



ORIGINAL ARTICLE

Review of the Status of Telemedicine Subject Presence in Scopus Database Scientific Articles

Mahdiyeh Khazaneha, AliHossein Ghasemi, Farideh KaabOmeir*, Najmeh Asabeh

Received 03/09/2025

Accepted for publication 28/09/2025

Published 29/10/2025

* **Correspondence to:** Farideh KaabOmeir, Department of Medical Library & Information Science, School of Allied Medical Sciences, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran, Postal Code: 61357-15794; Email: faridehkaabomir@yahoo.com

About the authors:

Mahdiyeh Khazaneha; PhD in Knowledge and Information Sciences, Assistant Professor, Department of General Courses, School of Medicine, Kerman University of Medical Sciences, Kerman, Iran.  

AliHossein Ghasemi; PhD in Library and Information Science, Associate Professor, Department of Medical Library and Information Science, School of Allied Medical Sciences, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.  

Farideh KaabOmeir; PhD in Knowledge and Information Sciences, Department of Medical Library and Information Science, School of Allied Medical Sciences, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.  

Najmeh Asabeh; B.S. in Library and Information Science, Department of Medical Library and Information Science, School of Allied Medical Sciences, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.  

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ABSTRACT

This study systematically examines scholarly trends in telemedicine research from 2020 to 2024, focusing on scientific growth and international collaboration. Using bibliometric data mining and lexical content analysis of 18,445 Scopus-indexed articles, we identified patterns in publication output, influential journals, active institutions, collaboration rates, and frequently used keywords. Articles were retrieved using the keywords “telemedicine,” “telehealth,” and “digital health,” with inclusion limited to English-language publications. Duplicates, conference abstracts, and non-peer-reviewed items were excluded. Findings showed an annual publication growth rate of 3.52%, with 24.17% of papers involving international collaboration. The International Journal of Environmental Research and Public Health, BMJ Open, and BMC Health Services Research had the highest publication volume. The University of California, the University of Toronto, and Harvard University led institutional contributions. Frequently occurring keywords included COVID-19, telemedicine, digital health, and health services accessibility. Despite progress, challenges such as infrastructure limitations, data privacy concerns, and uneven adoption across countries remain. This analysis highlights telemedicine’s transition from a supplementary tool to a core element of modern healthcare and underscores the need for future research on standardization, equity, and cross-national implementation.

Keywords: Telemedicine, Digital Health, Bibliometrics, Intersectoral Collaboration, Health Care Reform

INTRODUCTION

Telemedicine has become an essential component of contemporary healthcare, offering innovative modalities to enhance physician–patient interactions through digital technologies. By enabling timely, cost-effective access to care independent of geographic and temporal barriers, telemedicine has been shown to significantly improve the efficiency and responsiveness of health systems (1, 2). Its rapid expansion reflects not only technological advances but also patients’ increasing reliance on digital health resources, with studies indicating that over 40% of internet users search for health-related information online (3, 4).

The integration of digital platforms into medical practice has also transformed traditional models of physician–patient communication. Although the accessibility of abundant medical information online poses challenges related to misinformation and health literacy, healthcare providers have increasingly embraced telemedicine as a complementary solution (5, 6). Physicians now employ a wide range of digital communication channels—including teleconsultations, electronic health records, and patient education portals—to enhance care delivery, strengthen patient engagement, and promote shared decision-making (7, 8).



Historically, the origins of telemedicine can be traced to the 1960s, when the National Aeronautics and Space Administration (NASA) developed biomedical monitoring systems to track astronauts' physiological parameters during space missions (9). Early applications involved the remote transmission of electrocardiographic (ECG) signals, laying the foundation for remote health monitoring (10). In the 1970s, telemedicine expanded with the use of medical imaging and videoconferencing, facilitating physician-to-physician consultations across distances (11). By the 1990s, these innovations had matured into more structured care delivery systems, positioning telemedicine as a promising tool to improve access to healthcare.

Subsequent research highlighted the potential of telemedicine for clinical integration. In Iran, studies have shown that telemedicine can provide cost-effective solutions for underserved populations, although challenges such as cultural barriers, limited health literacy, and concerns about data security hinder large-scale adoption (12). More recent work has developed a model for telemedicine implementation in Iranian medical universities, stressing that managerial, technical, and infrastructural readiness are essential for sustainability (13).

At the global level, bibliometric studies have confirmed a significant surge of interest over the past decade, with publications in telemedicine increasing by more than 200% between 2017 and 2022, particularly during the COVID-19 pandemic (14). The United States has emerged as a leading contributor and hub for international collaboration (14). The pandemic also catalyzed an unprecedented shift toward virtual care, reshaping clinical workflows (15). Moreover, international organizations have emphasized telemedicine as a critical component of digital health strategies to achieve universal health coverage, particularly in low- and middle-income countries (16).

Alongside these clinical and policy developments, technological innovations such as artificial intelligence, the Internet of Things, wearable devices, and cloud computing have become transformative drivers of telemedicine applications (17). Studies have shown that these technologies not only improve diagnostic and therapeutic processes but also extend access to care for remote and vulnerable populations (7, 18). Collaborative efforts between healthcare providers, policymakers, and technology developers are therefore crucial to fully realize the potential of telemedicine.

Taken together, the evolution of telemedicine demonstrates its transition from experimental applications to a rapidly expanding global research domain. Yet, persistent challenges, including infrastructural inequalities, limited cultural acceptance, and data privacy concerns, must be addressed to ensure its sustainable and equitable integration into healthcare systems worldwide (15, 16).

The objective of this study was to examine the status of telemedicine in scientific publications indexed in the Scopus database. By identifying research trends and analyzing publication patterns, this study seeks to provide a deeper understanding of scientific priorities and knowledge gaps in this evolving field.

METHODS

This study employed a bibliometric and lexical content analysis to systematically examine peer-reviewed articles on telemedicine indexed in the Scopus database between 2020 and 2024. Bibliometric analysis enables the measurement of publication patterns, collaboration rates, and citation impact, while lexical content analysis provides insights into the frequency and distribution of keywords, thereby identifying emerging themes and research priorities (19, 20).

Data source and search strategy:

The Scopus database was selected due to its broad coverage of biomedical and interdisciplinary literature (1, 11). Articles were retrieved using the keywords “telemedicine,” “telehealth,” and “digital health.” Boolean operators were applied to maximize retrieval, and the search was restricted to journal articles published between January 2020 and December 2024.

The search was conducted in the Scopus database on June 30, 2024, to ensure inclusion of the most recent publications within the defined time frame. The period 2020–2024 was selected because it represents a critical phase in the evolution of telemedicine: the COVID-19 pandemic catalyzed the rapid expansion of digital health services worldwide (15, 16), followed by a transition toward long-term integration of telemedicine into healthcare systems supported by infrastructure improvements and digital health policies (14). This timeframe, therefore, captures both the surge in pandemic-driven telemedicine research and the subsequent post-pandemic consolidation phase, making it highly relevant for understanding global research trends.

Inclusion and exclusion criteria:

Eligible documents were original research or review articles written in English, focusing primarily on telemedicine or telehealth in clinical, technical, or policy contexts (15, 18). Excluded were editorials, conference abstracts, letters to the editor, and documents unrelated to healthcare applications of telemedicine. Duplicates were removed before analysis.

Data extraction and indicators:

For each included publication, bibliographic metadata were extracted, including publication year, authorship, journal title, institutional affiliation, citation counts, and keywords. Indicators such as annual publication growth, average citations per document, international collaboration rate, and co-authorship patterns were calculated (8, 14).

Keyword and content analysis:

Both author keywords and abstract terms were analyzed to identify high-frequency concepts and the evolution of themes. Visualization of keyword co-occurrence, institutional contributions, and international collaboration networks was performed using R software. This approach has been widely used in digital health bibliometric studies to track emerging topics (7, 16).

All figures presented in this study were generated by the authors using bibliometric data retrieved from the Scopus database. No third-party figures were used.



Ethical Statement

This study did not involve human participants, animals, or personal data. Therefore, it was not subject to ethical approval.

RESULTS

In this study, a total of 18,445 articles in telemedicine published between 2020 and 2024 were analyzed. The annual growth rate¹ of publications in this domain was 3.52%, with an average of three new sources published each year. The dataset examined included 22,288 general keywords and 23,401 author-defined specific keywords. A total of 103,062 individual authors contributed to research within this thematic area (Table 1).

TABLE I. DESCRIPTIVE INFORMATION ON THE TELEMEDICINE SUBJECT AREA

Description	Results
Timespan	2020:2024
article	18445
Annual Growth Rate %	3.52
Document Average Age	3
Average citations per doc	11.25
DOCUMENT CONTENTS	
Keywords Plus (ID)	22288
Author's Keywords (DE)	23401
Authors	103062
Authors of single-authored docs	691
Single-authored docs	782
Co-Authors per Doc	7.49
International co-authorships %	24.17

Trend of Changes in the Number of Telemedicine-Related Articles in Recent Years

The horizontal axis of the chart in Figure 1 represents the years of publication for telemedicine-related resources, while the vertical axis indicates the number of published sources in this field. The chart illustrates an overall upward trend in the number of articles over the five-year period. However, a downward trend in publications is observed from 2021 to 2023, followed by an upward trend in publications from 2023 onward.

Identifying Journals and Researchers with the Highest Volume of Publications in Telemedicine

The leading journals in the telemedicine domain, ranked by the number of published articles, are as follows: International Journal of Environmental Research and Public Health with 701 published articles; BMJ Open with 567 published articles; BMC Health Services Research with 538 published articles; and Journal of Medical Internet Research with 327 published articles in this field (Figure 2).

¹ Percentage increase or decrease in the number of published articles within a specific research domain over a defined time period.

The impact of journals in the telemedicine domain, measured by the h-index² of contributing authors, is ranked as follows: Journal of Medical Internet Research with an h-index of 37; International Journal of Environmental Research and Public Health with an h-index of 34; JAMA Network Open with an h-index of 34; BMC Public Health with an h-index of 29; and BMC Health Services Research with an h-index of 26 (Figure 3).

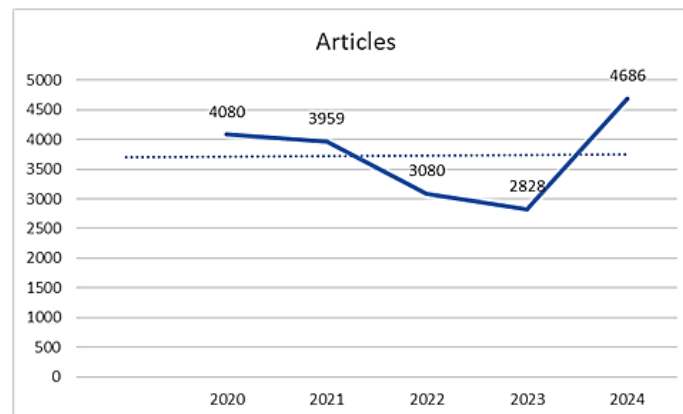


FIGURE I. ANNUAL FREQUENCY OF SCIENTIFIC PUBLICATIONS

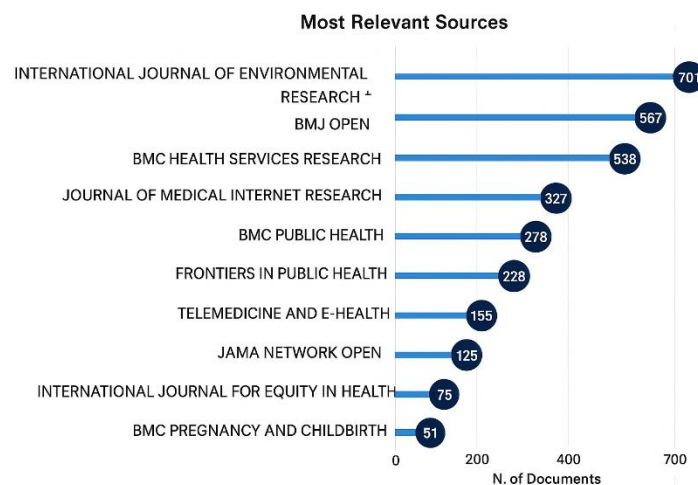


FIGURE II. LEADING JOURNALS IN THE FIELD OF TELEMEDICINE BASED ON THE G-INDEX

g-index: This metric assesses the impact of a researcher's publications and gives greater weight to highly cited articles.

² h-index: This metric reflects the scientific impact of an author or group of authors within a specific field or region. It is calculated based on the number of publications and the number of citations each publication has received.

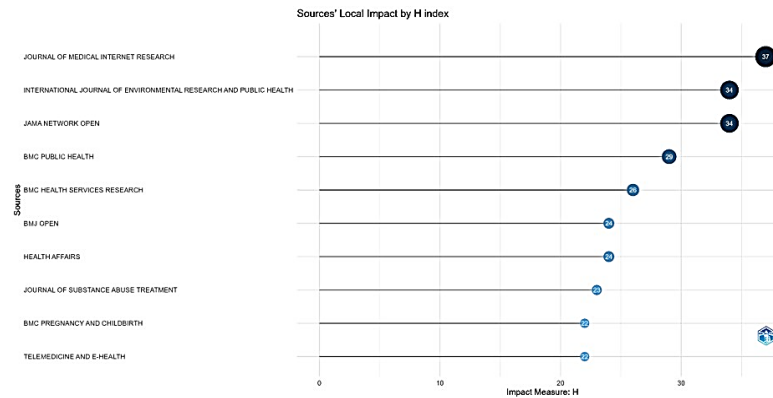


FIGURE III. JOURNAL IMPACT BASED ON H-INDEX

Figure 4 presents the distribution of scientific publications across five journals within the domain of public health and digital medicine between 2020 and 2024. The selected journals include: International Journal of Environmental Research and Public Health, BMJ Open, BMC Health Services Research, Journal of Medical Internet Research, and BMC Public Health. As illustrated, all journals demonstrated an upward trend in the number of published articles over the five-year period. Among them, the International Journal of Environmental Research and Public Health accounted for the highest volume of publications, while Journal of Medical Internet Research and BMC Public Health had the lowest. Notably, BMJ Open and BMC Health Services Research showed comparable publication rates over the observed period.

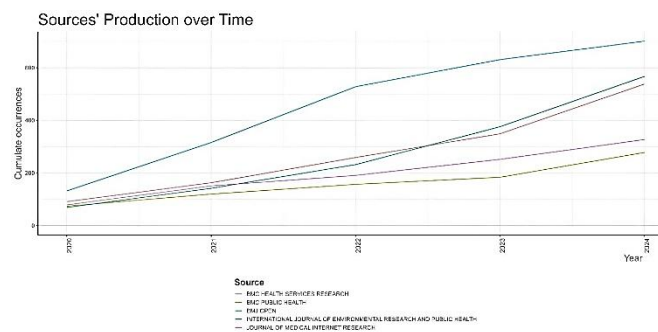


FIGURE IV. PUBLICATION TREND OF JOURNALS OVER A 5-YEAR PERIOD

Table 2 highlights the most influential scientific articles in telemedicine, ranked by citation frequency. As shown, the table provides detailed information for each article, including bibliographic data, individual citation counts, and the total number of references within the domain. The three most highly cited articles in this area are: Byrne et al. (2023), with 1,516 citations; Alzheimer's Disease Facts and Figures (2023), with 1,474 citations; and Surg (2020), with 1,114 citations.

TABLE II. MOST HIGHLY CITED ARTICLES IN THE FIELD OF TELEMEDICINE

Paper	DOI	Total Citations	TC per Year	Normalized TC
BYRNE RA, 2023, EUR HEART J	10.1093/eurheartj/ehad191	1516	505.33	288.80
NA NA, 2023, ALZHEIMER'S DEMENTIA	10.1002/alz.13016	1474	491.33	280.80
NEPOGODIEV D, 2020, BR J SURG	10.1002/bjs.11746	1114	185.67	44.81
CHURCHWELL K, 2020, CIRCULATION	10.1161/CIR.0000000000000936	687	114.50	27.63
CHICK RC, 2020, J SURG EDUC	10.1016/j.jsurg.2020.03.018	670	111.67	26.95
LEBEL C, 2020, J AFFECTIVE DISORD	10.1016/j.jad.2020.07.126	659	109.83	26.51
SAINI V, 2021, NEUROLOGY	10.1212/WNL.00000000000012781	653	130.60	41.94
HOGAN AB, 2020, LANCET GLOBAL HEALTH	10.1016/S2214-109X(20)30288-6	577	96.17	23.21
HAILE LM, 2021, LANCET	10.1016/S0140-6736(21)00516-X	568	113.60	36.48
JAVOID M, 2020, DIABETES METAB SYNDR CLIN RES REV	10.1016/j.dsx.2020.04.032	561	93.50	22.57

Figure 5 illustrates the distribution of author productivity in the telemedicine domain, as analyzed by Lotka's Law. The results indicated that over 60% of authors have contributed fewer than 5 scientific publications, while approximately 40% have authored 5 or more publications in this field.

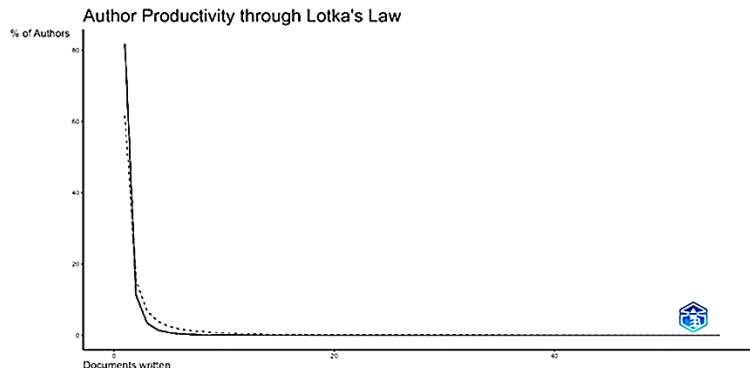


FIGURE V. NUMBER OF SCIENTIFIC WORKS BY AUTHORS BASED ON LOTKA'S LAW

An analysis of authors based on h-index and g-index metrics identifies the most influential contributors in the telemedicine domain. The top-ranked authors, in descending order of impact, are: WANG J, LI J, LIU Y, WANG Y, CHEN J, CHEN Y, LI Y, ZHANG J, CHEN S, and LI X (Table 3).

TABLE III. MOST HIGHLY CITED ARTICLES IN THE FIELD OF TELEMEDICINE

Author	<i>h_index</i>	<i>g_index</i>	<i>m_index</i> ³	<i>TC</i> ⁴	<i>NP</i> ⁵	<i>PY_start</i>
WANG J	17	40	2.833	6118	40	2020
LI J	15	48	2.5	2914	48	2020
LIU Y	14	44	2.333	3926	44	2020
WANG Y	14	52	2.333	3320	52	2020
CHEN J	13	45	2.167	2666	45	2020
CHEN Y	13	34	2.167	5301	34	2020
LI Y	13	55	2.167	5063	55	2020
ZHANG J	13	41	2.167	1708	41	2020
CHEN S	12	23	2	3756	23	2020
LI X	12	46	2	4133	46	2020

Identifying Institutions and Countries with the Highest Publication Output in Telemedicine

Figures 6 and 7 depict the institutional participation and publication frequency in the field of telemedicine over a five-year period. As illustrated in the charts, the most active institutions in this domain are the University of California (939 published articles), the University of Toronto (768), and Harvard Medical School (660).

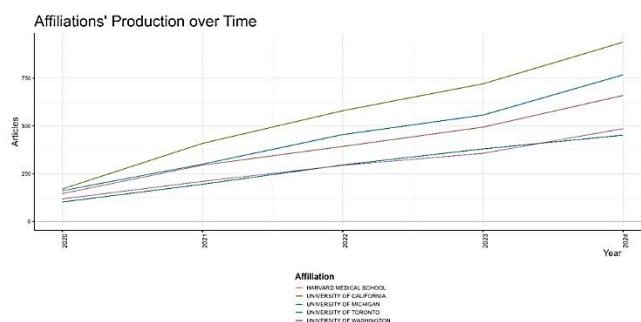


FIGURE VI. INSTITUTIONAL TRENDS IN SCIENTIFIC OUTPUT WITHIN THE FIELD OF TELEMEDICINE

³ A researcher's h-index is influenced by the duration of their academic activity, as both the number of publications and citations tend to increase over time. To enable fair comparisons among researchers at different stages of their careers, the M-index was introduced. This parameter is calculated by dividing a researcher's h-index by their academic age, defined as the number of years since their first article was published.

⁴ Total Citations

⁵ Number of Publications

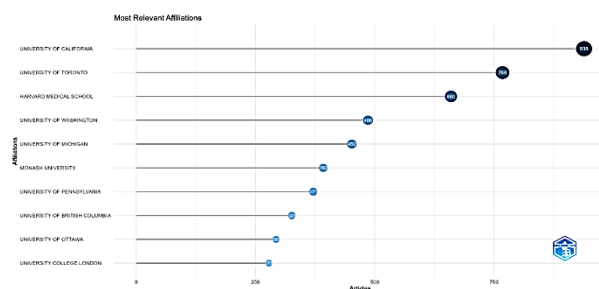


FIGURE VII. FREQUENCY OF SCIENTIFIC OUTPUT BY INSTITUTIONS IN THE FIELD OF TELEMEDICINE

Regarding the scientific output of countries in the field of telemedicine, Figure 8 illustrates the distribution of publications, distinguishing between single-country publications and multi-country (international) collaborations. As illustrated, the highest volume of single-country publications originates from the United States, Australia, and the United Kingdom, respectively. In contrast, the leading contributors to internationally co-authored publications are the United States, the United Kingdom, and Australia (Figure 8).

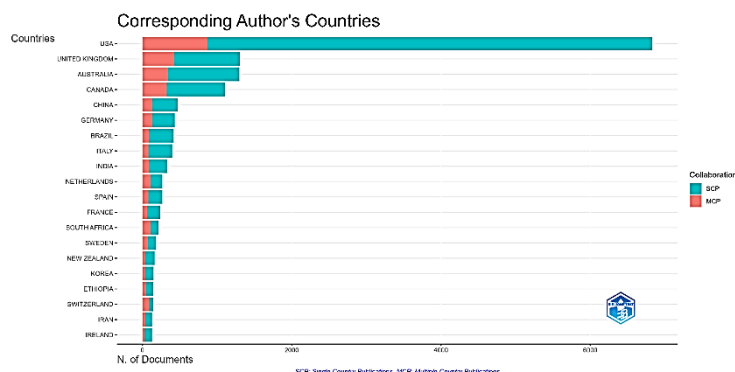


FIGURE VIII. NATIONAL AND INTERNATIONAL SCIENTIFIC COLLABORATIONS IN TELEMEDICINE

Identifying the Most Important Keywords in Telemedicine

Author and abstract keywords represented two distinct keyword groups, as shown in Table 4. Frequently used author keywords in telemedicine research include COVID-19, Telemedicine, Telehealth, Health Services Accessibility, Digital Health, and Mental Health. Common keywords in abstracts included health, care, patients, services, study, access, results, health care, data, and COVID-19.

Table 4 presents the most frequent author and abstract keywords. Among author keywords, “COVID-19” (n=2623), “telemedicine” (n=2329), and “telehealth” (n=1550) appeared most often. Abstract keywords such as “health” (n=50,614), “care” (n=46,254), and “patients” (n=28,610) were the most common. These frequencies highlight the dominance of pandemic-related themes alongside core telemedicine concepts.

TABLE IV. FREQUENCY OF AUTHOR AND ABSTRACT KEYWORDS

Authors keyword	Occurrences	Abstract Keyword	Occurrences
Covid-19	2623	Health	50614
Telemedicine	2329	Care	46254
telehealth	1550	Patients	28610
Health services accessibility	842	services	20039
Digital health	770	study	20020
Mental health	674	access	20996
Primary care	492	results	14067
Qualitative research	492	Health care	13809
Pandemic	441	data	13028
Public health	423	Covid-19	12207

Identifying the Key Research Topics in Telemedicine

Figure 9 illustrates the historical trends of topics in the field of telemedicine over a five-year period, categorized by frequency thresholds of 5,000, 10,000, and 15,000 occurrences. In 2020, the most frequently occurring topics were pneumonia, betacoronavirus, and priority journals, each with fewer than 5,000 mentions. In 2021, notable terms were procedures and pandemic (both <5,000), and health care delivery (5,000 occurrences). In 2022, the most prevalent topics were humans, human, and female, each appearing approximately 10,000 times. In 2023, dominant terms included interview (<5,000), qualitative research (5,000), and health care access (5,000). In 2024, emerging topics such as interviews, severe acute respiratory syndrome coronavirus 2, and therapy were each cited fewer than 5,000 times.

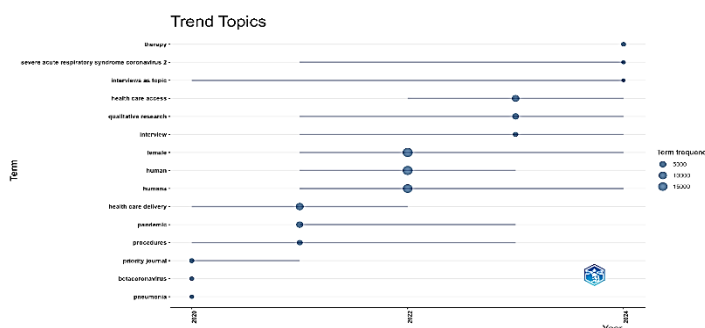


FIGURE IX. HISTORICAL TREND OF TOPIC FREQUENCY IN TELEMEDICINE OVER A 5-YEAR PERIOD

Figure 10 presents a thematic evolution map of the distribution and progression of telemedicine-related topics across three distinct time intervals, generated in R. Prominent topics in publications from 2020–2021 include health services accessibility and COVID-19. Key themes from 2022–2023 comprise Medicaid, COVID-19, access to care, health services accessibility, and digital health. Finally, the most prominent topics from 2024 are health services accessibility and telemedicine.

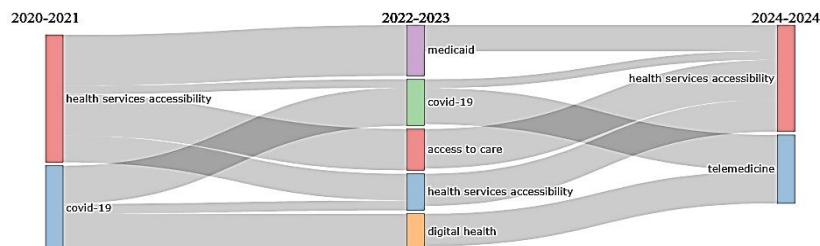


FIGURE X. THEMATIC EVOLUTION MAP OF TOPIC DISPERSAL IN TELEMEDICINE

DISCUSSION

The findings of this study demonstrate a consistent rise in scholarly attention to telemedicine between 2020 and 2024. Analysis of 18,445 articles during this period revealed an annual publication growth rate of 3.52%, reflecting the consolidation of telemedicine as both a healthcare delivery model and a research domain. This trend can be attributed to several interrelated drivers, including the increased demand for digital health services following the COVID-19 pandemic (15, 18), advances in information and communication technologies (17), and the strategic emphasis placed by international organizations such as the World Health Organization (2020) on digital health as a pathway to universal health coverage (16).

Beyond sheer publication volume, the diversity of research topics signals an expanding scope of inquiry. The dataset revealed over 22,000 general and 23,000 specialized keywords, highlighting both breadth and depth of engagement with the field. Frequently recurring terms such as COVID-19, telehealth, digital health, health services accessibility, and mental health reflect the multidisciplinary nature of telemedicine research and its integration into broader health system agendas (8, 14).

International collaboration emerged as a critical feature of telemedicine research. Approximately one-quarter of the analyzed articles were the product of cross-national partnerships, consistent with earlier bibliometric studies showing that the United States and Europe serve as hubs for global scientific collaboration in digital health (7, 14). Such collaborations not only enhance research quality by integrating diverse expertise but also facilitate the development of interoperable standards, which are crucial to ensuring the scalability of telehealth systems across jurisdictions (16).

The analysis also identified key journals that have shaped the intellectual trajectory of telemedicine. The Journal of Medical Internet Research and BMJ Open were among the most prolific outlets, with the former also ranking highest in terms of h-index, underscoring both volume and impact. This is consistent with prior findings that digital health-focused journals have played a leading role in disseminating innovations in telemedicine and virtual care (1, 11). Moreover, the concentration of influential publications in multidisciplinary journals highlights the integration of telemedicine into mainstream medical and public health discourse.



Author- and institution-level analyses further reinforce the global expansion of telemedicine scholarship. Leading contributors included researchers affiliated with top-tier universities such as the University of California, the University of Toronto, and Harvard Medical School. These institutions, long recognized for their leadership in digital health innovation, continue to play a pivotal role in advancing telemedicine through both empirical research and policy engagement (2, 7). The dominance of Chinese surnames among top contributors also reflects the rapid scaling of telehealth initiatives in Asia, particularly in China, where large-scale pilot programs have accelerated digital transformation in healthcare delivery.

Despite these advances, several persistent challenges limit the full integration of telemedicine. First, infrastructural inequalities remain a barrier, particularly in low- and middle-income countries lacking adequate broadband coverage and digital tools (16). Second, unresolved legal and ethical issues surrounding data protection and patient privacy continue to constrain adoption (2). Third, cultural and professional resistance persists, as both patients and physicians may be reluctant to fully embrace remote care modalities (12). Finally, the lack of international regulatory harmonization poses difficulties for establishing cross-border telemedicine practices, thereby limiting the scalability of global digital health frameworks (7).

Overall, this study highlights that telemedicine has transitioned from niche experimental applications in the mid-20th century (9, 10) to a core component of modern healthcare delivery. However, realizing its full potential requires addressing enduring barriers related to infrastructure, policy, and cultural acceptance.

This study has several limitations. First, the analysis was restricted to the Scopus database, which may not cover all relevant publications. Second, the study focused only on English-language articles, potentially excluding important research in other languages. Third, bibliometric indicators such as citation counts are time-dependent and may underestimate the impact of recent publications. Future studies should expand the scope by including additional databases and multilingual sources.

CONCLUSION

The bibliometric evidence underscores the strategic role of telemedicine in transforming healthcare systems worldwide. Sustained publication growth, coupled with increasing international collaboration, suggests that telemedicine has become an entrenched field of scientific inquiry and clinical practice. High-impact contributions from leading journals and prestigious institutions further highlight the centrality of telemedicine in contemporary health discourse. Looking forward, addressing infrastructural, ethical, and regulatory challenges will be essential to ensuring the equitable and sustainable integration of telemedicine into global health systems. In this sense, telemedicine represents not merely a technological innovation but a structural shift in healthcare delivery, with the potential to reshape access, quality, and equity in the coming decades.



Declaration of the Use of Artificial Intelligence Tools

Artificial intelligence tools (ChatGPT) were used to improve the English language and refine the structure of the manuscript. The authors reviewed, edited, and approved the final version, and they take full responsibility for the content of this publication.

Contributorship Statement

Author 1: Methodology, data analysis, validation, and critical revision of the manuscript.

Author 2: Conceptualization, critical revision of the manuscript. editing, and final approval of the version to be published.

Author 3: Methodology, data analysis, validation, and critical revision of the manuscript. Supervision, editing, and final approval of the version to be published.

Author 4: Literature review and manuscript drafting.

All authors reviewed and commented on the manuscript, as well as all being responsible for the content of the manuscript.

Funding Statement

This research did not receive any specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Declaration Of Conflicting Interests

The authors declared there are no conflicts of interest regarding the research, authorship, and publication of this article.

Data Availability Statements

No new data were generated or analyzed in support of this research.



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