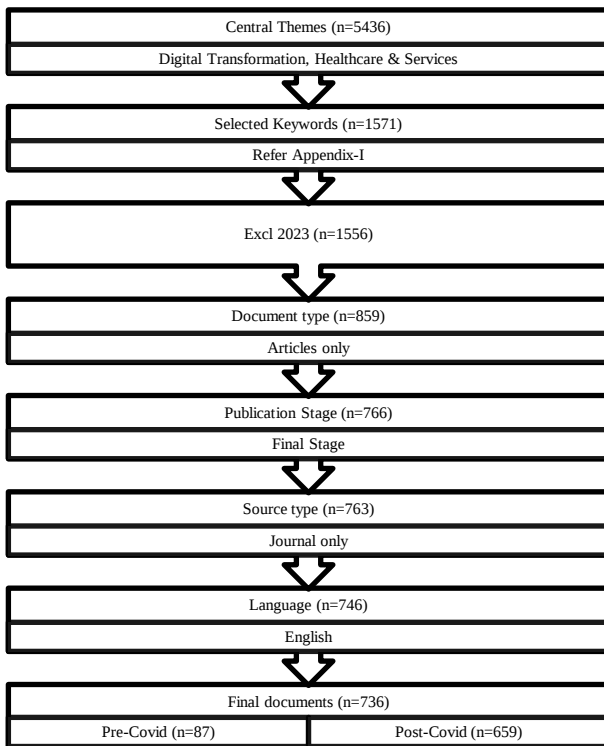


Fig. 1. Search Flow Chart

### 4. Data Analysis and Results

The bibliometric analysis was performed on two data sets: pre-Covid-19 and post-Covid-19. Further, the analysis was done based on publication output across the timeframe, the most productive journals and authors, the most prominent countries and institutions, contributions across different disciplines, co-authorship for authors and countries, co-occurrence of author keywords, and bibliographic coupling of documents.

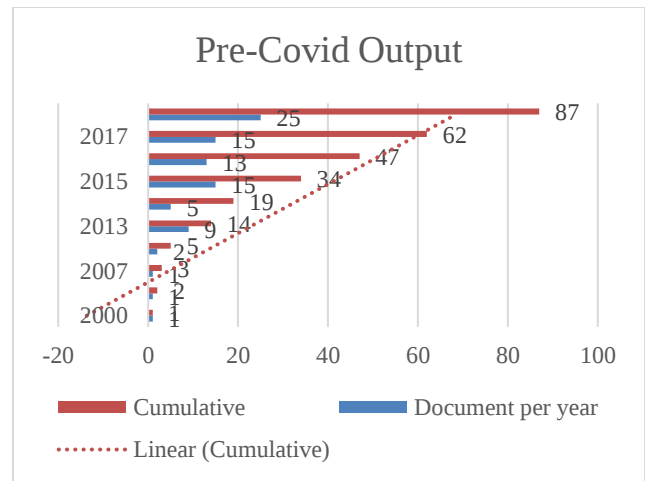


Fig. 2. Publication output before Covid-19

#### 4.1. Publication Output

Results contain publication output before and after the pandemic of Covid-19. It was revealed that there is an increasing trend throughout the timeline from 2000 to 2022 (Error! Reference source not found. & Error! Reference source not found.). But most publications happened after Covid-19. For the 22 years of search, 736 research papers have been published. Till 2018, before the pandemic 87 papers were produced with an increasing linear trend same as after the pandemic but the output was quite higher in numbers that showed the interest and need for research studies in healthcare services regarding digital transformation. It has an increasing trend showing the increasing interest in years to come as well.

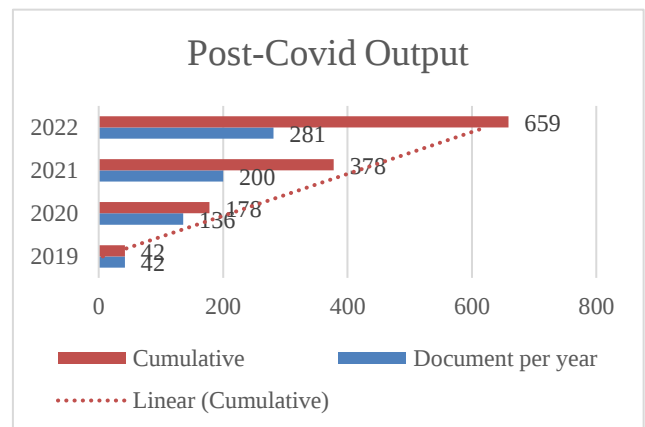


Fig. 3. Publication output after Covid-19

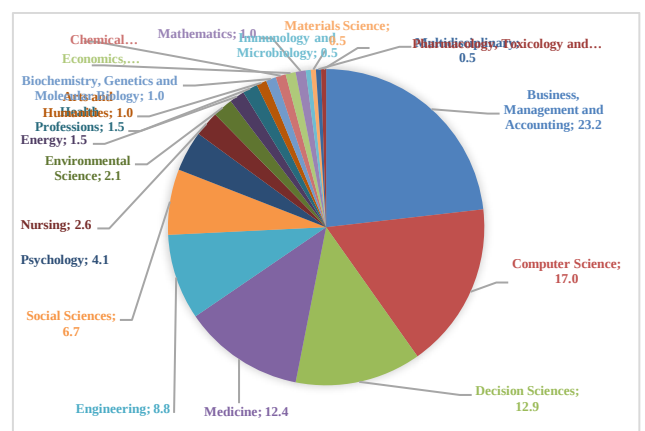


Fig. 4. Distribution across subject areas before Covid-19

Results also revealed the publication output across different subject areas in the body of knowledge. Before the pandemic, most of the publications were made in Business, Management, and Accounting (23.2%), followed by Computer Science (17%), Decision Sciences (12.9), Medicine (12.4), and others mentioned in Figure 04. Publication scenario across subject areas changed with the rise of Covid-19, and Medicine became the leading subject with the contribution of 16.9% publication output for digital transformation in healthcare services followed by Computer Science (16.4%), Business, Management, and Accounting (15%) and others mentioned in Figure 05.

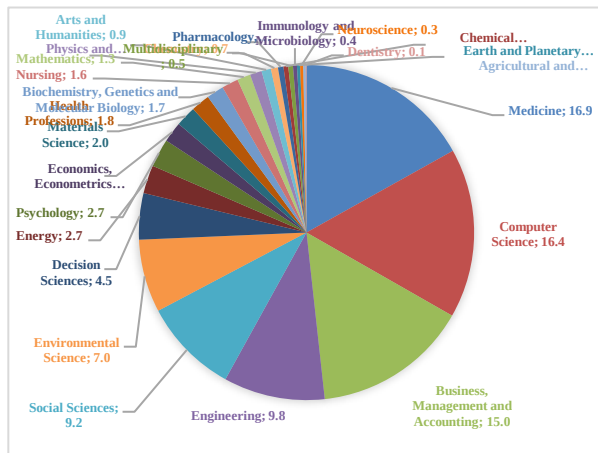


Fig. 5. Distribution across subject areas after Covid-19

Table 1

Table of most productive journals, authors, countries, and institutions before Covid-19.

| Most Productive Journals<br>(n ≥ 02)                          |    | Most Prolific Authors<br>(n ≥ 02) |    | Most Productive Countries (n ≥ 02) |    | Most Productive Institutions<br>(n ≥ 02)                |    |
|---------------------------------------------------------------|----|-----------------------------------|----|------------------------------------|----|---------------------------------------------------------|----|
| Journal                                                       | TP | Author                            | TP | Country                            | TP | Institution                                             | TP |
| Journal of Operations Management                              | 7  | Gastaldi, L.                      | 5  | United States                      | 48 | Politecnico di Milano                                   | 5  |
| Technological Forecasting and Social Change                   | 5  | Corso, M.                         | 4  | Italy                              | 10 | University at Buffalo, The State University of New York | 3  |
| MIS Quarterly Management Information Systems                  | 4  | Boyer, K.K.                       | 3  | United Kingdom                     | 9  | Lehigh University                                       | 2  |
| Information Systems Research                                  | 3  | Barrett, M.                       | 2  | Australia                          | 6  | The Ohio State University                               | 2  |
| International Journal of Medical Informatics                  | 3  | Darzi, A.                         | 2  | Canada                             | 6  | National Taiwan University                              | 2  |
| Management Science                                            | 3  | Dey, A.                           | 2  | Germany                            | 6  | Brigham Young University                                | 2  |
| Sustainability Switzerland                                    | 3  | Gardner, J.W.                     | 2  | China                              | 4  | Hong Kong Polytechnic University                        | 2  |
| Australian Health Review                                      | 2  | Kohli, R.                         | 2  | South Korea                        | 4  | Auburn University                                       | 2  |
| Decision Support Systems                                      | 2  | McQueen, J.                       | 2  | Hong Kong                          | 3  | City University of Hong Kong                            | 2  |
| European Journal of Information Systems                       | 2  | Parston, G.                       | 2  | Taiwan                             | 3  | Imperial College London                                 | 2  |
| Health Policy and Technology                                  | 2  | Patel, H.                         | 2  | Denmark                            | 2  | University of Washington                                | 2  |
| Information Systems Frontiers                                 | 2  | Sharman, R.                       | 2  | Finland                            | 2  | Rheinisch-Westfälische Technische Hochschule Aachen     | 2  |
| International Journal of Healthcare Technology and Management | 2  | Sherer, S.A.                      | 2  | France                             | 2  | Indiana University Bloomington                          | 2  |
|                                                               |    | Staib, A.                         | 2  | Greece                             | 1  | Princess Alexandra Hospital                             | 2  |
|                                                               |    | Sullivan, C.                      | 2  | Iran                               | 1  | Università degli Studi di Roma Tor Vergata              | 2  |
|                                                               |    | Tan, Y.                           | 2  | Japan                              | 1  | Temple University                                       | 2  |
|                                                               |    | Wang, Y.                          | 2  | Morocco                            | 1  | University of Cambridge                                 | 2  |
|                                                               |    |                                   |    | New Zealand                        | 1  | University of Akron                                     | 2  |
|                                                               |    |                                   |    | Qatar                              | 1  | VTT Technical Research Centre of Finland                | 2  |
|                                                               |    |                                   |    | Romania                            | 1  | Cambridge Judge Business School                         | 2  |
|                                                               |    |                                   |    | Russian Federation                 | 1  | Raymond A. Mason School of Business                     | 2  |
|                                                               |    |                                   |    | Saudi Arabia                       | 1  | Foster School of Business                               | 2  |

#### 4.2. Most Productive Journals, Authors, Countries, and Institutions

The most productive journals, authors, countries, and institutions have been identified in the searched area of 'digital transformation in healthcare' before and after COVID-19 (Table 1 & Table 2). It is the Journal of Operations Management that contributes the most by producing 07 articles based on digital transformation and healthcare and it is taken over by the International Journal of Environmental Research and Public Health which has contributed 64 articles after the Covid-19. Gastaldi, L. is the leading author who has produced 05 papers before COVID-19, and Cresswell, K., Sheikh, A., and Williams, R. are leading after COVID-19 by producing 06 publications respectively. Before COVID-19, the United States appeared leading all other countries with 48 publications whereas the United Kingdom replaced it after Covid-19 by producing 92 publications. Among the most productive institutions, Politecnico di Milano is leading with 05 publications and after Covid-19, it is the University of Melbourne contributed 12 publications in 'digital transformation and healthcare'.

Table 2

Table of most productive journals, authors, countries and institutions after Covid-19.

| Most Productive Journals<br>(n ≥ 05)                                |    | Most Prolific<br>Authors<br>(n ≥ 04) |    | Most Productive<br>Countries (n ≥ 20) |    | Most Productive Institutions<br>(n ≥ 08)       |    |
|---------------------------------------------------------------------|----|--------------------------------------|----|---------------------------------------|----|------------------------------------------------|----|
| Journal                                                             | TP | Author                               | TP | Country                               | TP | Institution                                    | TP |
| International Journal of Environmental Research and Public Health   | 64 | Cresswell, K.                        | 6  | United Kingdom                        | 92 | University of Melbourne                        | 12 |
| Sustainability Switzerland                                          | 32 | Sheikh, A.                           | 6  | United States                         | 84 | Parthenope University of Naples                | 11 |
| Technological Forecasting and Social Change                         | 28 | Williams, R.                         | 6  | Italy                                 | 67 | The University of Edinburgh                    | 11 |
| IEEE Access                                                         | 22 | Schiavone, F.                        | 5  | Germany                               | 65 | Queensland University of Technology            | 10 |
| Journal of Medical Internet Research                                | 16 | Sullivan, C.                         | 5  | China                                 | 60 | Università degli Studi di Napoli Federico II   | 10 |
| BMC Health Services Research                                        | 10 | Capurro, D.                          | 4  | Australia                             | 52 | The University of Queensland                   | 10 |
| Journal of Business Research                                        | 10 | Eason, S.                            | 4  | India                                 | 40 | Edinburgh Medical School                       | 10 |
| International Journal of Medical Informatics                        | 8  | Gray, K.                             | 4  | Spain                                 | 27 | University College London                      | 9  |
| Sensors                                                             | 7  | Hinder, S.                           | 4  | Saudi Arabia                          | 25 | Oulun Yliopisto                                | 8  |
| Information Systems Research                                        | 6  | Horgan, D.                           | 4  | Finland                               | 24 | Norges Teknisk-Naturvitenskapelige Universitet | 8  |
| International Journal of Advanced Computer Science and Applications | 6  | Krasuska, M.                         | 4  | South Korea                           | 24 | Universidade Nova de Lisboa                    | 8  |
| Technology in Society                                               | 6  | Lane, W.                             | 4  | Canada                                | 23 | School of Computing and Information Systems    | 8  |
| Frontiers in Public Health                                          | 5  | Leone, D.                            | 4  | Netherlands                           | 23 |                                                |    |
| Information Switzerland                                             | 5  | Mason, K.                            | 4  | Portugal                              | 20 |                                                |    |
| Journal of Strategic Information Systems                            | 5  | Merolli, M.                          | 4  |                                       |    |                                                |    |
|                                                                     |    | Mozaffar, H.                         | 4  |                                       |    |                                                |    |

## 5. Bibliometric Maps

Mapping and visualization of two central themes of the current study – digital transformation & healthcare were performed on VOSviewer (Centre for Science and Technology Studies, Leiden University, Netherlands), a freely available software. It synthesizes the bibliometric maps about citations, author keywords, and bibliographical information of databases. Maps include items that represent the documents, authors, countries, and keywords. These items are associated with each other by the link and their strength. This link is shown with a positive numerical value. The higher the value, the higher the link strength between the two items (Van Eck & Waltman, 2013).

### 5.1. Co-authorship (Authors)

#### 5.1.1. Pre Covid-19

The co-authorship analysis embodies two authors contributing to a publication together. It is the link strength between two authors who have co-authored several publications. However, the total link strength (TLS) shows the total co-authorship strength of a selected author with other authors.

Different thresholds can be applied to software for sorting out the items. For Co-authorship (authors), the maximum number of authors per document remains at 25. The minimum number of documents of an author is 01, and the minimum number of citations is 00. It results in 276 total number of authors (n=276). The mapping of these authors has been visualized in two maps generated from VOSviewer. Map 1 (Figure 06) shows all authors connected with different other authors and grouped in different clusters. Among these connected clusters, the largest cluster or map (Figure 07) contains 16 authors who have collaborated in the publication of different papers in ‘digital transformation & healthcare’. Results of mapping of the literature before Covid-19 reveal that Gastaldi L. is leading all other authors in terms of

publication (documents; 05) and collaborations (total link strength; 18) whereas Wang Y. has been cited the most (Citations; 721) (Table 3).

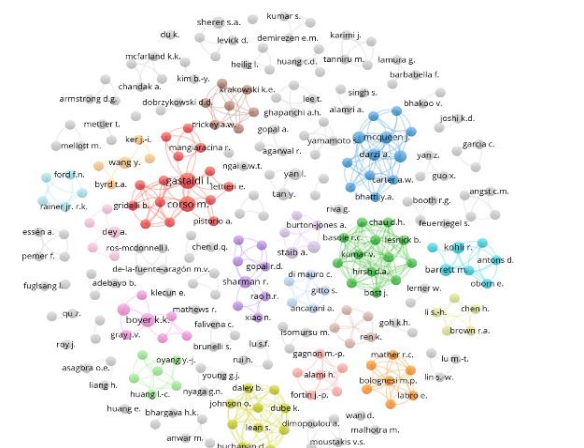


Fig. 6. Pre-Covid-19; Screenshot of Co-authorship (Authors): Complete set

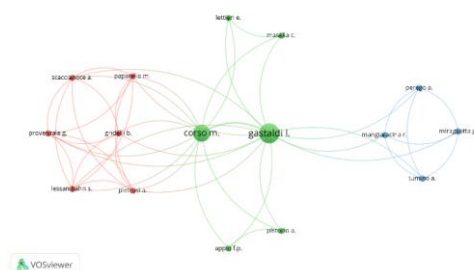


Fig. 7. Pre-COVID-19; Screenshot of Co-authorship (Authors): Largest connected set.

Table 3

List showing the most productive and collaborative authors before COVID-19.

| Total Link Strength (TLS; n≥9) |   |     |    | Documents (D; n≥2) |   |     |    | Citations (C; n≥102) |   |     |    |
|--------------------------------|---|-----|----|--------------------|---|-----|----|----------------------|---|-----|----|
| Author                         | D | C   | T  | Author             | D | C   | T  | Author               | D | C   | T  |
| Gastaldi L.                    | 5 | 115 | 18 | Gastaldi L.        | 5 | 115 | 18 | Wang Y.              | 2 | 721 | 4  |
| Corso M.                       | 4 | 105 | 14 | Corso M.           | 4 | 105 | 14 | Byrd T.A.            | 1 | 711 | 2  |
| Darzi A.                       | 2 | 46  | 14 | Boyer K.K.         | 3 | 137 | 7  | Kung L.              | 1 | 711 | 2  |
| Mcqueen J.                     | 2 | 46  | 14 | Darzi A.           | 2 | 46  | 14 | Sharman R.           | 2 | 234 | 7  |
| Parston G.                     | 2 | 46  | 14 | Mcqueen J.         | 2 | 46  | 14 | Rao H.R.             | 1 | 216 | 3  |
| Patel H.                       | 2 | 46  | 14 | Parston G.         | 2 | 46  | 14 | Upadhyaya S.         | 1 | 216 | 3  |
| Basole R.C.                    | 1 | 41  | 12 | Patel H.           | 2 | 46  | 14 | Xiao N.              | 1 | 216 | 3  |
| Bost J.                        | 1 | 41  | 12 | Barrett M.         | 2 | 66  | 7  | Chen D.Q.            | 1 | 189 | 2  |
| Braunstein M.L.                | 1 | 41  | 12 | Kohli R.           | 2 | 66  | 7  | Preston D.S.         | 1 | 189 | 2  |
| Chau D.H.                      | 1 | 41  | 12 | Sharman R.         | 2 | 234 | 7  | Xia W.               | 1 | 189 | 2  |
| Hirsh D.A.                     | 1 | 41  | 12 | Staib A.           | 2 | 39  | 5  | Lin S.-W.            | 1 | 141 | 2  |
| Kahng M.                       | 1 | 41  | 12 | Sullivan C.        | 2 | 39  | 5  | Lu M.-T.             | 1 | 141 | 2  |
| Kumar V.                       | 1 | 41  | 12 | Dey A.             | 2 | 47  | 4  | Tzeng G.-H.          | 1 | 141 | 2  |
| Lesnick B.                     | 1 | 41  | 12 | Gardner J.W.       | 2 | 45  | 4  | Alamri A.            | 1 | 139 | 2  |
| Park H.                        | 1 | 41  | 12 | Wang Y.            | 2 | 721 | 4  | Singh S.             | 1 | 139 | 2  |
| Schissel B.L.                  | 1 | 41  | 12 | Sherer S.A.        | 2 | 52  | 3  | Yassine A.           | 1 | 139 | 2  |
| Serban N.                      | 1 | 41  | 12 | Tan Y.             | 2 | 97  | 3  | Boyer K.K.           | 3 | 137 | 7  |
| Tamersoy A.                    | 1 | 41  | 12 | Yan L.             | 2 | 97  | 3  | Gastaldi L.          | 5 | 115 | 18 |
| Thompson M.                    | 1 | 41  | 12 |                    |   |     |    | Corso M.             | 4 | 105 | 14 |
| Buchanan D.                    | 1 | 26  | 9  |                    |   |     |    | Bhakoo V.            | 1 | 102 | 1  |
|                                |   |     |    |                    |   |     |    | Choi T.              | 1 | 102 | 1  |

### 5.1.2. Post Covid-19

Co-authorship analysis of authors after COVID-19 revealed the collaborations of different authors with one another. Map 1 (Figure 08) and Map 2 (Figure 09) show the visualization of coauthorship among authors. Cresswell K., Sheikh A., and Williams R. were leading in

producing the greatest number of publications (06) than others and, they are leading in collaboration with others based on their TLS (49). Kim D. was leading in securing most of the citations (252) than others mentioned in Table 4.

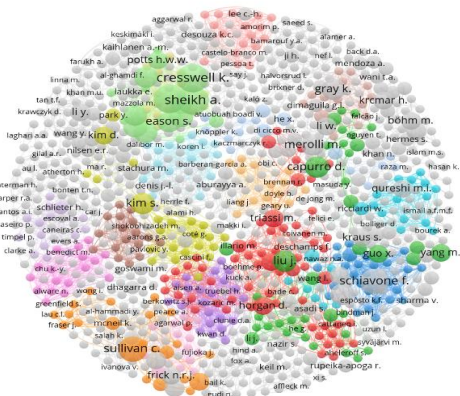


Fig. 8. Post Covid-19; Screenshot of Co-authorship (Authors): Complete set.

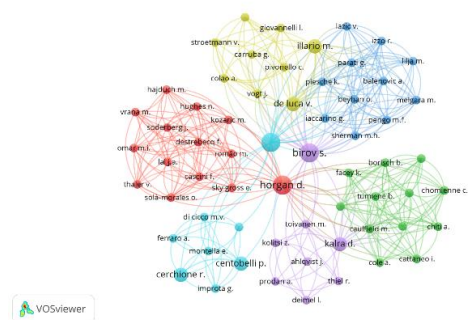


Fig. 9. Post Covid-19; Screenshot of Co-authorship (Authors): Largest connected set.

Table 4

Post-COVID-19; List of the most collaborative and productive authors.

| Documents (D; n≥04) |   |    |     | Citations (n≥100) |   |     |     | Total Link Strength (n≥22) |   |    |     |
|---------------------|---|----|-----|-------------------|---|-----|-----|----------------------------|---|----|-----|
| Author              | D | C  | TLS | Author            | D | C   | TLS | Author                     | D | C  | TLS |
| Cresswell K.        | 6 | 24 | 49  | Kim D.            | 3 | 252 | 5   | Cresswell K.               | 6 | 24 | 49  |

|              |   |     |    |                    |   |     |   |               |   |    |    |
|--------------|---|-----|----|--------------------|---|-----|---|---------------|---|----|----|
| Sheikh A.    | 6 | 24  | 49 | Atherton H.        | 1 | 193 | 7 | Sheikh A.     | 6 | 24 | 49 |
| Williams R.  | 6 | 24  | 49 | Bikker A.          | 1 | 193 | 7 | Williams R.   | 6 | 24 | 49 |
| Schiavone F. | 5 | 161 | 5  | Campbell J.        | 1 | 193 | 7 | Eason S.      | 4 | 17 | 45 |
| Sullivan C.  | 5 | 55  | 26 | Donaghy E.         | 1 | 193 | 7 | Hinder S.     | 4 | 17 | 45 |
| Capurro D.   | 4 | 43  | 8  | Hammersley V.      | 1 | 193 | 7 | Krasuska M.   | 4 | 17 | 45 |
| Eason S.     | 4 | 17  | 45 | Mckinstry B.       | 1 | 193 | 7 | Lane W.       | 4 | 17 | 45 |
| Gray K.      | 4 | 3   | 10 | Mcneilly H.        | 1 | 193 | 7 | Mason K.      | 4 | 17 | 45 |
| Hinder S.    | 4 | 17  | 45 | Robbins L.         | 1 | 193 | 7 | Mozaffar H.   | 4 | 17 | 45 |
| Kim S.       | 4 | 24  | 21 | Schiavone F.       | 5 | 161 | 5 | Franklin B.D. | 3 | 16 | 34 |
| Krasuska M.  | 4 | 17  | 45 | Kraus S.           | 3 | 129 | 8 | Potts H.W.W.  | 3 | 16 | 34 |
| Lane W.      | 4 | 17  | 45 | Xu X.              | 2 | 124 | 7 | Triassi M.    | 3 | 15 | 31 |
| Leone D.     | 4 | 76  | 6  | Aheleroff S.       | 1 | 119 | 6 | Birov S.      | 3 | 8  | 31 |
| Liu J.       | 4 | 61  | 15 | Aristizabal M.     | 1 | 119 | 6 | Sullivan C.   | 5 | 55 | 26 |
| Mason K.     | 4 | 17  | 45 | Joa B.             | 1 | 119 | 6 | Horgan D.     | 3 | 9  | 26 |
| Merolli M.   | 4 | 53  | 13 | Lu Y.              | 1 | 119 | 6 | Singh R.      | 2 | 4  | 26 |
| Mozaffar H.  | 4 | 17  | 45 | Pablo Velásquez J. | 1 | 119 | 6 | De Luca V.    | 2 | 7  | 24 |
|              |   |     |    | Valencia Y.        | 1 | 119 | 6 | Illario M.    | 2 | 7  | 24 |
|              |   |     |    | Jan S.             | 1 | 100 | 2 | Nguyen H.T.   | 2 | 6  | 22 |
|              |   |     |    | Nadeem A.          | 1 | 100 | 2 |               |   |    |    |
|              |   |     |    | Siddiqui M.S.      | 1 | 100 | 2 |               |   |    |    |

## 5.2. Co-authorship (Countries)

### 5.2.1. Pre Covid-19

Co-authorship analysis for countries is a mapping of the literature regarding associations and collaborations among countries. Keeping the thresholds the same as that of the authors, results showed a total of 28 items (countries). The largest connected cluster represents 12 countries

and their links with other countries. Both maps (Figure 10) and (Figure 11) show the dominance of the United States and its collaborations with other countries. The United States is leading in terms of publications (48), collaborations (21), and citations (2422). It also reveals that Greece, Romania, the Russian Federation, Singapore, and Sweden have not collaborated with any other country before COVID-19 in the area of ‘digital transformation and healthcare’ (Table 5).

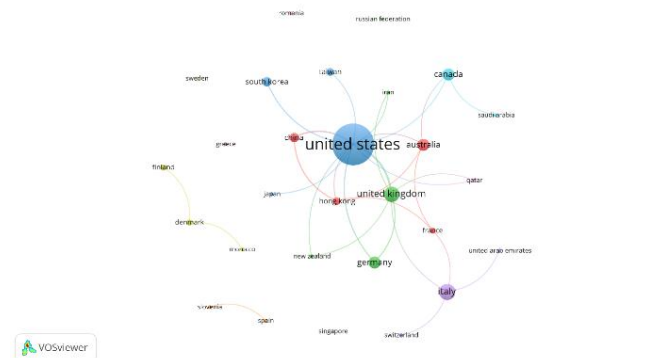


Fig. 10. Pre Covid-19; Screenshot of Co-authorship (Countries): Complete set.

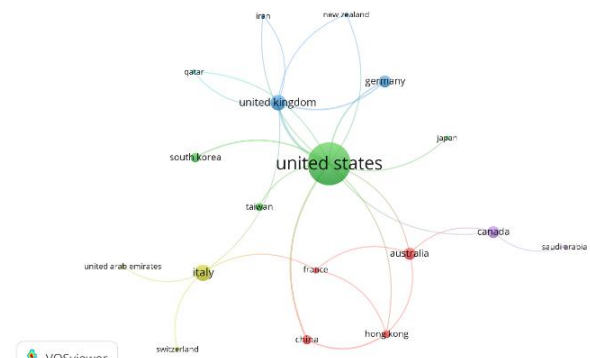


Fig. 11. Pre-COVID-19; Screenshot of Co-authorship (Countries): Largest connected set.

Table 5

Pre-COVID-19; List of the most collaborative and productive countries.

| Total Link Strength (n=28) |    |      |    | Documents (n=28) |    |      |    | Citations (n=28) |    |      |    |
|----------------------------|----|------|----|------------------|----|------|----|------------------|----|------|----|
| Country                    | D  | C    | T  | Country          | D  | C    | T  | Country          | D  | C    | T  |
| United States              | 48 | 2422 | 21 | United States    | 48 | 2422 | 21 | United States    | 48 | 2422 | 21 |
| United Kingdom             | 9  | 269  | 12 | Italy            | 10 | 219  | 4  | South Korea      | 4  | 287  | 2  |
| China                      | 4  | 124  | 5  | United Kingdom   | 9  | 269  | 12 | United Kingdom   | 9  | 269  | 12 |
| Hong Kong                  | 3  | 51   | 5  | Australia        | 6  | 168  | 4  | Taiwan           | 3  | 221  | 1  |
| Australia                  | 6  | 168  | 4  | Germany          | 6  | 159  | 4  | Italy            | 10 | 219  | 4  |

|                      |    |     |   |                      |   |     |   |                      |   |     |   |
|----------------------|----|-----|---|----------------------|---|-----|---|----------------------|---|-----|---|
| Germany              | 6  | 159 | 4 | Canada               | 6 | 201 | 3 | Canada               | 6 | 201 | 3 |
| Italy                | 10 | 219 | 4 | China                | 4 | 124 | 5 | Australia            | 6 | 168 | 4 |
| Canada               | 6  | 201 | 3 | South Korea          | 4 | 287 | 2 | Germany              | 6 | 159 | 4 |
| France               | 2  | 36  | 3 | Hong Kong            | 3 | 51  | 5 | Saudi Arabia         | 1 | 139 | 1 |
| Denmark              | 2  | 25  | 2 | Taiwan               | 3 | 221 | 1 | China                | 4 | 124 | 5 |
| Iran                 | 1  | 10  | 2 | France               | 2 | 36  | 3 | Hong Kong            | 3 | 51  | 5 |
| New Zealand          | 1  | 26  | 2 | Denmark              | 2 | 25  | 2 | France               | 2 | 36  | 3 |
| Qatar                | 1  | 18  | 2 | Finland              | 2 | 19  | 1 | Japan                | 1 | 33  | 1 |
| South Korea          | 4  | 287 | 2 | Iran                 | 1 | 10  | 2 | New Zealand          | 1 | 26  | 2 |
| Finland              | 2  | 19  | 1 | New Zealand          | 1 | 26  | 2 | Singapore            | 1 | 26  | 0 |
| Japan                | 1  | 33  | 1 | Qatar                | 1 | 18  | 2 | Denmark              | 2 | 25  | 2 |
| Morocco              | 1  | 9   | 1 | Japan                | 1 | 33  | 1 | Greece               | 1 | 22  | 0 |
| Saudi Arabia         | 1  | 139 | 1 | Morocco              | 1 | 9   | 1 | Switzerland          | 1 | 21  | 1 |
| Slovenia             | 1  | 5   | 1 | Saudi Arabia         | 1 | 139 | 1 | Finland              | 2 | 19  | 1 |
| Spain                | 1  | 5   | 1 | Slovenia             | 1 | 5   | 1 | Qatar                | 1 | 18  | 2 |
| Switzerland          | 1  | 21  | 1 | Spain                | 1 | 5   | 1 | United Arab Emirates | 1 | 18  | 1 |
| Taiwan               | 3  | 221 | 1 | Switzerland          | 1 | 21  | 1 | Iran                 | 1 | 10  | 2 |
| United Arab Emirates | 1  | 18  | 1 | United Arab Emirates | 1 | 18  | 1 | Morocco              | 1 | 9   | 1 |
| Greece               | 1  | 22  | 0 | Greece               | 1 | 22  | 0 | Romania              | 1 | 9   | 0 |
| Romania              | 1  | 9   | 0 | Romania              | 1 | 9   | 0 | Slovenia             | 1 | 5   | 1 |
| Russian Federation   | 1  | 2   | 0 | Russian Federation   | 1 | 2   | 0 | Spain                | 1 | 5   | 1 |
| Singapore            | 1  | 26  | 0 | Singapore            | 1 | 26  | 0 | Russian Federation   | 1 | 2   | 0 |
| Sweden               | 1  | 1   | 0 | Sweden               | 1 | 1   | 0 | Sweden               | 1 | 1   | 0 |

### 5.2.2. Post Covid-19

Mapping of post-Covid-19 analysis for co-authorship among countries highlighted the dominance and prominence of the United Kingdom (Figure 12 & Figure 13). It is leading in the publication of the most papers (92) and the most collaborations with other countries (118)

whereas the United States is leading in terms of citations (1294) (**Error! Reference source not found.**). It also revealed that Slovenia, South Africa, Peru, Kazakhstan, and Bangladesh did not collaborate with any other country after COVID-19 in the area of ‘digital transformation and healthcare’ (Tables 6 & 7).

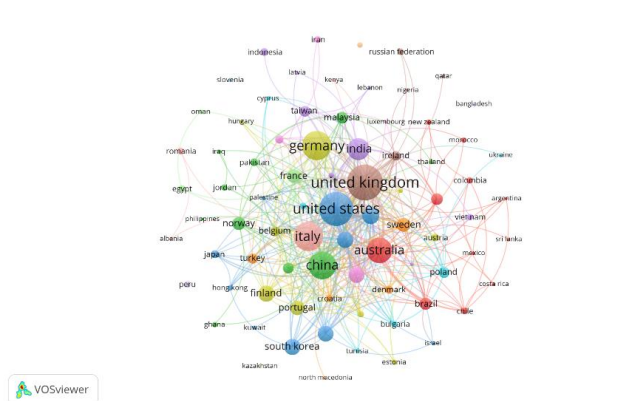


Fig. 12. Post Covid-19; Screenshot of Co-authorship (Countries): Complete set.

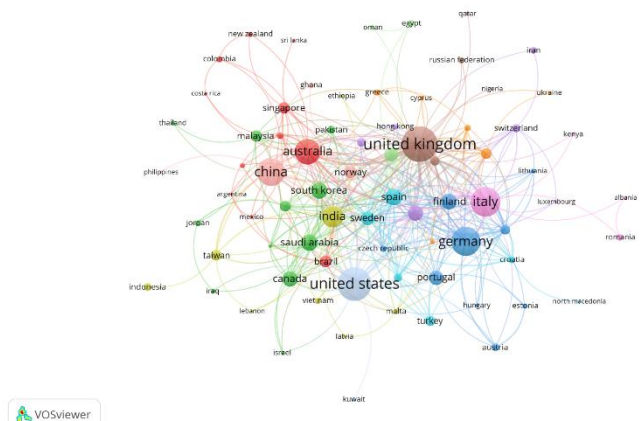


Fig. 13. Post Covid-19; Screenshot of Co-authorship (Countries): Largest connected set.

Table 6  
 Post-COVID-19; List of the most collaborative and productive countries.

| Documents (N≥10)     |    |      |     | Citations (N≥100) |    |      |     | Total Link Strength (N≥15) |    |      |     |
|----------------------|----|------|-----|-------------------|----|------|-----|----------------------------|----|------|-----|
| Country              | D  | C    | TLS | Country           | D  | C    | TLS | Country                    | D  | C    | TLS |
| United Kingdom       | 92 | 193  | 118 | United States     | 84 | 1294 | 70  | United Kingdom             | 92 | 193  | 118 |
| United States        | 84 | 1294 | 70  | Italy             | 67 | 917  | 86  | Italy                      | 67 | 917  | 86  |
| Italy                | 67 | 917  | 86  | Germany           | 65 | 816  | 48  | United States              | 84 | 1294 | 70  |
| Germany              | 65 | 816  | 48  | Viet Nam          | 5  | 697  | 4   | Netherlands                | 23 | 4    | 56  |
| China                | 60 | 362  | 51  | Australia         | 52 | 681  | 50  | Spain                      | 27 | 463  | 52  |
| Australia            | 52 | 681  | 50  | Finland           | 24 | 506  | 28  | China                      | 60 | 362  | 51  |
| India                | 40 | 441  | 32  | France            | 19 | 465  | 47  | Australia                  | 52 | 681  | 50  |
| Spain                | 27 | 463  | 52  | Spain             | 27 | 463  | 52  | Germany                    | 65 | 816  | 48  |
| Saudi Arabia         | 25 | 1    | 33  | India             | 40 | 441  | 32  | France                     | 19 | 465  | 47  |
| South Korea          | 25 | 68   | 19  | Qatar             | 2  | 393  | 1   | Belgium                    | 11 | 66   | 36  |
| Finland              | 24 | 506  | 28  | China             | 60 | 362  | 51  | Sweden                     | 19 | 0    | 35  |
| Canada               | 23 | 330  | 20  | Canada            | 23 | 330  | 20  | Saudi Arabia               | 25 | 1    | 33  |
| Netherlands          | 23 | 4    | 56  | New Zealand       | 4  | 261  | 3   | India                      | 40 | 441  | 32  |
| Portugal             | 20 | 42   | 16  | Sri Lanka         | 1  | 257  | 1   | Finland                    | 24 | 506  | 28  |
| France               | 19 | 465  | 47  | Austria           | 7  | 249  | 9   | Ireland                    | 10 | 96   | 26  |
| Sweden               | 19 | 0    | 35  | Singapore         | 14 | 237  | 12  | Canada                     | 23 | 330  | 20  |
| Norway               | 17 | 0    | 12  | Malaysia          | 14 | 220  | 15  | Brazil                     | 15 | 73   | 20  |
| Brazil               | 15 | 73   | 20  | United Kingdom    | 92 | 193  | 118 | South Korea                | 25 | 68   | 19  |
| Malaysia             | 14 | 220  | 15  | Slovenia          | 3  | 191  | 0   | Poland                     | 13 | 0    | 19  |
| Singapore            | 14 | 237  | 12  | Denmark           | 8  | 178  | 16  | Denmark                    | 8  | 178  | 16  |
| Poland               | 13 | 0    | 19  | Nigeria           | 1  | 139  | 1   | Czech Republic             | 5  | 57   | 16  |
| Taiwan               | 13 | 53   | 13  | Colombia          | 5  | 130  | 4   | Portugal                   | 20 | 42   | 16  |
| United Arab Emirates | 13 | 6    | 13  | Egypt             | 6  | 116  | 3   | Bulgaria                   | 5  | 33   | 16  |
| Turkey               | 12 | 5    | 8   | Malta             | 4  | 107  | 11  | Malaysia                   | 14 | 220  | 15  |
| Belgium              | 11 | 66   | 36  | Ukraine           | 2  | 107  | 2   | Switzerland                | 8  | 87   | 15  |
| Ireland              | 10 | 96   | 26  |                   |    |      |     | Croatia                    | 6  | 49   | 15  |

Table 7  
 Post-COVID-19; List of the countries with no collaborations.

| Countries with No Collaborations |   |     |     |
|----------------------------------|---|-----|-----|
| Country                          | D | C   | TLS |
| Slovenia                         | 3 | 191 | 0   |
| South Africa                     | 4 | 81  | 0   |
| Peru                             | 5 | 3   | 0   |
| Kazakhstan                       | 2 | 2   | 0   |
| Bangladesh                       | 1 | 0   | 0   |

### 5.3. Co-occurrence (Author Keywords)

#### 5.3.1. Pre Covid-19

Co-occurrence analysis represents the occurrence of items in a particular document. The current study's mapping of the literature contains co-occurrence of author keywords. Results revealed a total of 339 keywords after merging similar keywords. Visualization of all these keywords is shown in Figure 14. The co-occurrence of these keywords is organized into two themes i.e., healthcare-related themes (Appendix – I) and digital transformation-related themes (Table 8). Before COVID-19, these prominent keywords were included and studied most in the studies mentioning digital transformation and healthcare. The most prominent keywords related to digital transformation are 'Information and Communication Technologies' (Occurrence, 04; TLS, 20), 'Big Data' (Occurrence, 03; TLS, 18), 'Cloud Computing' (Occurrence, 03; TLS, 16), 'Internet of Things' (Occurrence, 03; TLS, 23) and others mentioned in Table. Similarly,

'Electronic Health Records' (Occurrence, 13; TLS, 66), 'Healthcare Information Technology' (Occurrence, 12; TLS, 66), 'Healthcare Information Systems' (Occurrence, 04; TLS, 18), 'Hospitals' (Occurrence, 04; TLS, 20) and others mentioned in Table 9 are the dominant keywords found before Covid-19.

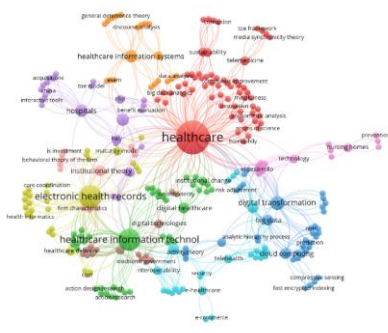


Fig. 14. Pre Covid-19; Co-occurrence of Author Keywords.

Table 8  
 Pre-COVID-19; Co-occurrence of author keywords (Themes related to Healthcare).

| Healthcare-related themes before COVID-19           |             |     |
|-----------------------------------------------------|-------------|-----|
| Keyword                                             | Occurrences | TLS |
| Healthcare                                          | 28          | 131 |
| Electronic Health Records                           | 13          | 66  |
| Healthcare Information Technology                   | 12          | 66  |
| Healthcare Information Systems                      | 4           | 18  |
| Hospitals                                           | 4           | 20  |
| Digital Healthcare                                  | 3           | 16  |
| E-Healthcare                                        | 2           | 6   |
| Health Care Supply Chain                            | 2           | 8   |
| Healthcare Delivery                                 | 2           | 8   |
| Nursing Homes                                       | 2           | 7   |
| Patient Engagement                                  | 2           | 7   |
| Telehealth                                          | 2           | 13  |
| Telemedicine                                        | 2           | 8   |
| Access to Oral Health Care                          | 1           | 3   |
| Dentistry                                           | 1           | 3   |
| Diabetes                                            | 1           | 9   |
| Diabetic Foot Care                                  | 1           | 9   |
| Diabetic Foot Ulcers                                | 1           | 9   |
| Health                                              | 1           | 7   |
| Health Care Applications                            | 1           | 9   |
| Health Informatics                                  | 1           | 9   |
| Health Information Exchange                         | 1           | 2   |
| Health Information Technology (Hit) Functionalities | 1           | 4   |
| Health Information Technology Assessment            | 1           | 4   |
| Health Information Technology Planning              | 1           | 4   |
| Health Policy                                       | 1           | 5   |
| Health Promotion                                    | 1           | 3   |
| Health Status                                       | 1           | 4   |
| Health Technology                                   | 1           | 4   |
| Healthcare Interoperability                         | 1           | 7   |
| Healthcare Management                               | 1           | 3   |
| Healthcare Predictive Analytics                     | 1           | 5   |
| Hospital Characteristics                            | 1           | 4   |
| Hospital Operations                                 | 1           | 8   |
| Hospital Operations Management                      | 1           | 3   |
| Hospital-Based Health Technology Assessment         | 1           | 5   |

Table 9  
 Pre Covid-19; Co-occurrence of author keywords (Themes related to digital transformation)

| Digital Transformation themes before Covid-19 |             |     |
|-----------------------------------------------|-------------|-----|
| Keyword                                       | Occurrences | TLS |
| Digital Transformation                        | 5           | 30  |
| Information and Communication Technologies    | 4           | 20  |
| Big Data                                      | 3           | 18  |
| Cloud Computing                               | 3           | 16  |
| Internet of Things                            | 3           | 23  |
| Digital Technologies                          | 2           | 10  |
| Information Technology                        | 2           | 9   |
| Big Data Analytics                            | 1           | 4   |
| Big Data Analytics Architecture               | 1           | 4   |
| Big Data Analytics Capabilities               | 1           | 4   |
| Cloud Virtual Machine (Vm)                    | 1           | 4   |
| Cloud-Based Prediction Model                  | 1           | 4   |
| Digital Data                                  | 1           | 4   |
| Digital Divide                                | 1           | 4   |

|                        |   |   |
|------------------------|---|---|
| Digital Maturity       | 1 | 4 |
| Digital Objects        | 1 | 4 |
| Digital Platforms      | 1 | 7 |
| Digitalization         | 1 | 5 |
| Task-Technology Fit    | 1 | 9 |
| Technology Abandonment | 1 | 7 |
| Technology Adoption    | 1 | 3 |
| Technology Readiness   | 1 | 4 |
| Technology Use         | 1 | 7 |

### 5.3.2. Post Covid-19

Post-COVID-19 keyword analysis for co-occurrence resulted in 342 items (author keywords) with 15 clusters, 1934 links, and 2572 total link strength presented in Figure 15. The bibliometric map shows the dominance of certain themes such as digital transformation, healthcare, the Internet of things, COVID-19, telemedicine, blockchain, and others. Obtained keywords have been organized into three themes i.e., digital transformation, healthcare, and other emerging themes that become the focus of research after COVID-19 (Appendix – I).

The prominent themes associated with digital transformation include artificial intelligence, the Internet of Things, digitalization, digital technologies, big data, and others mentioned in Appendix – I. These themes remained the focus of studies after Covid-19. Similarly, COVID-19, e-health, hospital, telemedicine, digital health, and others mentioned in the table were found to be prominent in healthcare. The third theme associated with other emerging themes comprised blockchain, industry 4.0, innovation, digital strategy, digital innovation,

and others mentioned in the Table 10. Besides the central themes of the current study, these themes also remained the center of attention in the body of knowledge.

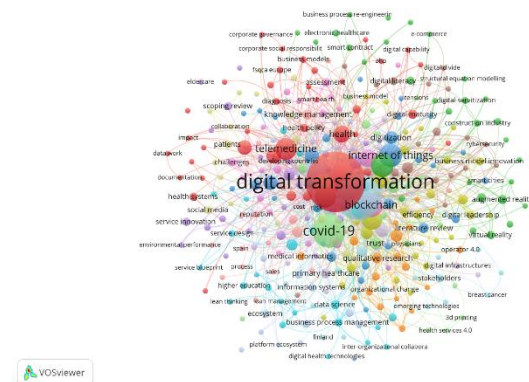


Fig. 15. Mapping of author keywords after Covid-19

Table 10

Post Covid-19, list of digital transformation themes, healthcare themes, and other emerging themes

| Digital Transformation Themes |            |     | Healthcare Themes          |            |     | Other Emerging Themes        |            |     |
|-------------------------------|------------|-----|----------------------------|------------|-----|------------------------------|------------|-----|
| Item                          | Occurrence | TLS | Item                       | Occurrence | TLS | Item                         | Occurrence | TLS |
| Digital Transformation        | 218        | 497 | Healthcare                 | 128        | 327 | Blockchain                   | 35         | 93  |
| Artificial Intelligence       | 42         | 127 | Covid-19                   | 68         | 155 | Industry 4.0                 | 26         | 73  |
| Digitalization                | 33         | 90  | E-health                   | 29         | 80  | Innovation                   | 19         | 68  |
| Internet of Things            | 33         | 85  | Hospital                   | 29         | 92  | Digital Strategy             | 14         | 45  |
| Digital Technologies          | 23         | 82  | Telemedicine               | 29         | 94  | Digital Innovation           | 11         | 27  |
| Big Data                      | 18         | 52  | Digital Health             | 26         | 97  | Sustainability               | 11         | 42  |
| Technology                    | 14         | 42  | Health                     | 17         | 44  | Digitization                 | 10         | 36  |
| Cloud Computing               | 8          | 25  | Telehealth                 | 15         | 56  | Systematic Literature Review | 10         | 24  |
| Information Technology        | 8          | 18  | Electronic Health Records  | 13         | 32  | Trust                        | 10         | 27  |
| Machine Learning              | 8          | 28  | Mobile Health              | 13         | 34  | Bibliometric Analysis        | 7          | 15  |
| Big Data Analytics            | 6          | 18  | Electronic Medical Records | 9          | 18  | Communication                | 7          | 24  |
| Augmented Reality             | 5          | 10  | Public Health              | 8          | 24  | Leadership                   | 9          | 33  |
| Data Science                  | 5          | 11  | Primary Care               | 6          | 14  | Interoperability             | 7          | 14  |
| Digital Maturity              | 5          | 12  | Primary Healthcare         | 6          | 18  | Literature Review            | 7          | 17  |
| Digital Twin                  | 5          | 13  | Patient Safety             | 5          | 21  | Qualitative Research         | 7          | 17  |
| Institutional Logics          | 5          | 11  |                            |            |     | Knowledge Management         | 6          | 20  |
|                               |            |     |                            |            |     | Supply Chain                 | 6          | 20  |
|                               |            |     |                            |            |     | Change Management            | 5          | 23  |
|                               |            |     |                            |            |     | Privacy                      | 5          | 14  |
|                               |            |     |                            |            |     | Risk                         | 5          | 13  |
|                               |            |     |                            |            |     | Risk Management              | 5          | 16  |
|                               |            |     |                            |            |     | Security                     | 5          | 18  |

## 6. Discussion

The current study is intended to achieve certain objectives in identifying the publication trend of digital transformation in healthcare services, the most productive, prominent, and prolific authors, countries, institutions, subject areas, collaborations among authors and countries, and emerging themes before and after COVID-19. It discusses the transition of these items from pre-COVID-19 to post-COVID-19 literature.

Publication output trend kept increasing before and after COVID-19. However, the rate and number of publications based on digital transformation in healthcare were greater in post-Covid-19. It reflects that COVID-19 has triggered researchers to unpack the role of digital technologies as digital transformation in healthcare services. Results reported the transition of subject areas being dominated by digital transformation in healthcare. A major focus was placed on Business, Management, and Accounting in pre-Covid-19 whereas Medicine and computer science took over when Covid-19 hit the world and researchers shifted their focus to these subject areas. Similarly, sources (journals) containing themes of business & management were reported dominant before COVID-19 which are taken over by sources (journals) associated with the environment, public health, technology, information systems, and others.

Moreover, the United States remained the center of published studies related to the central themes of the current study before Covid-19 and it has collaborated the most with other countries. However, Covid-19 infected Europe especially the United Kingdom and Italy badly and most of the publications and collaborations started coming from these two countries after COVID-19.

Certain thematic transitions from pre-Covid-19 to post-Covid-19 have been identified in the current study. Themes (keywords) such as Big Data, Cloud Computing, Internet of things, Digital Technologies, Electronic Health Records, Healthcare Information Technology & Systems, and Digital Healthcare have been considered prominent alike before and after COVID-19. Some themes have emerged after COVID-19 that have drawn the attention of researchers around the globe. These themes are Artificial Intelligence, Machine Learning, Blockchain, Industry 4.0, Digital Strategy, Digital Innovation, Digital Maturity, Digital Twin, and Sustainability.

## 7. Limitations and Future Research Directions

The current study is not free from limitations. The search term was limited to 'digital transformation & healthcare services' only, therefore, it may not cover all the aspects of the topic. The current study excluded the 2023 year thus possibly excluding the most recent developments in the central topic of the study. Data extracted for mapping of the literature was driven from only one database i.e. Scopus, which possibly has limited the findings of the current study.

The findings of the current study have revealed some avenues for future considerations. First, there are a few interesting subject areas related to digital transformation and healthcare services where minimal research and studies have been noticed such as Dentistry, Immunology & Microbiology, Pharmacology & Toxicology, Biochemistry, Genetics & Molecular Biology, Health Professions, Psychology, and Decision Sciences. Asian countries are far behind the European and Western countries where more studies are suggested in the central theme of the current study. A few countries e.g., Slovenia, South Africa, Peru, Kazakhstan, and Bangladesh have not collaborated with any other country in the said research area, it is recommended to collaborate with these countries. Different themes emerged that can revolutionize the body of knowledge in general; digital transformation and healthcare in particular, therefore, researchers are suggested to focus on these

emerging themes after Covid-19. These themes are such as Artificial Intelligence, IoT, Big data, Cloud Computing, Machine Learning, AR, Data Science, Digital Maturity, Digital Twin, Digital Health, Electronic Health Records, Mobile Health, Blockchain, Industry 4.0, Digital Strategy, Digital Innovation, and Sustainability.

## 8. Conclusion

This study presented a literature mapping of two themes: digital transformation and healthcare services. Mapping covered two stages of the literature: before Covid-19 i.e., from 2000 to 2018, and after Covid-19 i.e., from 2019 to 2022. It was observed and analyzed that there has been a rapid hike in publications related to digital transformation in healthcare services after COVID-19. Digital transformation has become the utmost research avenue for researchers and practitioners specifically in healthcare because COVID-19 has changed the priorities of everyone in this world.

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## Appendix

### Research String

#### Before Covid-19

digital PRE/1 transformation AND healthcare AND services OR service AND ( LIMIT-TO ( EXACTKEYWORD , "Digital Transformation" ) OR LIMIT-TO ( EXACTKEYWORD , "Health Care" ) OR LIMIT-TO ( EXACTKEYWORD , "Health Care Delivery" ) OR LIMIT-TO ( EXACTKEYWORD , "Healthcare" ) OR LIMIT-TO ( EXACTKEYWORD , "Hospitals" ) OR LIMIT-TO ( EXACTKEYWORD , "Delivery Of Health Care" ) OR LIMIT-TO ( EXACTKEYWORD , "Health" ) OR LIMIT-TO ( EXACTKEYWORD , "Health Services" ) OR LIMIT-TO ( EXACTKEYWORD , "Health Care System" ) OR LIMIT-TO ( EXACTKEYWORD , "Healthcare Services" ) OR LIMIT-TO ( EXACTKEYWORD , "Hospital" ) OR LIMIT-TO ( EXACTKEYWORD , "Health Service" ) OR LIMIT-TO ( EXACTKEYWORD , "Healthcare Industry" ) ) AND ( EXCLUDE ( PUBYEAR , 2023 ) ) AND ( LIMIT-TO ( DOCTYPE , "ar" ) ) AND ( LIMIT-TO ( PUBSTAGE , "final" ) ) AND ( LIMIT-TO ( SRCTYPE , "j" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) ) AND ( EXCLUDE ( PUBYEAR , 2022 ) OR EXCLUDE ( PUBYEAR , 2021 ) OR EXCLUDE ( PUBYEAR , 2020 ) OR EXCLUDE ( PUBYEAR , 2019 ) )

#### After Covid-19

**digital PRE/1 transformation AND healthcare AND services OR service AND ( LIMIT-TO ( EXACTKEYWORD , "Digital Transformation" ) OR LIMIT-TO ( EXACTKEYWORD , "Health Care" ) OR LIMIT-TO ( EXACTKEYWORD , "Health Care Delivery" ) OR LIMIT-TO ( EXACTKEYWORD , "Healthcare" ) OR LIMIT-TO ( EXACTKEYWORD , "Hospitals" ) OR LIMIT-TO ( EXACTKEYWORD , "Delivery Of Health Care" ) OR LIMIT-TO ( EXACTKEYWORD , "Health" ) OR LIMIT-TO ( EXACTKEYWORD , "Health Services" ) OR LIMIT-TO ( EXACTKEYWORD , "Health Care System" ) OR LIMIT-TO ( EXACTKEYWORD , "Healthcare Services" ) OR LIMIT-TO ( EXACTKEYWORD , "Hospital" ) OR LIMIT-TO ( EXACTKEYWORD , "Health Service" ) OR LIMIT-TO ( EXACTKEYWORD , "Healthcare Industry" ) ) AND ( EXCLUDE ( PUBYEAR , 2023 ) ) AND ( LIMIT-TO ( DOCTYPE , "ar" ) ) AND ( LIMIT-TO ( PUBSTAGE , "final" ) ) AND ( LIMIT-TO ( SRCTYPE , "j" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) ) AND ( LIMIT-TO ( PUBYEAR , 2022 ) OR LIMIT-TO ( PUBYEAR , 2021 ) OR LIMIT-TO ( PUBYEAR , 2020 ) OR LIMIT-TO ( PUBYEAR , 2019 ) )**