Original Article

Elderly and Virtual Reality: Bibliometric Analysis

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Abstract

Aim: This research aims to identify and visualize articles on the elderly and virtual reality, to highlight trends, and to provide future researchers with a literature-based overview of the subject.

Methods: The data obtained in our study was collected from the Web of Science Core Collection database in January 2024, and the analyzes were performed using the VOSviewer (1.6.15) program. Analyzes were made according to publication numbers, years, authors, country, journal, institution and keywords.

Results: In our study, bibliometric analysis was performed on 420 articles published between 1997-2024. It was determined that the author who published the most on the subject was Riva G (n: 30). In the searches made with relevant keywords, it was seen that the institution with the most publications was Università Cattolica del Sacro Cuore (n:27), and the most productive country was Italy (n:64). The journal with the most publications on the subject is Annual Review of CyberTherapy and Telemedicine (n:13). In the map where the relationship between at least three keywords is visualized, the three most frequently used keywords are virtual reality (n: 212), elderly (n: 88), virtual reality (n: 80).

Conclusion: As a result of our research, it has been observed that the number of studies on this subject has increased in recent years, Italy is the most productive country and our country cooperates with the USA. The results obtained from this study are expected to help evaluate the current status of the studies, provide a broad perspective to researchers, guide future nursing studies and contribute to the relevant literature.

Key Words: Elderly; virtual reality; bibliometric analysis

Introduction

It is known that life expectancy has increased, and there is an increase in the elderly population in countries today (WHO, 2022) While the number of individuals aged 60 and over was 1 billion in 2019, it is projected to reach 1.4 billion in 2030 and 2.1 billion in 2050, with the increase expected to accelerate, especially in developing countries, as reported by the World Health Organization (WHO) (WHO, 2020). According to the report of the Turkish Statistical Institute, the elderly population rate in our country is projected to reach 12.9% in 2030, 16.3% in 2040, and 22.6% in 2060 (TUİK, 2022).

It can be said that one of the most important concepts that has emerged with the 21st century is the "aging of societies" and the global increase in life expectancy (Hassan et.al., 2017). Factors such as scientific advancements, technological solutions, and medical progress, along with a decrease in birth rates, are among the most important factors contributing to the aging of societies (Gokce Kutsal, 2006). In aging societies, the increasing burden of disease leads to more healthcare utilization by elderly individuals, the emergence of medical care needs, increased use of healthcare services, and a decrease in healthcare resources (Paúl and Teixeira, 2012).

Especially in societies with elderly populations where necessary social support systems are not in place, it is anticipated that

the pressure on healthcare systems will result in economic, political, social, and emotional challenges concerning issues such as the distribution of healthcare services and the implementation of social security rights (Hassan et. al., 2017;Arlati et. al., 2019).

Therefore, alternative and complementary new methods are required for the long-term sustainability of healthcare services (Secer,2022). Emerging technologies, digital advancements, and virtual reality applications are bringing about rapid change and transformation, especially in the healthcare sector. Virtual reality applications, which have significant potential in medicine and healthcare services, are expected to facilitate improvements in services offered to the elderly population and the use of remote intervention methods (Arlati et. al., 2019; Lhotska et. al., 2022).

In recent years, virtual reality applications designed for healthcare have increasingly targeted older adults and aging populations, leading to a rise in projects focusing on this group (Lhotska et.al., 2022). Initially used in the mental health field in 1993, virtual reality applications have spread to the healthcare sector with technological advancements and are now widely used in various areas. Virtual reality applications emerge as usable and applicable tools in areas such as reducing the risk of falls in older adults, enhancing psychosocial well-being, providing movement- and visually-based experiences for chronic pain management, reducing age-related vision problems, evaluating the cognitive and emotional health status of older adults, and identifying their physical functionalities and impairments (Gurcan, 2018).

Upon reviewing the literature on the subject, no bibliometric analysis examining the popular points and trends of virtual reality studies in the context of aging has been found. This study is anticipated to assist researchers and institutions in understanding the trends, current topics, and popular points in the field of virtual reality in aging, as well as fostering innovative ideas. Moreover, it is expected to provide future researchers with a general literature-based perspective and contribute to the advancement of studies in this area. This research aims to identify and visualize articles on the elderly and virtual reality, to highlight trends, and to provide future researchers with a literature-based overview of the subject.

Materials And Methods

This study is a descriptive type study and the data was obtained from the Web of Science (WoS) database on January 24, 2024. The WoS database contains three important search indexes. These indexes provide the opportunity to review the literature, contribute to theoretical frameworks, and review citations and sources related to the topic under investigation (Zhu and Liu, 2020; Kaya and Dincer, 2023). In our study, the data obtained was analyzed bibliometrically using the VOSviewer (1.6.15) program with scientific mapping method. VOSviewer is a computer program used to create maps based on network data and visualize the obtained data (van Eck and Waltman,2010).

Selection process and search method: The data obtained for this study were obtained considering inclusion and exclusion criteria. Only research articles were included in the study, while book chapters, conference papers, meeting abstracts, editorials, and rewrites were excluded. There was no year restriction in the study, and studies conducted between 1997 and 2024 were analyzed. The relevant database was searched using the keywords "elderly" and "virtual reality", and the research universe was determined as 717. From these publications, 420 articles classified as research articles were included in the bibliometric analysis.

Data analysis: Analyses were conducted on the number of publications by year, authors, country, journal, institution, and keywords. Bibliometric analysis consists of four basic steps: defining the objectives of the bibliometric study, determining analysis techniques, data collection, analysis and writing (Donthu et al., 2021). After the inclusion criteria and keywords to be scanned are determined, the data file containing all information about the relevant studies is exported in a format suitable for data analysis. In bibliometric analysis, citation analysis is used to determine the most influential publications in a particular field; co-occurrence analysis to determine the conceptual relationship between documents where two keywords occur multiple times; Co-authorship analysis is conducted to

investigate formal collaborations and academic interactions between researchers. In this study, keyword analysis was performed using VOSviewer software. The density visualization map is used in the VOSviewer program to show the size and impact of an area. Each keyword used in this map is represented by a node with a color corresponding to the cluster it is in. In the analysis, keywords are shown closer to each other and with nodes of the same color, meaning that these keywords appear in similar studies. The more frequently a node used in keyword analysis appears, the larger it becomes and the more connections it has to other nodes (McAllister et.al., 2022).

This study aims to answer the following questions:

- What is the distribution of articles on the topic of elderly and virtual reality by year?
- What is the distribution of authors, countries, and institutions of articles on the topic of elderly and virtual reality?
- What are the most commonly used keywords, author keywords, and plus keywords in articles on the topic of elderly and virtual reality?
- What is the distribution of the most cited publications on the subject?
- What is the distribution of journals where articles on the topic of elderly and virtual reality are published?
- What are the most cited sources related to the topic?
- What is the distribution of authors with moderate citations related to the topic?

Research ethics: In this study, no interaction with humans and/or animals has been made. Studies were searched through the database using relevant keywords, published works were retrospectively examined, and the study was conducted using secondary data. Therefore, ethical approval was not obtained for this study.

Results

Basic publication information

In our study, bibliometric analysis was conducted on 420 articles published between 1997 and 2024. When the number of publications was examined by year, it was found that studies on the subject began in 1997, and there was an increase in the number of studies after 2010. It was determined that the highest number of publications (n: 59) was in 2021. When examining the categories in which the studies were published, it was observed that the Neurosciences category ranked first with 57 publications, followed by the Geriatrics Gerontology category with 50 publications. It was determined that the studies were mostly published in English (n: 410) and in the Science Citation Index Expanded (SCI-EXPANDED) (n: 299).

When the studies on the subject were examined by year, it was determined that there was an increase in the number of studies and citations in recent years (Graph 1).

Author analyses and publication information

According to the authors' co-authorship analysis, a network map was created by determining at least 1 publication and at least 1 citation criteria to identify the most connected and collaborative authors. The analysis showed that there were 1650 connections among 1877 authors. As a result of the analysis, it is seen that there is no connection between some authors, the largest set of linked authors consists of 95 names united in 1 cluster, with 637 connections and 1021 total connection strength between them. According to the co-authorship analysis, the authors who published the most on the subject were Riva G. (n:30), Cipresso P (n:19), Pedroli E (n:14) and Serino S (n:14), respectively. . When the most cited authors were evaluated, it was determined that Riva G., who was also the author with the most publications (30 publications, 641 citations), was the most cited author. After Riva G., Hausdorff JM (4 publications, 633 citations) and Mirelman A. (4 publications, 633 citations) are the most cited authors (Figure 1).

When the distribution of authors according to the number of citations is examined; The most cited authors are Riva G.(n:641) and Hausdorff J.M. (n:633) and Mirelman A. (n:633).

The examination of the institutions affiliated with the authors

The analysis of the institutions affiliated with common authors is presented in Figure 2. In searches conducted with relevant keywords, the institutions with the highest number of

publications are Università Cattolica del Sacro Cuore (n:27), Istituto Auxologico Italiano (n:16), and IRCCS Istituto Auxologico Italiano (n:10), respectively. When evaluating the universities receiving the most citations, it is observed that different institutions from those with the highest number of publications are in the top three positions. Tel Aviv University ranks first with 6 publications and 733 citations, Tel Aviv Sourasky Medical Center ranks second with 4 publications and 633 citations, and Katholieke Universiteit Leuven ranks third with 5 publications and 551 citations, identified as the top three universities receiving the most citations.

The distribution of publications and authors by countries

An analysis of publications obtained through searches with relevant keywords was conducted based on countries. Italy (n:64), the United States (n:53), and the People's Republic of China (n:43) ranked as the top three countries with the most publications (Fig 3). The countries receiving the most citations are determined as follows: the United States (53 publications, 2595 citations), Italy (64 publications, 1761 citations), and the Netherlands (16 publications, 863 citations).

Journal and source analyses: When examining the journals with the most publications related to the relevant keywords, the top three are determined to be Annual Review of CyberTherapy and Telemedicine (n:13), International Journal Of Environmental Research And Public Health (n:12), and Frontiers in Psychology (n:11). Analyzing the journals with the most citations, Clinical Interventions in Aging ranks first with 7 publications and 533 citations, followed by Neurobiology of Aging with 2 publications and 261 citations, and Lancet ranks third with 1 publication and 255 citations (Figure 4). When investigating journals with common citations by authors publishing on the subject, Gait Posture ranks first with 244 citations, followed by Journal of American Society with 221 citations, and Archives of Physical Medicine and Rehabilitation with 218 citations. An analysis of the most cited sources by authors reveals that Mirelman (2016) ranks first with 255 citations, followed by Mirelman (2011) with 245 citations, and Moffat (2001) with 235 citations.

Keyword analyses: In this research, a total of 1927 keywords were used. In the map where the relationship between at least three keywords is visualized, the most frequently used keywords were identified as virtual reality (n:212), elderly (n:88), virtual-reality (n:80), rehabilitation (n:78), and older-adults (n:75), respectively. It was determined that the 332 keywords, which appeared at least three times, had 6981 connections and a total link strength of 11437. The author keyword is defined as the keyword field provided by the author that represents the essence of the publication (12). The most frequently used author keywords in publications have been examined, revealing that virtual reality (n:212), elderly (n:88), and aging (n:25) are the top three keywords. Plus keywords refer to expanded terms derived from cited references or the bibliography, provided by an algorithm. In our study, the top three most frequently used plus keywords are virtual-reality (n:80), older-adults (n:75) and rehabilitation (n:63) (Figure 5).
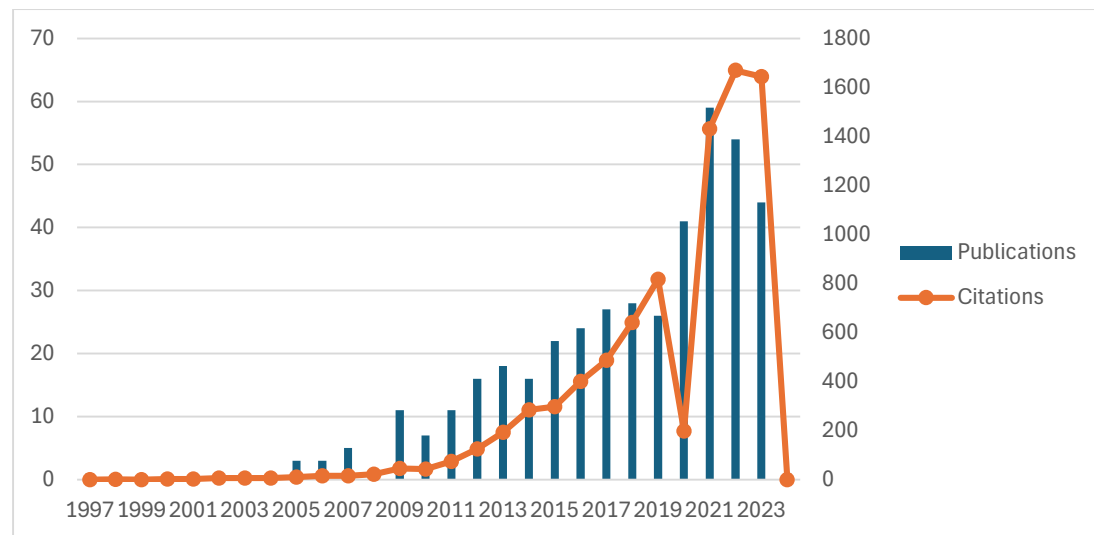
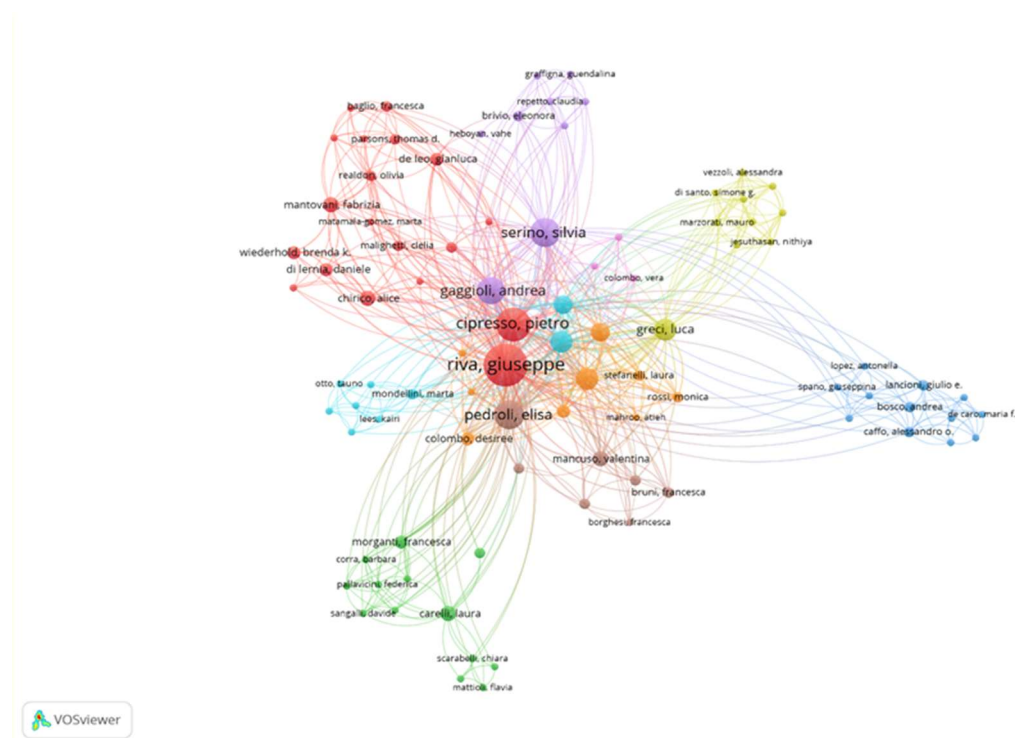**Graph 1. Number of Publications and Citations by Year**
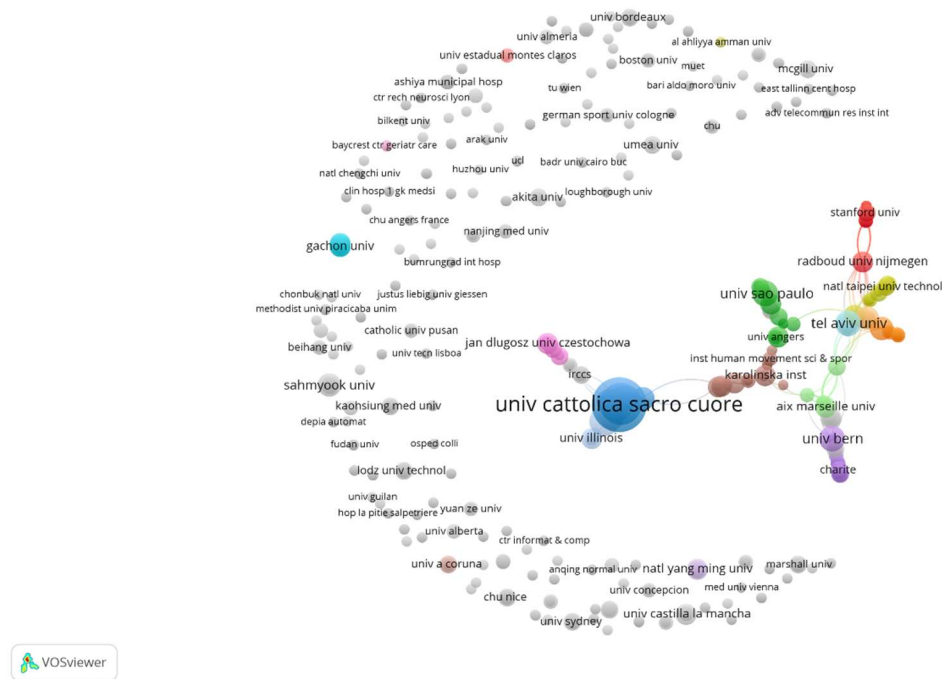

Figure 1. Most Cited Authors

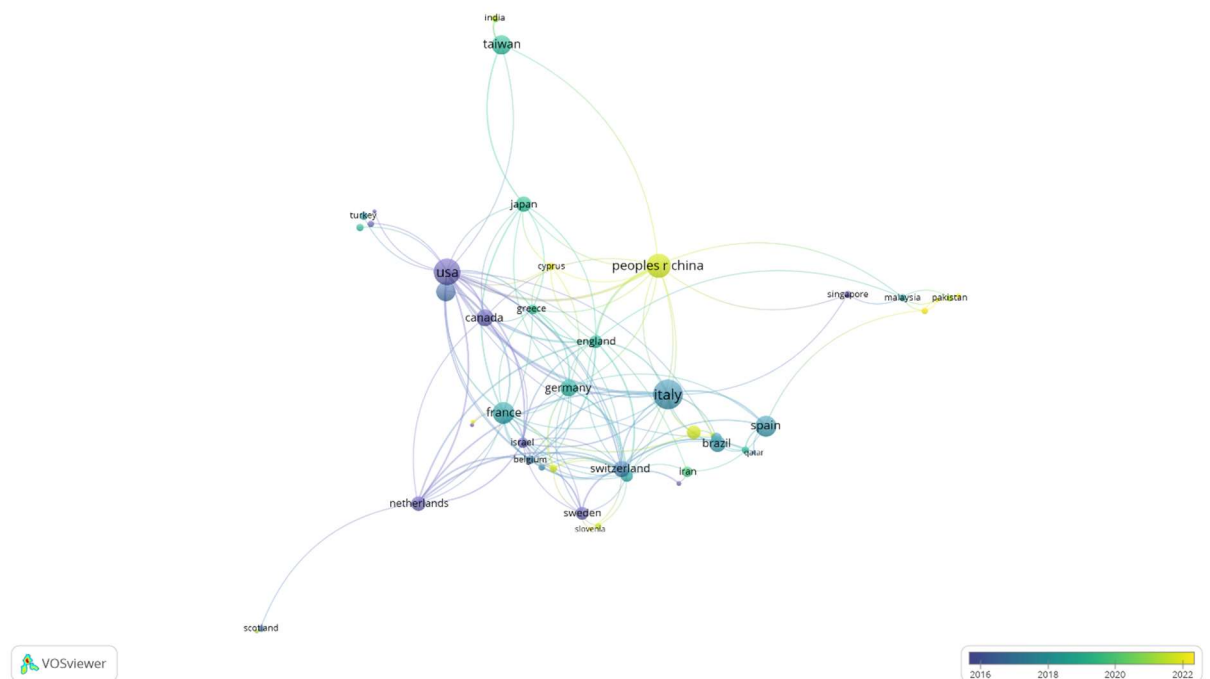**Figure 2. Universities with the Most Publications**

Figure 3. Countries with the Most Publications

Figure 4. Journals with the Most Citations

Figure 5. Keyword Analysis

Discussion

The advancement of technology has led to an increase in the average lifespan worldwide. Aging at the biological level results in a gradual decline in physical and mental capacities in individuals and an increased risk of illness. Therefore, there is a strong need for virtual reality, especially in the elderly population. Nowadays, technological advancements being more realistic and accessible, and applicable in all areas of life, create the necessity to integrate virtual reality into care for this population (Lodha et.al., 2020). In this study, a bibliometric analysis of publications related to virtual reality and aging has been conducted. The data obtained from the analysis are presented with numerical and visual maps. Our study did not impose a year restriction, and the analysis included 420 articles published between 1997 and 2024. The analysis results indicate that the highest number of publications was in 2021. Pawassar et al. (2021) conducted a bibliometric analysis on virtual reality in healthcare services, mentioning that the highest number of publications was in 2020 (Pawassar and Tiberius, 2021). Another bibliometric analysis on dementia and virtual reality conducted between 1998 and 2018 using CiteSpace revealed an increasing trend in studies from 2014 to 2018 (Sobral ve Pestana, 2020). When examining these studies, it is possible to say that our study results differ from the literature. In the searches conducted with relevant keywords, it has been observed that the author with the highest number of publications and citations is Riva G. When examining the co-citation author network map, it was found that Riva G. is the top author with the highest number of publications and citations, followed by Serino S in second place, and Folstein MF in third place. In Zhu et al.'s study (2021), a bibliometric analysis of virtual reality and mild cognitive impairment was conducted, and it was stated that the author with the highest number of publications is Riva G. (Zhu et.al.,2021). Sobral and Pestana's study (2020) also indicated that Riva G. is the author with the highest number of publications using the keywords dementia and virtual reality. In light of this information, it can be seen that our findings are consistent with the literature (Sobral ve Pestana, 2020).

When evaluating the analyzed publications in our study, it was observed that the organization with the highest number of publications is Università Cattolica del Sacro Cuore, while the organization with the highest number of citations is Tel Aviv University, which differs from the organization with the highest number of publications. In searches conducted with relevant keywords, it was found that Italy is the country with the highest number of publications, while the United States is the country with the highest number of citations. In Zhu et al.'s study (2021), it was mentioned that the highest number of publications is from the United States, while in Sobral and Pestana's study (2020), the highest contributions and publications were noted to be from the United States and the United Kingdom(Sobral ve Pestana, 2020; Zhu et.al., 2021). When analyzing the country data, it was observed that our study results differ from the literature. It is thought that this difference may be due to the keywords used in the analyses not being identical. In our study, the most frequently used keywords were found to be "virtual reality," "elderly," and "rehabilitation." In Zhu et al.'s study (2021), the most commonly used keywords were reported to be "virtual reality," "Alzheimer's disease," and "dementia." Pawassar et al.'s study (2021) indicated that the most frequently used keywords were "virtual," "reality," and "training" (Pawassar and Tiberius, 2021; Zhu et.al., 2021). Upon reviewing the literature, it can be said that our study results are partially similar to the literature.

Conclusion: Our research provides comprehensive information on the popular points and trends of studies related to aging and virtual reality from past to present. As a result of our research, it was observed that the number of studies on this topic has increased in recent years, with Italy being the most productive country, and that our country has collaborated with the USA. This research is expected to contribute to identifying institutions, researchers, and countries with which researchers working on this topic can collaborate. The literature review conducted within the scope of this study revealed that nursing studies on the topic are insufficient. This study's strength lies in highlighting the deficiency in nursing studies related to this

topic. The results obtained from this study are expected to help evaluate the current state of studies, provide researchers with a broad perspective, guide future planned nursing studies, and contribute to the relevant literature.

Contribution to the field: With global aging and technological advancements, the impact of virtual reality applications on the nursing care process is being demonstrated through numerous studies. It is believed that virtual reality applications can provide positive contributions in many areas, particularly cognitive abilities, for elderly individuals and enhance their quality of life. By keeping up with current technological developments and integrating them into the care process, nurses can improve the quality and individualization of care.

Limitation: In this study, data was obtained from the Web of Science database using the keywords "virtual reality" and "elderly." For future studies, it is recommended to explore the keywords along with different concepts in various databases such as PubMed, Embase, Scopus, SpringerLink, Google Scholar, and ScienceDirect, and to use different and multiple analysis programs to examine the differences between them.

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