

REVIEW OF TELEMEDICINE AND E-HEALTH: A BIBLIOMETRIC ANALYSIS

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ABSTRACT

The fields of telemedicine and e-health have grown in recent years due to advancements in technology and wearable devices. This research aimed to look back at the last 27 years of e-health and telemedicine studies to see how they've evolved. Article details for the selected papers were obtained from the Scopus database. Article details for the selected papers were retrieved using the Scopus database.

Existing data suggests an increasing tendency in the total number of publications, as well as an unusual distribution pattern for both authors and articles. Nine of the most influential researchers and the most often cited works were identified. VOS viewer software underwent keyword, author, and country co-occurrence analyses, as well as co-authorship analysis. According to a country-by-country research review, the United States, Italy, and Germany are the top three countries in article production in telemedicine and electronic health. Doarn (8 publications), Merrell R.C. (7 publications), Giansanti D. (7 publications), and Maccioni G (4 publications) were found to be the most prolific authors in the field of telemedicine and e-health. The study used bibliometric analysis to determine that the keywords "telemedicine," "human," and "e-health" were the most frequently used in the 69 publications chosen for the study.

This study is useful for telemedicine and e-health since it provides a thorough understanding of the literature in these subjects, highlighting the most studied and understudied areas from which to launch future research endeavours.

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KEYWORDS

citations, e-health, telemedicine

INTRODUCTION

The health outcomes of various situations, such as an accident or a lifelong chronic health condition, can be greatly influenced by the prompt and effective interchange of information [1]. Innovations in information and communication technology have made it possible for more people to share and access health-related data [2]. The health sector has deployed several Information and Communication Technology (ICTs) worldwide to improve the efficiency of information sharing across all levels of health care. In addition to easing communication between specialists, modern ICTs have made formerly inefficient clinical and consulting services much more cost-effective. In addition to easing communication between specialists, modern ICTs have made formerly inefficient clinical and consulting services much more cost-effective. In addition to easing communication between specialists, modern ICTs have made formerly inefficient clinical and consulting services much more cost-effective. The term "e-health" has come to describe the practice of utilizing information and ICTs to provide medical treatment [3]. When information and communication technologies are applied to medicine, the result is known as "eHealth." Access, activity, and monitoring are the three primary areas where e-health aims to enhance healthcare delivery. Telemedicine is a related but more prevalent concept.[2]. The phrases "telemedicine" and "e-health" are often used synonymously with one another [3].

Telemedicine is a crucial part of the digital transformation of conventional medical practice [4]. Telemedicine is an answer to the problem of underserved areas lacking adequate medical facilities, with the overarching goal of giving universal healthcare access [5]. There has been a worldwide uptick in interest in deploying telemedicine technology among healthcare institutions to deliver care and services [6] better. Over the past two decades, telemedicine's function has expanded to include virtual doctor visits, critical care, mental health monitoring, chronic disease management, and other previously available services through in-person doctor and hospital visits. Rapid growth in the area of telemedicine makes it difficult to keep up with the most current research and developing trends. Fortunately, bibliometric analysis makes it possible to assess a large body of literature in order to

identify the most productive authors, articles, and keywords. Even though the term "e-health" was developed far later than telemedicine (and its variants), telemedicine is currently the most talked about topic in the field of "e-health." The area of telemedicine and electronic health has been the subject of numerous systematic literature reviews and bibliometric analyses [7].

According to our understanding, this is the first study to present a bibliometric analysis of telemedicine and e-health literature based on Scopus-indexed papers from the previous decade (2000–2022). This study is distinctive in its incorporation of a thorough bibliometric examination (co-authorship analysis, co-occurrence analysis, and country-wise analysis) [8]. This study aims to determine these three research questions:

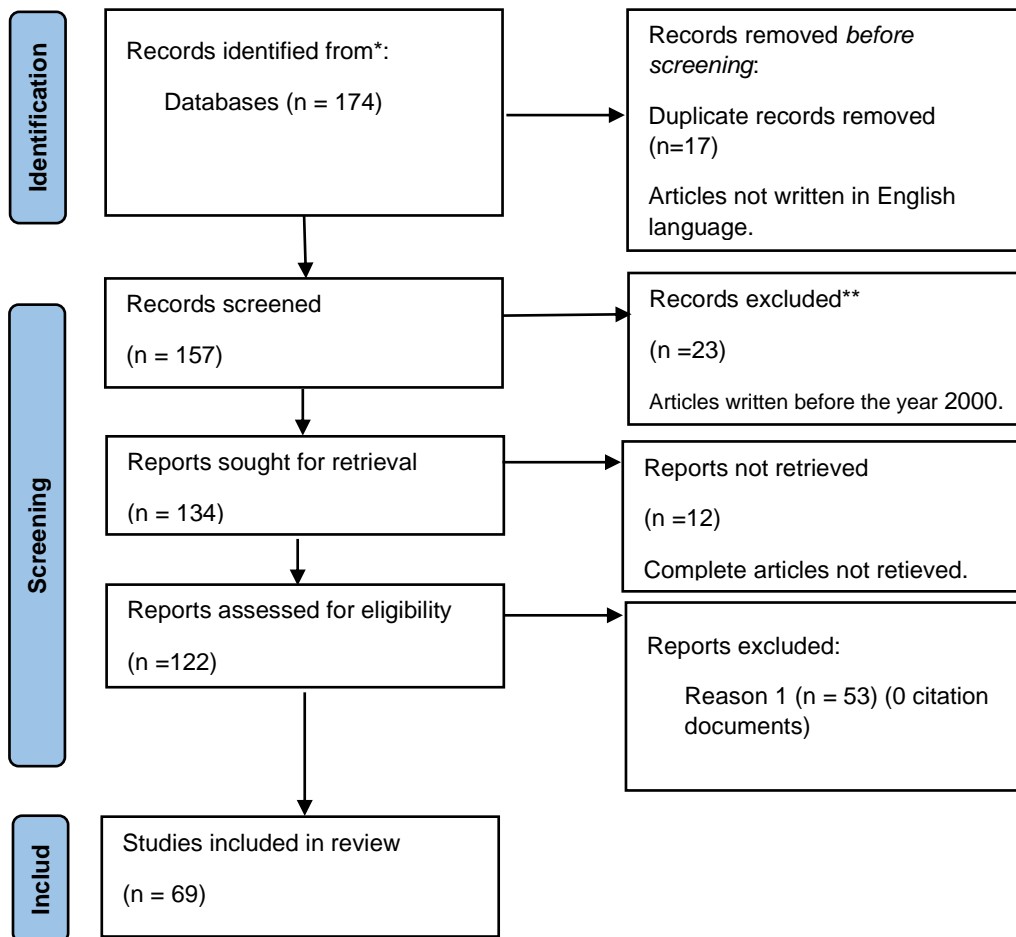
- 1. What is Long-Term Sustainable Growth in telemedicine and e-health based on current research trends?**
- 2. Which are the most influential authors and articles regarding Scopus citations?**
- 3. What are the predominant authors, co-authors and keywords in the domain of telemedicine and e-health?**

METHOD

Selection Criteria of Articles in the Study:

The existing study used bibliometric analysis to review the topics of telemedicine and electronic health. The study followed a specific criterion for the inclusion and exclusion of articles by following a PRISMA flowchart. Articles not written in the English language were excluded from the study. Moreover, the existing study only took into consideration articles written from 1996 until August 2022. Researchers used the terms 'telemedicine' and 'e-health' to do a keyword search in Scopus. Meta-analysis and the "Preferred Reporting Items for Systematic Reviews" (PRISMA) were used to streamline literature search process in the study. [9] (Figure 1). This investigation uncovered 174 documents. One hundred five records were deleted due to their lack of relevance (Figure 1). Sixty-nine documents were discovered in the final database.

FIGURE 1: PRISMA ARTICLE SELECTION GUIDELINES MOHER, ET.AL., (2009)



The bibliometric data (authors, titles, and citations) of 69 documents were exported and saved for future data analysis. Bibliometric analysis was utilized to examine the data. This includes an examination of 'citation analysis,' which refers to the "visualization of commonalities" by reading 'author co-citations' and keywords that appear together [10-12]. Bibliometric analysis was also conducted using VOS viewer bibliometric software, Scopus analytical tools, and Microsoft Excel [12].

RESULTS

The results of a bibliometric analysis of the literature on telemedicine and e-health are presented here. In this study, we answered the three research questions in the following sequence:

LONG-TERM SUSTAINABLE GROWTH IN TELEMEDICINE AND E-HEALTH BASED ON CURRENT RESEARCH TRENDS

Articles from the years 1996–2022 were consulted for this overview. Scholarly interest (Figure 2) in this area did not spike until 2022 (n=23) when 13.21 percent more scholarly works were searched for. In 2018, over 6.32 percent of all articles were on "telemedicine and e-health;" by 2021, that number is expected to rise to 10.34 percent. All 174 articles that were found were used to create the trend analysis.

The geographical locations of the authors were explored (Figure 3) to see whether or not there is a concentration of academic interest in telemedicine and e-health research. Over half of the telemedicine and e-health articles used in this study had authors from only five countries: the United States (15), Germany (11), Italy (15), France (9), and the United Kingdom (7). The fact that this type of work has been produced in seven different countries worldwide demonstrates the widespread interest in the topic (Figure 3).

FIGURE 2: TRENDS IN TELEMEDICINE AND E-HEALTH FROM JANUARY 1996 TO AUGUST 2022 (N = 174).

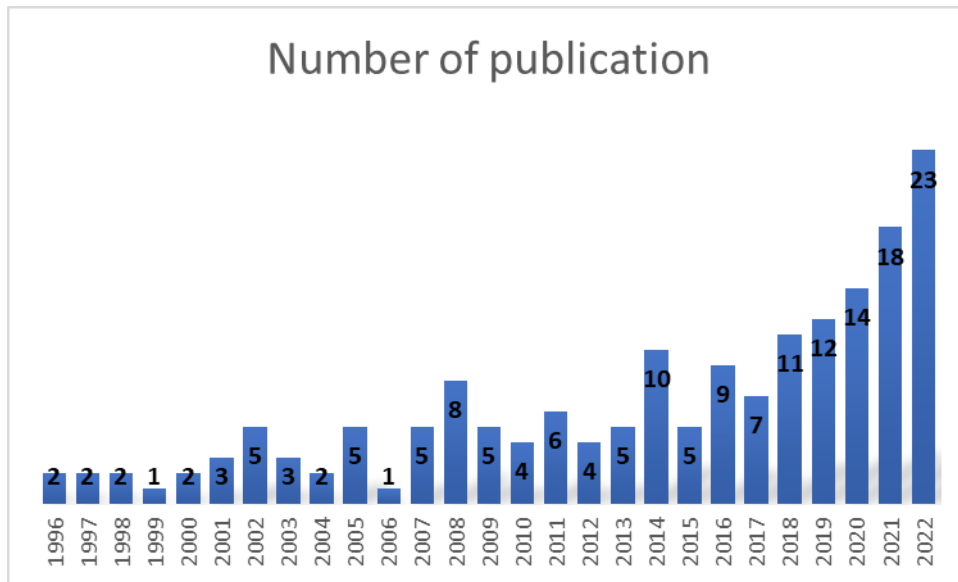
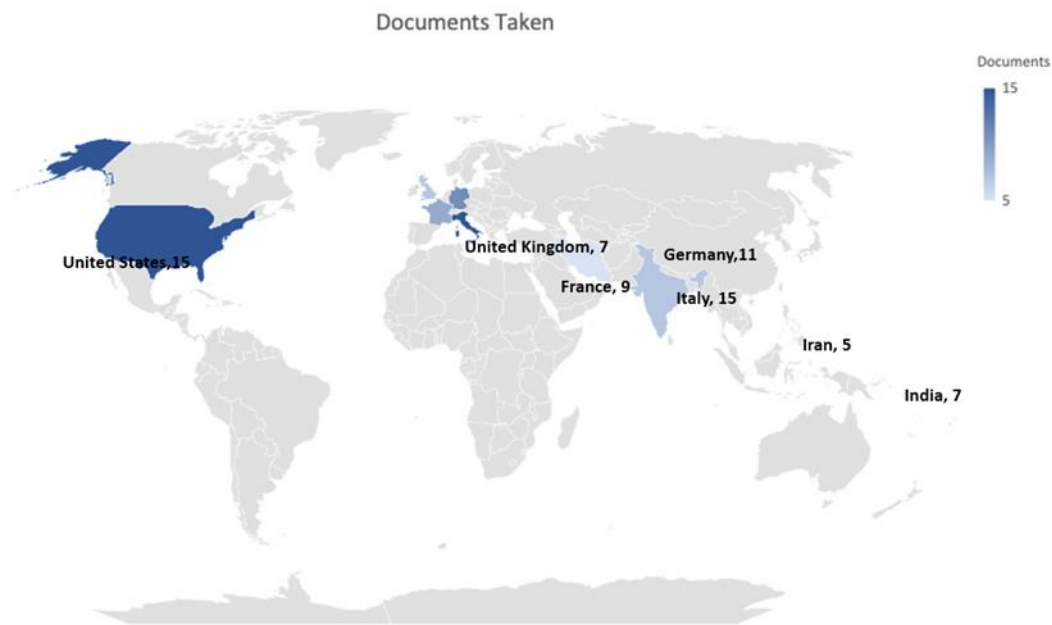


FIGURE 3: CONCENTRATED WORLDWIDE DISTRIBUTION OF TELEMEDICINE AND E-HEALTH, JANUARY 2000–APRIL 2022 (N = 69)



THE MOST INFLUENTIAL AUTHORS AND ARTICLES IN TERMS OF CITATIONS

The results of this author citation analysis can be seen in Table 1 below, which displays data from Scopus. Before anything else, we noticed that 69 authors were listed in our review database (not tabled). This suggests that there is considerable academic interest in this area. However, it is also clear that most contributors (Table 1) publish relatively few works relating telemedicine and e-health. For instance, the most prolific scholar in this discipline, Doarn, C.R. (2014)

from the United States, has only published eight articles. The authors' areas of interest range from telemedicine to e-health. These results indicate the creation of an emerging sector of long-term sustainability in telemedicine and e-health, written by authors with various interests and perspectives.

United States (Doarn C.R., Merrell R.C., Latifi R.), Malaysia (Algaet M.A., Milad A.A., Shughatullah A.S.), followed by Italy (Giansanti D., Maccioni G.), Iran (Bahaadinbeigy

K.)are the highly cited countries and authors in the study These highly cited researchers looked into the potential of telemedicine and e-health, wireless personal communication, Wireless telemedicine for e-health services and mobile health (m-health).

As set out in Table 1, the most cited authors in the field of telemedicine and e-health are Della (135 Scopus citations), Tachakra (211), Niyato (94) and Fathehi (89). The current study also required at least three publications by each author for this study; because of this, the table does not include many additional highly referenced authors who only created a single impact paper.

Table 2 displays the top-cited publications in the subject of telemedicine and e-health, as compiled by the citation analysis tool Scopus. There were almost a hundred references in the first six texts [13]. These references are considered to be of fair quality in terms of their applicability to the widespread use of e-health and telemedicine today. "Readers used to gauge influence by the number of citations found in a publication's Impact Factor should be warned that the number of citations found in Scopus is almost invariably much lower for the same document or author mentioned in academic references cited by Google." It is clear from Table 2 that research review articles have played a crucial role in the development of this subject.

TABLE 1. SCOPUS CITATIONS AND PUBLISHED DOCUMENTS LIST THE "MOST INFLUENTIAL AUTHORS AND ARTICLES" ON TELEMEDICINE AND E-HEALTH (N=69)

| Author | Country | Documents | Scopus citations | Citation per document | Focus |
|-------------------|---------------|-----------|------------------|-----------------------|---|
| Doarn C.R. | Unites States | 8 | 39 | 4.875 | Telemedicine and e-health |
| Merrell R.C. | Unites States | 7 | 34 | 4.857 | Telemedicine and e-health |
| Algaet M.A. | Malaysia | 3 | 34 | 11.33 | Wireless personal communication |
| Milad A.A. | Malaysia | 3 | 34 | 11.33 | Wireless telemedicine |
| Shughatullah A.S. | Malaysia | 3 | 34 | 11.33 | Wireless telemedicine for e-health services |
| Giansanti D. | Italy | 7 | 21 | 3 | Telemedicine and e-health |
| Maccioni G. | Italy | 4 | 12 | 3 | m-health |
| Latifi R. | Unites States | 3 | 12 | 4 | Telemedicine and e-health |
| Bahaadinbeigy K. | Iran | 3 | 14 | 4.66 | Telemedicine and e-health |

PREDOMINANT AUTHORS, CO-AUTHORS AND KEYWORDS IN THE DOMAIN OF TELEMEDICINE AND E-HEALTH.

TABLE 2. TELEMEDICINE AND E-HEALTH, JANUARY 2000-AUGUST,2022 (N = 69): THE MOST "INFLUENTIAL SCOPUS CITATIONS"

| Authors | Title | Focus | Cited by | Type of Paper |
|---------|---|--------------------------------------|----------|-------------------|
| (14) | "Provisioning quality of service of wireless telemedicine for E-health services: A review." | "Wireless telemedicine and E-health" | 23 | Review |
| (15) | "IEEE 802.16/WiMAX-based broadband wireless access and its application for telemedicine/E-health services." | Wireless telemedicine and E-health | 94 | Exploratory Study |

| | | | | |
|------|---|---|-----|--------------------------|
| (16) | "Telemedicine and e-Health Solutions for COVID-19: Patients' Perspective." | "Telemedicine and E-health" | 45 | Experimentation approach |
| (17) | "HEMAN: Health monitoring and nous: An IoT based e-health care system for remote telemedicine." | E-health care system | 33 | Conceptual |
| (18) | "Evaluation of the Education "clinical Telemedicine/e-Health" in the Curriculum of Medical Students at the University of Zurich." | "Telemedicine and E-health" | 21 | Clinical approach |
| (19) | "Telemedicine and e-health in disaster response." | "Telemedicine and E-health" | 24 | Exploratory Study |
| (20) | "Telemedicine, telehealth or e-health? A bibliometric analysis of the trends in the use of these terms." | "Telemedicine, telehealth and E-health" | 89 | Exploratory study |
| (21) | "Quality of Service consideration for the wireless telemedicine and e-health services." | "Telemedicine and E-health" | 53 | Conceptual |
| (22) | "E-health and the Universitas 21 organization: 2. Telemedicine and underserved populations." | Telemedicine | 22 | Exploratory study |
| (23) | "Mobile e-Health: The Unwired Evolution of Telemedicine" | Mobile e-health | 211 | Exploratory study |
| (24) | "What is e-health (2): The death of telemedicine?" | E-health | 135 | Descriptive Study |
| (25) | "Increasing the cost-effectiveness of telemedicine by embracing e-health." | E-health | 57 | Exploratory Study |

Niyato (2007) conducted an exploratory study based on "Broadband wireless connection is the foundation of wireless telemedicine and electronic health records." Tachakra (2003) carried out an exploratory study based on mobile e-health and also stated the evolution of telemedicine. Della (2001) documented descriptive research and noted the relevance of e-health. The subsequent highly cited research was conducted by Fathehi (2012) based on telemedicine, telehealth and e-health. The study's findings stated the growing importance of e-health in the coming times.

Authors employed VOS viewer software for analyzing co-authorship to show the telemedicine and e-health fields' underlying intellectual structure (Figure 4). Using an examination of co-authorship, the study counted how often each of the 69 review articles cited the others in their list of references. By analyzing the frequency of "author citations," in order to "visualise similarities," the VOS viewer software generates a network diagram. Among the co-authors who are cited in the telemedicine and e-health databases. Based on the examination of co-authorship, it seems that academics frequently referenced by others have comparable areas of interest.

FIGURE 4: NETWORK VISUALISATION USED FOR CO-AUTHORS ANALYSIS

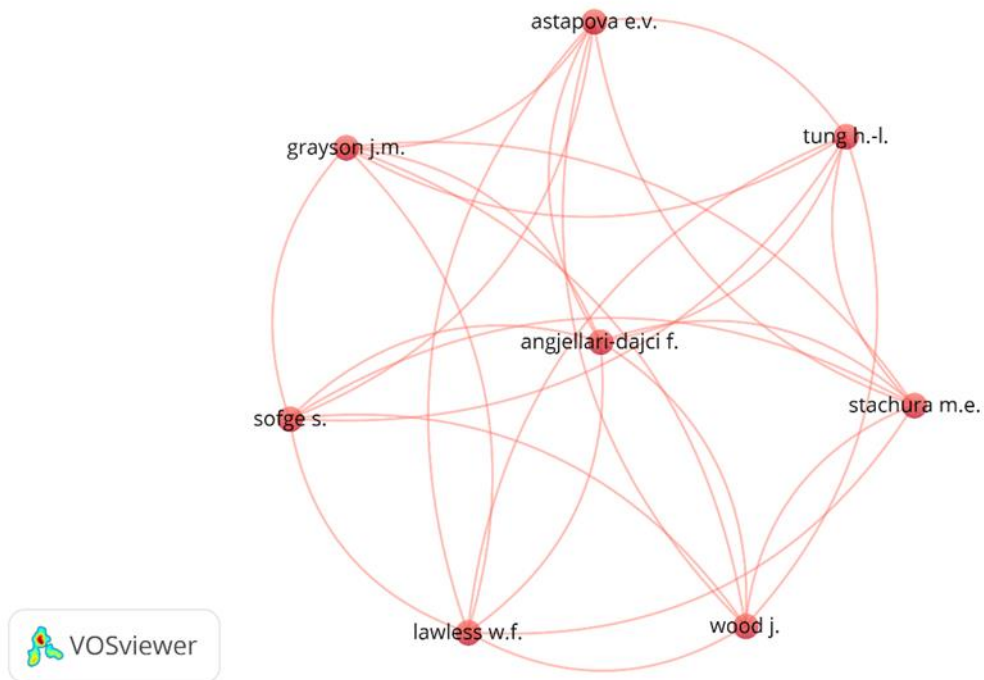


FIGURE 5: NETWORK VISUALIZATION OF MOST OCCURRED KEYWORDS IN THE STUDY

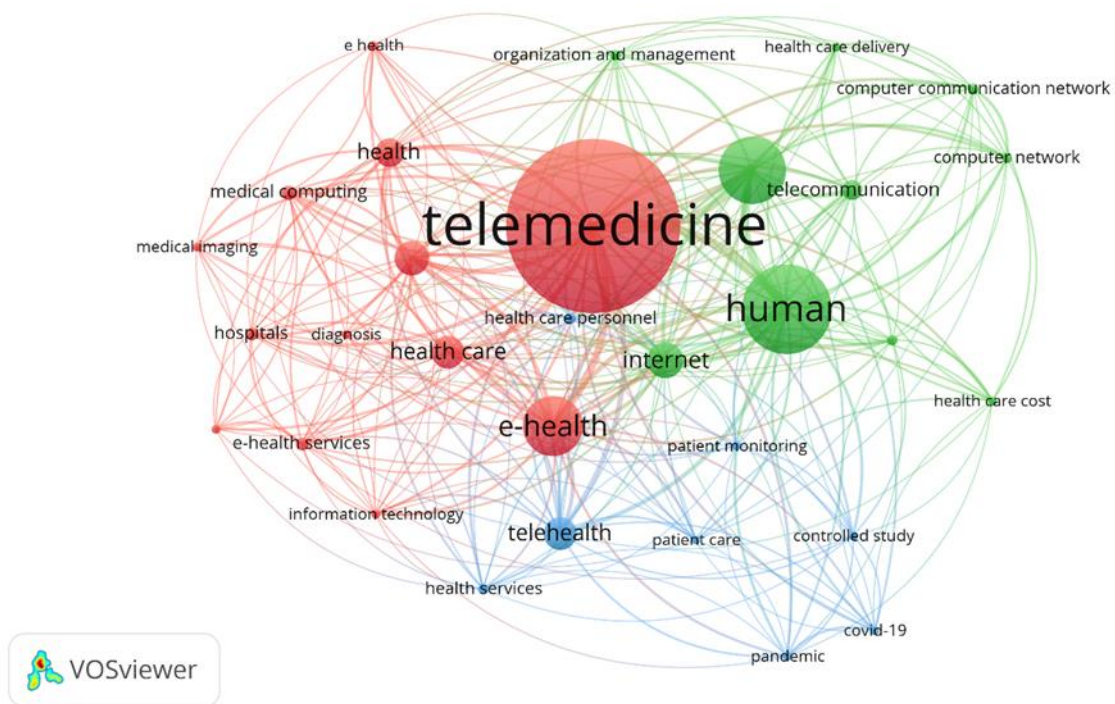


FIGURE 6: OVERLAY VISUALISATION OF MOST OCCURRED KEYWORDS IN THE STUDY

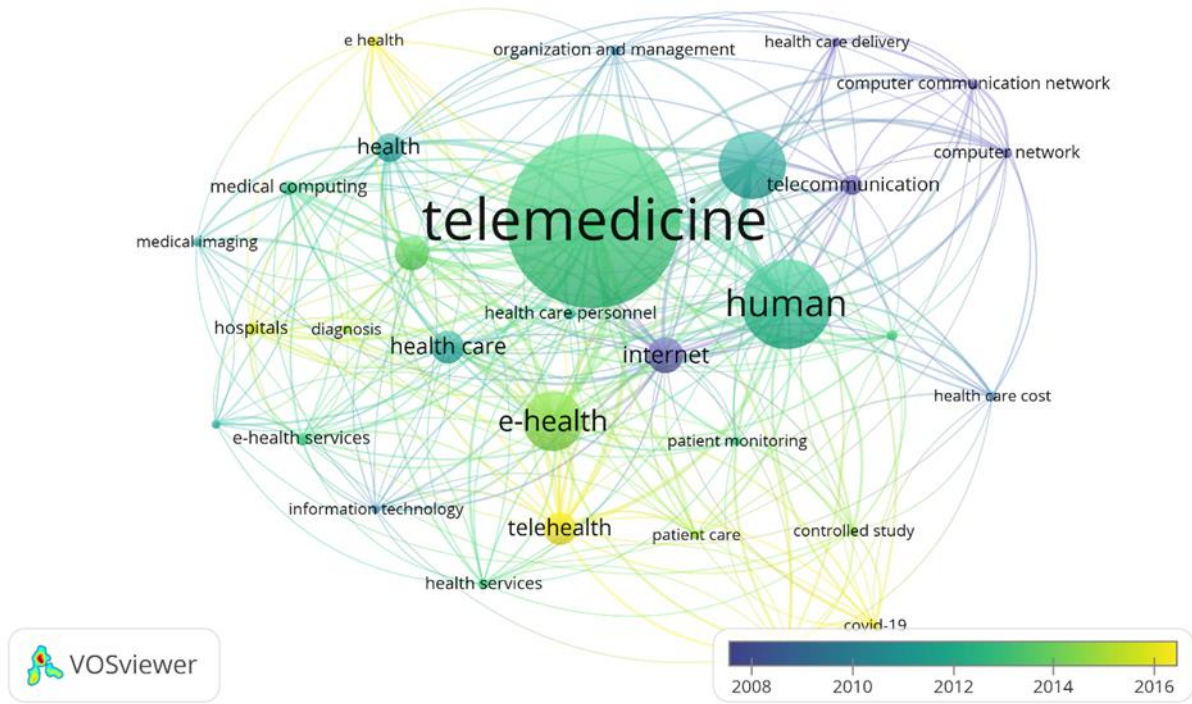
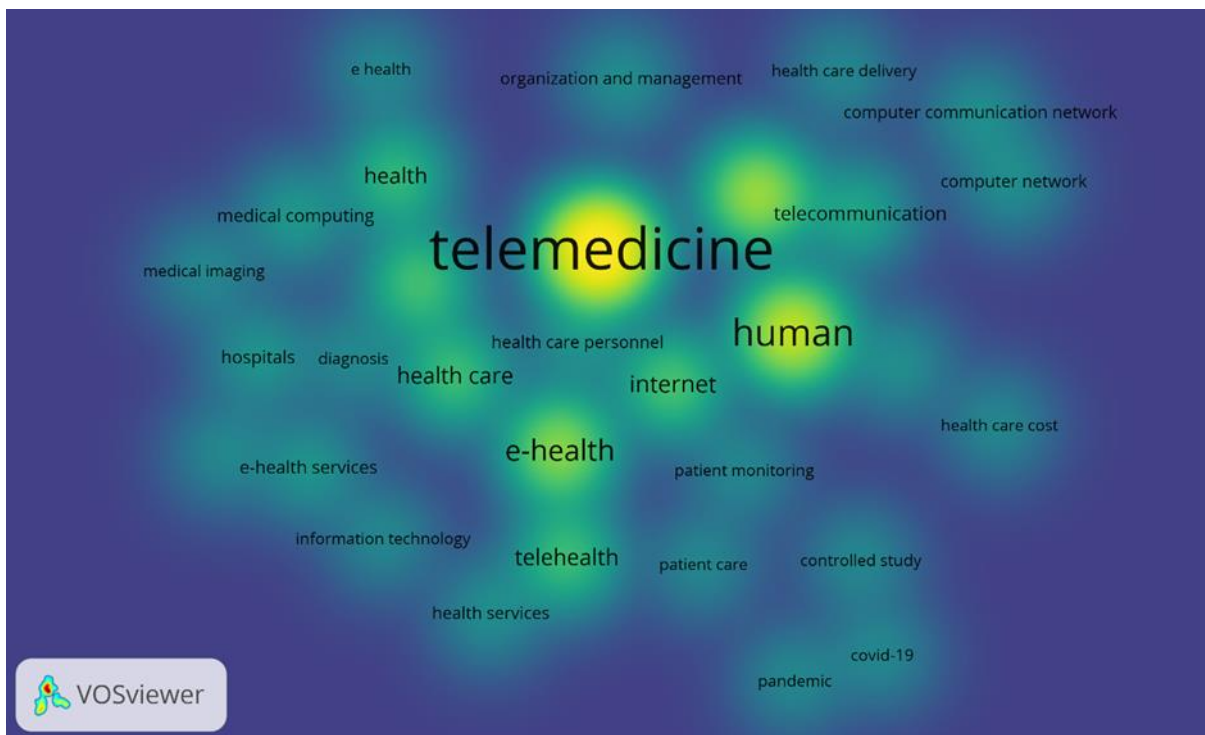


FIGURE 7: DENSITY VISUALIZATION OF MOST OCCURRED KEYWORDS IN THE STUDY



Keyword analysis was performed on the telemedicine and e-health literature. VOS viewer software was used to identify the "most frequent words." The "yellow/lighter tinted bubbles" depict the current focus of researchers in this field, while the "darker bubbles" depict more established concerns. Different maps, such as the density map (Figure 7) or the common network visualisation (Figure 5) or the

overlay visualisation (Figure 6), describe the relationships between the topics or themes; for example, "the most frequently occurring keywords" were "telemedicine" (13 occurrences) or "human" (10 occurrences), "e-health" (13 occurrences), "telehealth" (13 occurrences), and "healthcare" (13 occurrences). The keywords used in the articles published between 2008 and 2016 are also shown

on the map as an overlay. The network was visually represented by the maps as three distinct groups. Cluster 1 (red in the Figure 5 network diagram) has 11 items that are keywords (diagnosis, e-health, e-health services, health, health care, hospitals, information technology, medical computing, medical imaging, quality of service and telemedicine). Cluster 2 (shown in green on the network visualisation map) has 10 items that serve as keywords (computer communication, computer network, health care cost, health care delivery, human, humans, internet, organisation and management, telecommunication and teleconsultation). Cluster 3 (in blue on the network map) contains keywords for a total of eight items (controlled study, COVID-19, health care personnel, health services, pandemic, patient care, patient monitoring telehealth). This VOS viewer trend supports findings from keyword occurrence analysis that emphasised the preponderance of telemedicine, human, and e-health terms in the 69 articles chosen for this study.

CONCLUSION

In this bibliometric study, we look at how telemedicine and electronic health care have evolved and what patterns we expect to see in the future. Hundreds of scholarly papers are published yearly, marking its emergence as a new field of study. The United States, Italy, and Germany have the most publications on telemedicine and electronic health care, according to a country-by-country examination of the literature. Doarn (8 publications), Merrell R.C. (7 publications), Giansanti D. (7 publications), and Maccioni G (4 publications) were found to be the most prolific authors in the field of telemedicine and e-health.

Based on a bibliometric examination of the 69 papers, this study found that the phrases "telemedicine," "human," and "e-health" were the most often used in the area of telemedicine and e-health. The findings of this study will be useful to researchers in the fields of telemedicine and electronic health care because it gives a comprehensive knowledge base of the literature in these fields, highlighting both the most studied and understudied areas from which to launch future research initiatives. The famous authors who have published works are also listed in this study. Most studies are undertaken in the United States, Italy, and Germany, but this opens the door for researchers in developing nations to conduct their investigations.

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