



Geliş Tarihi (Received): 14.05.2024

Kabul Tarihi (Accepted): 28.06.2024

Original Review Article/Orijinal Derleme Makale

## Earthquake and Dialysis; Bibliometric Analysis

### Deprem ve Diyaliz: Bibliyometrik Analiz

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**Alıntı (Cite):** Tüzün Özdemir S., Döner NH., Usta Yeşilbalkan Ö. Earthquake and Dialysis; Bibliometric Analysis. YBH dergisi. 2024;5(2):126-144

\*Bu çalışma 1. Uluslararası Değişen Dünyada Çeşm-i Cihan Sağlık Kongresi'nde sözel bildiri olarak sunulmuştur.

## Abstract:

**Aim:** This research was conducted with the aim of identifying and visualizing articles on the relationship between dialysis and earthquakes, highlighting trends, and providing future researchers with a literature-based overview.

**Methods:** The data were obtained from the "Web of Science Core Collection" data base on November 20, 2023, using the keywords 'dialysis' and 'earthquake,' resulting in 94 research articles from a population of 138 studies. Bibliometric analysis was carried out using the "VOSviewer" and "R-based Bibliometrix" programs, including performance analysis and scientific mapping.

**Results:** As a result of the analysis, it was determined that the most frequently used keywords in the Web of Science category were 'acute-renal-failure', 'management', 'dialysis', 'earthquake', 'acute kidney injury', 'crush syndrome'. When the countries of publication were evaluated, it was determined that the most studies were conducted in 2009 and in Türkiye, and the author who published the most and contributed the most was 'Vanholder R.'. It was determined that the first three most frequently used keywords in the publications were 'crush syndrome', 'dialysis' and 'acute-renal failure'.

**Conclusion:** The findings of this study are believed to contribute to evaluating the management of dialysis patients in the event of a possible earthquake and guiding future research planning.

**Key Words:** Acute kidney injury; bibliometric analysis; dialysis; earthquakes.

## Özet:

**Amaç:** Bu araştırma, diyaliz ve deprem arasındaki ilişkiye ilişkin makaleleri belirlemek ve görselleştirmek, eğilimleri vurgulamak ve gelecekteki araştırmacılara literatüre dayalı bir genel bakış sağlamak amacıyla yapılmıştır.

**Yöntemler:** Veriler, 20 Kasım 2023 tarihinde "Web of Science Core Collection" veritabanından 'diyaliz' ve 'deprem' anahtar kelimeleri kullanılarak elde edildi ve sonuçta 138 çalışmadan oluşan bir popülasyondan 94 araştırma makalesi elde edildi. Bibliyometrik analiz, performans analizi ve bilimsel haritalamayı içeren "VOSviewer" ve "R-tabanlı Bibliyometrix" programları kullanılarak gerçekleştirildi.

**Bulgular:** Yapılan analiz sonucunda Web of Science kategorisinde en çok kullanılan anahtar kelimenin "acute-renal-failure", "management", "dialysis", "earthquake", "acute kidney injury", "crush sendrome" olduğu belirlenmiştir. Yayın yapılan ülkeler değerlendirildiğinde en fazla çalışmanın 2009 yılında ve Türkiye'de yapıldığı, en fazla yayın yapan ve en fazla katkı sağlayan yazarın "Vanholder R." olduğu saptanmıştır. Yayınlarında en sık kullanılan ilk üç anahtar kelimenin "crush sendromu", "diyaliz" ve "akut-böbrek yetmezliği" olduğu belirlenmiştir.

**Sonuç:** Bu çalışmanın bulgularının olası bir deprem durumunda diyaliz hastalarının yönetiminin değerlendirilmesine ve gelecekteki araştırma planlamalarına yol göstermesine katkı sağlayacağı düşünülmektedir.

**Anahtar Kelimeler:** Akut böbrek hasarı; bibliyometrik analiz; deprem; diyaliz.

## Introduction

Disasters are defined as sudden calamities causing significant disruption to the functioning of a community, resulting in substantial humanitarian, material, economic, environmental losses, and impacts.<sup>(1)</sup> The United Nations Office for Disaster Risk Reduction (UNDRR) defines a disaster as the serious disruption of the functioning of a community or society at any scale due to hazardous events leading to humanitarian, material, economic, environmental losses, and impacts.<sup>(2)</sup> Disasters manifest as severe events disrupting or completely halting the lifestyle of communities, marked by physical, economic, and social losses caused by various natural events.<sup>(3)</sup>

An earthquake is described as the sudden and rapid shaking of the Earth's surface, resulting from volcanic or magmatic activity on the planet. Earthquakes can occur abruptly without any warning and can lead to injuries, property damage, housing problems, and even fatalities.<sup>(4)</sup> According to the World Health Organization (WHO), earthquakes are identified as one of the most destructive natural disasters with the capacity to damage and destroy buildings and infrastructure within seconds.<sup>(5)</sup>

Due to its geological and topographical characteristics, Türkiye is frequently exposed to natural disasters, with earthquakes ranking first as the most devastating type of disaster over the years, given its tectonic position.<sup>(6,7)</sup> Türkiye is situated in one of the world's most significant seismic zones, with 92% of its territory located in earthquake-prone areas.<sup>(8)</sup> According to the Disaster and Emergency Management Authority (AFAD) statistics as of 2023, an average of 22.000 earthquakes are recorded annually, with an average of one earthquake above magnitude 6.0 occurring each year, and around 200 earthquakes ranging from 4.0 to 5.0.<sup>(7)</sup> According to the nature-related event statistics published by AFAD in 2022, the earthquake rate in Türkiye is stated as 91.61%.<sup>(9)</sup>

The earthquake centered in Kahramanmaraş on February 6, 2023, affecting 11 provinces, resulted in the loss of thousands of lives and had a physical and psychological impact on millions of people.<sup>(6)</sup> During the Marmara earthquake in 1999, centered in Kocaeli, official records indicate that approximately 17.000 deaths occurred, numerous individuals were injured, and a total of 704 patients developed kidney problems due to crush syndrome, with 491 of these patients receiving hemodialysis treatment.<sup>(10)</sup> Studies have found that between 1998 and 2020, more than 500.000 people lost their lives in earthquakes, over 2.000 earthquake victims experienced crush syndrome, and more than 1.200 people required dialysis.<sup>(11,12)</sup> Examining major earthquakes and the need for dialysis worldwide, it is known that Japan (1995) had 639

cases of crush syndrome and 477 cases requiring acute dialysis; Taiwan (1999) had 95 cases of crush syndrome and 32 cases requiring acute dialysis; and Pakistan (2005) had 88 cases of crush syndrome and 55 cases requiring acute dialysis.<sup>(13)</sup> Crush injury involves pressure-related muscle damage, while crush syndrome encompasses the systemic consequences of this damage, including acute kidney injury, electrolyte disturbances, hypovolemic shock, compartment syndrome, multiple organ failure, and death.<sup>(14)</sup> From the perspective of kidney diseases, earthquakes rank among the most devastating disasters.<sup>(1)</sup> A study examining the causes of death among individuals hospitalized and those who lost their lives after an earthquake identified crush syndrome as one of the risk factors.<sup>(15)</sup>

Disasters cause significant disruptions in the care of individuals with chronic illnesses, the elderly, and those with special needs.<sup>(3,16)</sup> Earthquakes, in particular, pose significant challenges to the nursing profession, emphasizing the critical role of nurses in disaster preparedness and response. Natural disasters like earthquakes can disrupt healthcare services and create resource shortages, interrupting vital treatment processes such as hemodialysis. This situation threatens the lives of patients with end-stage renal disease.<sup>(16-18)</sup> Dialysis centers in Türkiye provided services to 71.38% of patients needing renal replacement therapy as of the end of 2022.<sup>(19)</sup> The inability to conduct dialysis sessions can lead to increased hospitalization rates and higher mortality. Therefore, dialysis centers must be prepared for potential disasters, conduct necessary patient and staff training, and establish emergency action plans. A study in Japan investigating factors related to emergency hemodialysis preparedness during natural disasters found that 71.9% of participants were unprepared. As highlighted in this research, Türkiye's high seismic activity underscores the necessity for nurses to be prepared for such emergencies.<sup>(20)</sup> This study, by analyzing the relationship between earthquakes and dialysis, will assist nurses in developing evidence-based strategies for disaster preparedness and emergency planning. The focus on dialysis and earthquakes is particularly relevant for nursing, as it addresses the preparedness of healthcare facilities and the continuity of care for patients with end-stage renal disease.<sup>(16-18)</sup> Understanding the distribution of publications, the network of research collaborations, and key trends in this field can equip nurses with evidence-based knowledge to develop and implement effective disaster response plans. This research not only contributes to the academic literature but also serves as a practical guide for nurses, emphasizing the importance of continuous education and training in disaster preparedness to ensure the resilience of healthcare services in the face of natural calamities.

Bibliometric analysis is a scientific method used to provide both quantitative and qualitative analyses of large bibliographic datasets, offering insights into fundamental research components, including authors, countries, journals, and emerging trends. Unlike other research methods, bibliometric analysis does not aim to provide specific and limited answers to a research question; instead, it offers a general and comprehensive overview.<sup>(21)</sup> Bibliometric analysis is particularly suitable for handling large datasets and broader research scopes. The critical aspect in bibliometric analysis is the selection of databases for obtaining the dataset.<sup>(21,22)</sup> Currently, multiple databases such as PubMed, Embase, Scopus, SpringerLink, Google Scholar, and ScienceDirect are employed for bibliometric analysis, with WoS being one of the most frequently used databases among researchers.<sup>(23,24)</sup>

This research aims to identify and visualize articles on the relationship between dialysis and earthquakes, highlight trends, and provide researchers in the future with a literature-based overview of the subject.

### **Research Questions**

- What is the distribution of publications over the years?
- How are authors, countries, and institutions distributed?
- What is the distribution of the most cited publications?
- What is the network map of common author-author, institution, and organization connections, and what are the country linkages?
- What is the map of common keyword analysis?
- How does the network appear based on citation analysis?
- What is the map of articles, journals, institutions, and countries?

## **Methods**

### **Research Design and Sample**

In this descriptive qualitative study, the Web of Science (WoS) data base was utilized. The data were retrieved from the "Web of Science Core Collection" database on November 20, 2023. WoS is a bibliographic database that showcases the impact of scientific journals across various disciplines, indicating the number of citations received by published articles and listing authors' articles along with their references. Within this database, studies published in the fields of dialysis and earthquakes were examined using bibliometric analysis to reveal the current global status. A bibliographic search with the keywords 'dialysis' and 'earthquake' was conducted in the WoS database, resulting in a research population of 138. The sample size for

the study was determined as 95 based on inclusion criteria. The analysis of the obtained data was performed through bibliometric methods using "VOSviewer" and the "R-based Bibliyometrix" program, enabling performance analysis and scientific mapping.<sup>(25-27)</sup>

### **Inclusion Criteria**

For bibliometric data, a total of 138 publications were accessed. A search was conducted in the WoS database using the keywords 'dialysis' and 'earthquake'. Inclusion criteria comprised articles categorized under WoS, and studies published in English. As a result of these limitations, a total of 94 articles from the WoS database formed the dataset for this study.

### **Ethical Consideration**

Since this study involves the retrospective examination of previously published research, ethical approval was not required.

### **Data Analysis**

Bibliometric analysis included numerical distribution of publications and citations over the years, prominent countries, the most frequently used language in publications, journals, active institutions, active publications, common authors, partner institutions, collaborations with partner countries, leading researchers, and the most used keywords. There are four main stages in bibliometric analysis. The first step is to define the objectives of the planned bibliometric study, the second step is to determine the bibliometric analysis techniques, the third step is data collection, and the fourth step is the analysis and writing stage.<sup>(25)</sup>

All document information, including citation information, bibliographic information, abstracts, keywords, and cited references, was exported. The exported data files were converted into a format suitable for data analysis. The research focus, thematic trends, and the evolution of studies were analyzed using thematic maps, trend topics, thematic evolution, and co-occurrence map analyses.

Citation analysis is carried out to determine the most influential publications in a particular field by considering the number of citations a paper has received. Co-citation analysis is a technique used for scientific mapping and is based on the assumption that publications frequently cited together indicate similar themes. This analysis is used to reveal the intellectual structure of a research field. Co-occurrence analysis is conducted to determine the conceptual relationship between documents where two keywords appear together multiple times. Co-authorship analysis refers to formal collaborations between researchers and aims to investigate academic interactions within a research field. In this study, keyword analysis was conducted based on co-occurrence analysis. VOSviewer and Bibliometrix software were used for the

keyword analysis.<sup>(25)</sup> A density visualization map shows the size and impact of a field. Each keyword is represented by a node in a color corresponding to its cluster. To identify significant keywords, VOSviewer uses a statistical technique called probabilistic latent semantic analysis to find the likelihood of words co-occurring. Keywords appearing in similar studies are shown closer together and with nodes of the same color. VOSviewer aims to prevent overlapping labels, but when a node is selected, by hovering over it or selecting it from the cluster list, the network displays its connections to other nodes prominently. The more frequently a node appears, the larger it becomes, and its connections to other nodes increase.<sup>(28)</sup>

VOSviewer (1.6.15) and the "R-based Bibliyometrix" package program were used to visualize bibliometric analysis in this study. Data were graphically represented using the VOSviewer software for better understanding.<sup>(26,27)</sup>

## Results

### Descriptive Analysis of Publications

A bibliometric analysis of the 94 articles published between 1989 and 2023 was conducted. In articles with multiple authors, a total of 464 authors were identified, with only 10 articles being authored by a single author. The percentage of international collaboration among authors was found to be 27.6%. The total number of author keywords was 189, and the average age of documents was 14 years, with an average of 25.64 citations per document (Figure 1a.). Evaluating the publication count over the years, it was determined that the highest number of publications occurred in 2009 (n=8), followed by 2002, 2011, and 2021, each with 7 publications (Figure 1b.). When assessing publication categories, the category with the highest number of studies was determined to be Urology Nephrology (n:59) (Figure 1c.).

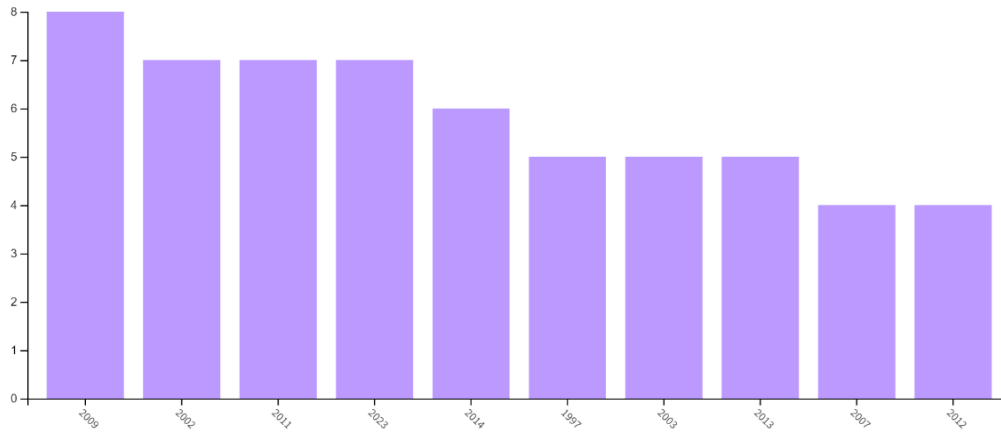
### Author Analysis

In relevant studies published on the topics of dialysis and earthquakes, the authors with the highest number of publications were identified as "Vanholder R. (n:20)," "Sever M.S. (n:20)," and "Lameire N. (n:15)," with the author contributing the most being "Vanholder R. (a.f.: 3.28)" who received the highest number of publications and citations (Figure 2a). The authors with the highest number of citations were Vanholder R. with a total of 15 publications and 1173 citations, followed by Lameire N. with 14 publications and 1146 citations, Sever M.S. with 12 publications and 1048 citations, and Ereğ E. with 11 publications and 1039 citations (Figure 2b). Figure 2c. presents a co-author citation network map, revealing that the top three

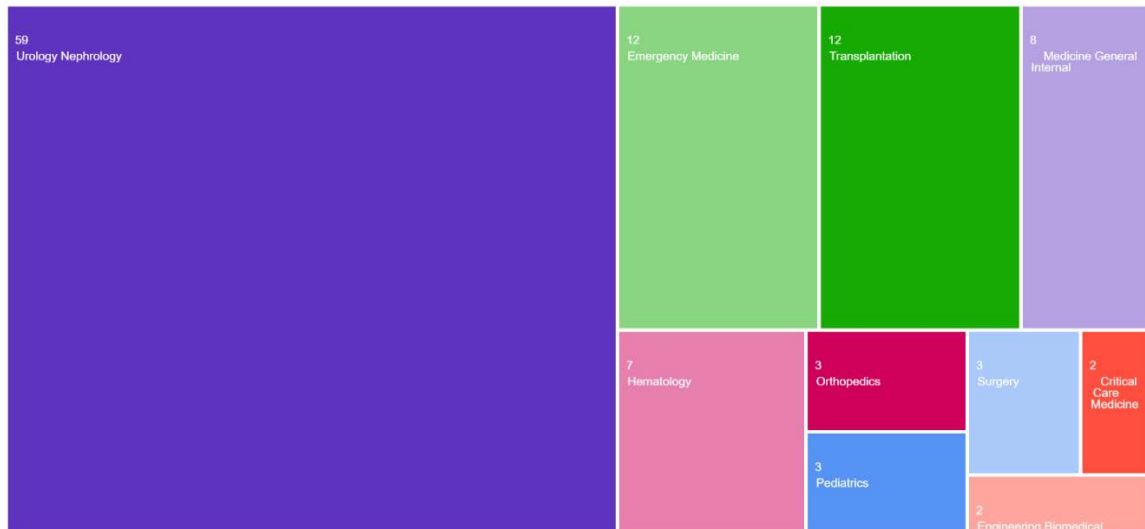
authors with the highest co-citation networks were Sever M.S. (a.s.:149), Better O.S. (a.s.:104), and Vanholder R. (a.s.:84).



### 1a. Basic Publication Informations



### 1b. Publication Data Over The Years



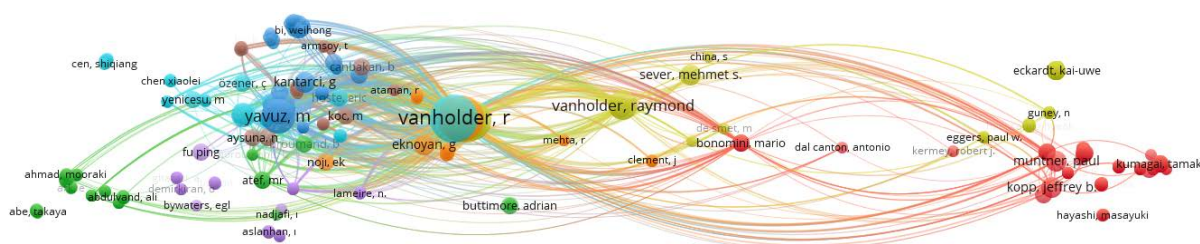
### 1c. WoS Category

Figure 1. Trends in Publications

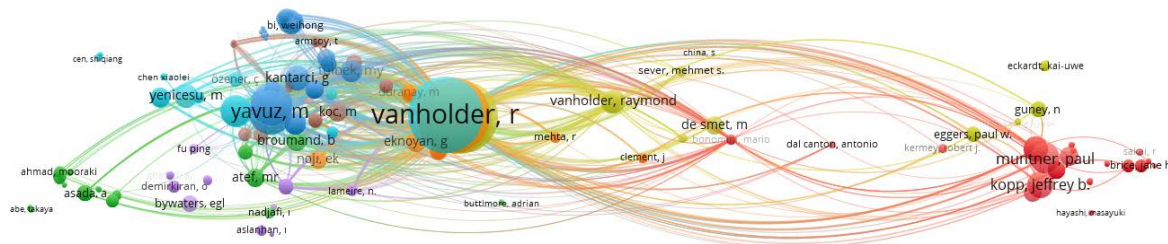


## Institutions Analysis

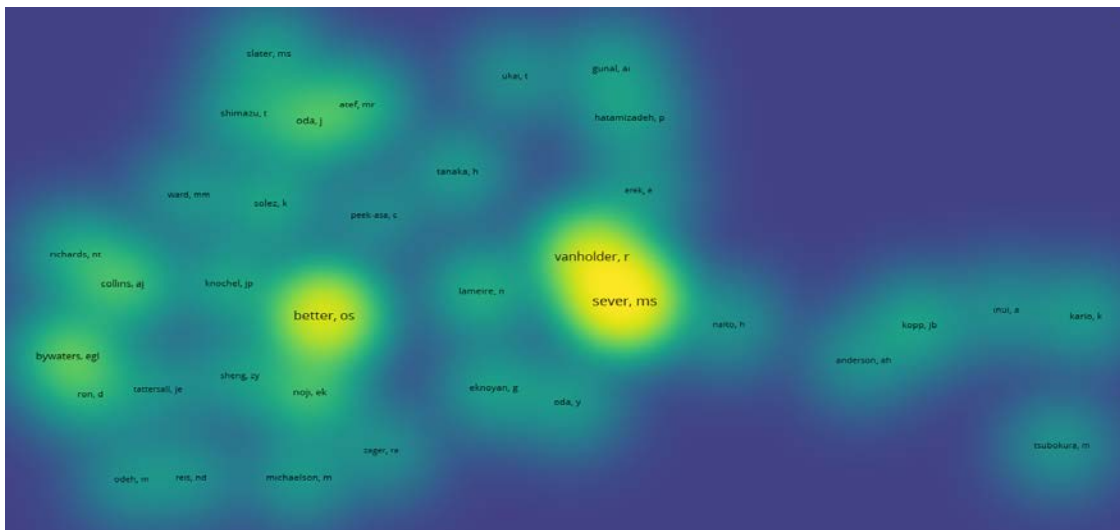
The analysis of institutions to which authors contributing to publications on the subject are affiliated was conducted using the VOSviewer program. As a result of the analysis, the top five institutions publishing on the subject were determined as follows: Istanbul University (n:13), Ghent University (n:10), Cerrahpasa Faculty of Medicine (n:9), Marmara University (n:8), and Uludag University (n:7) (Figure 3a). Additionally, the citation ranking of the publishing institutions is as follows: Ghent University (n:900), Istanbul University (n:608), Istanbul Faculty of Medicine (n:453), Cerrahpasa Faculty of Medicine (n:433), and Marmara University (n:401) (Figure 3b).



### 2a. Author Publications



### 2b. Author Citation Network

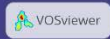
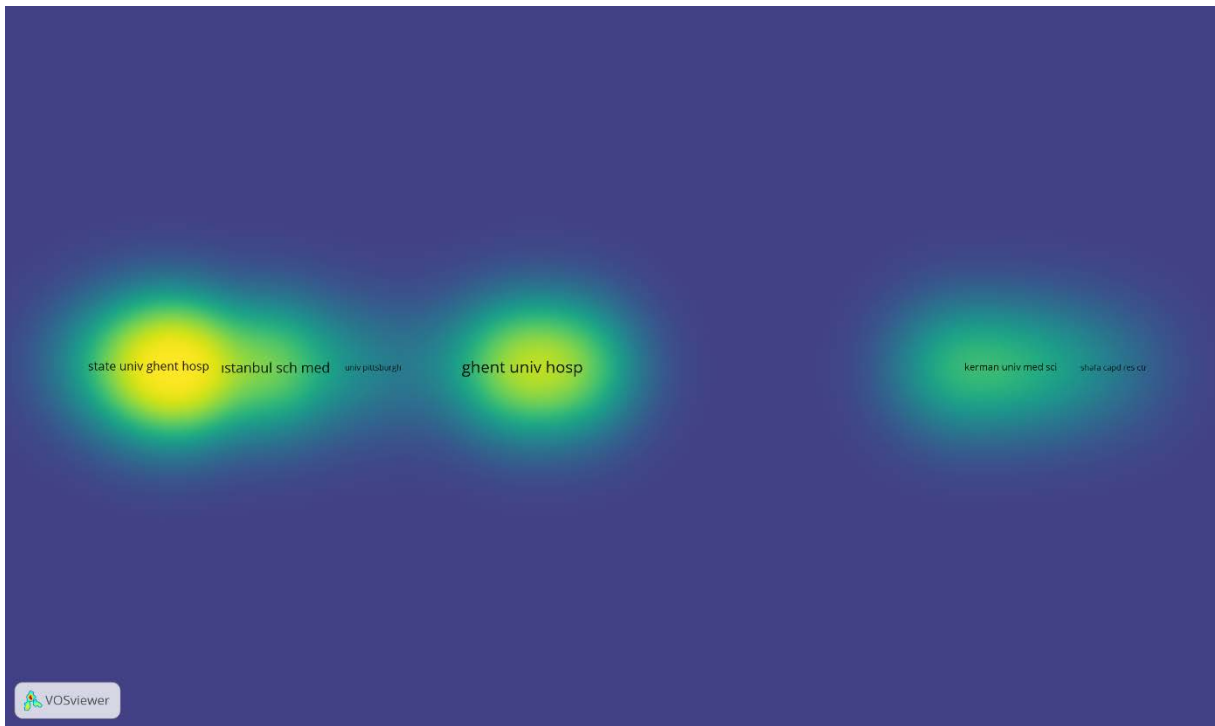


### 2c. Co-Author Citation Network Map

Figure 2. Author Analysis



### 3a. Most Broadcasting Organization



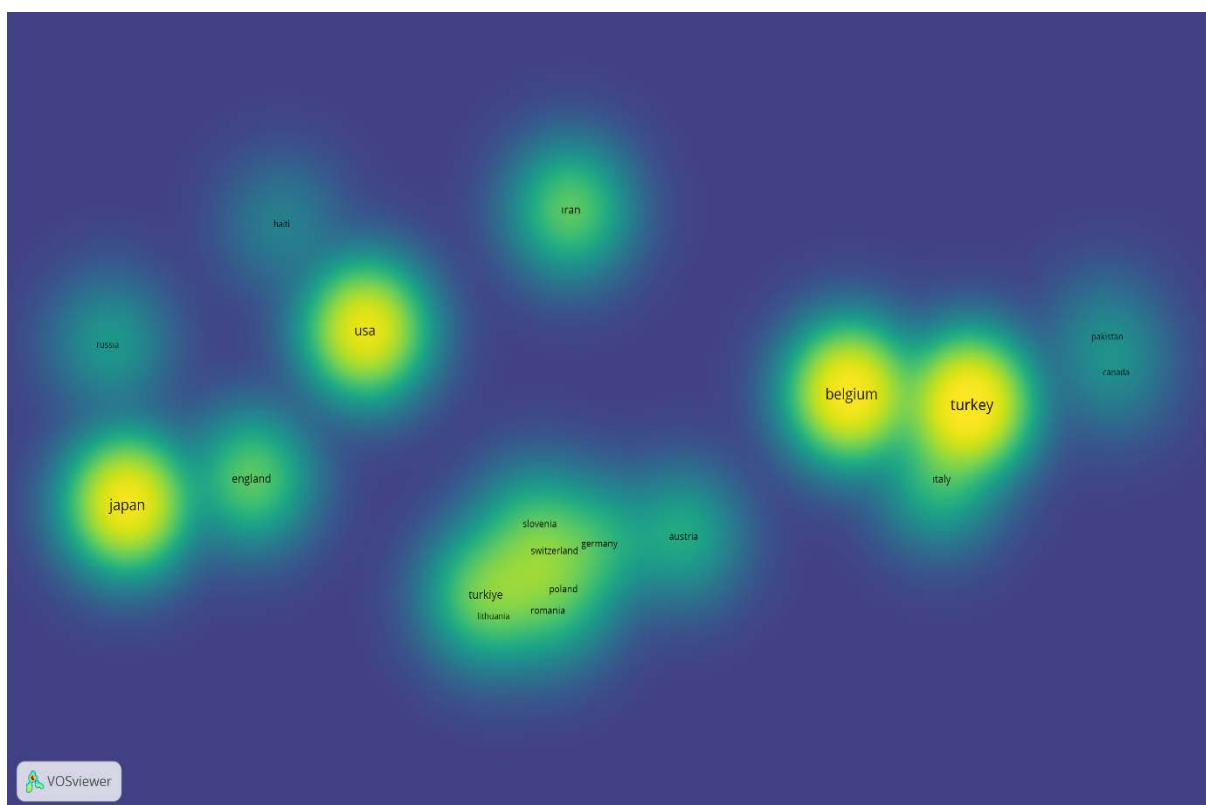
### 3b. Most Cited Organization

Figure 3. Affiliated Institutions of Authors

## Country Analyses

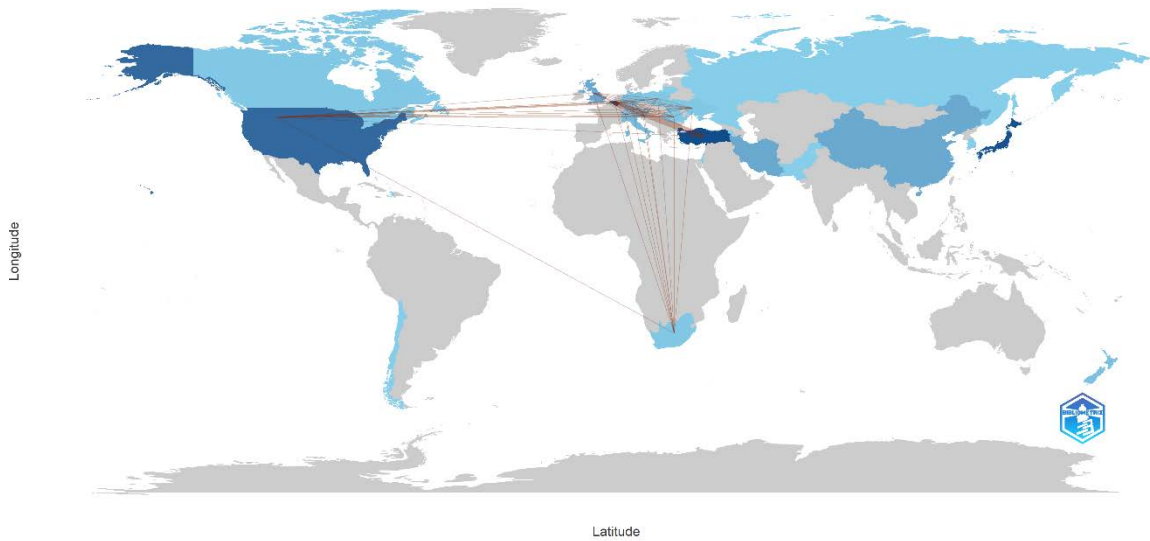
The analysis map based on the countries where studies on earthquakes and dialysis were conducted is presented in Figure 5a. According to the analysis, the countries with the highest number of publications are, in order: Türkiye (n:23), Belgium (n:21), Japan (n:19), and the United States (n:17).

The collaboration analysis among countries was conducted using the Bibliyometrix program. Upon examining the results, it was observed that Türkiye and Belgium have the highest collaboration, with a total of 18 connections, evident from the high number of links in the node section. Following closely, the second and third-ranking countries collaborated in three publications each, namely Belgium-Germany and the United States-Belgium, respectively (Figure 4b.).



### 4a. Country with The Most Broadcasts

## Country Collaboration Map



### 4b. Broadcast Collaborations of Countries

Figure 4. Country Analyses

### Formation of Keywords, Thematic Evolutions, and Keyword Analyses

This section aims to assist in understanding various themes by utilizing the relationships between keywords. Firstly, the co-occurrence network was employed to assess the connections between hospital accreditation keywords. Subsequently, these keyword networks were visualized with a two-dimensional matrix called the "Thematic Map" to analyze the centrality and density of the network.

### Co-occurrence Network

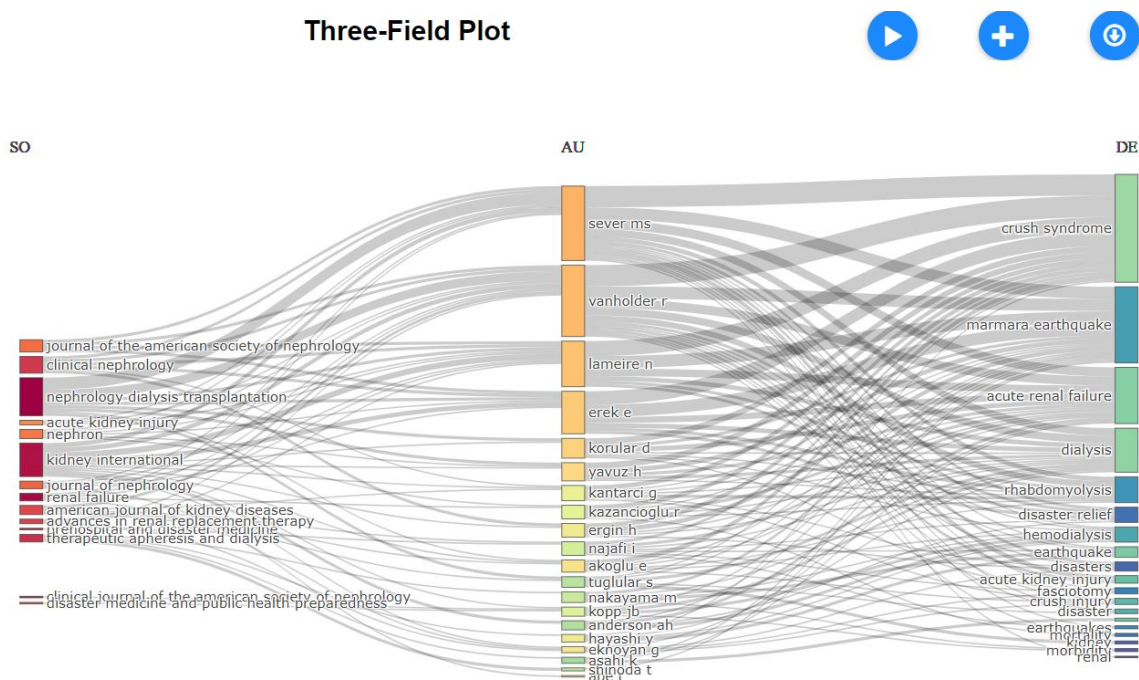
The co-occurrence networks of keywords in publications related to earthquakes and dialysis are presented in Figure 5. In Figure 5a, the positions of keywords in the visual network are referred to as nodes, and the connections between nodes are defined as links. The size of the nodes in Figure 5a corresponds to the frequency of usage of keywords in other studies, increasing or decreasing parallelly and converging. In this context, the keywords "acute-renal-failure" and "victims" emerge as central keywords in the literature, with connections to keywords such as "dialysis," "earthquake," "rhabdomyolysis," 'failure Armenian earthquake,' and "traumatic rhabdomyolysis," indicating their association and presence in the vicinity of "acute-renal-failure" and "victims" (Figure 5a).

### Keyword Analyses

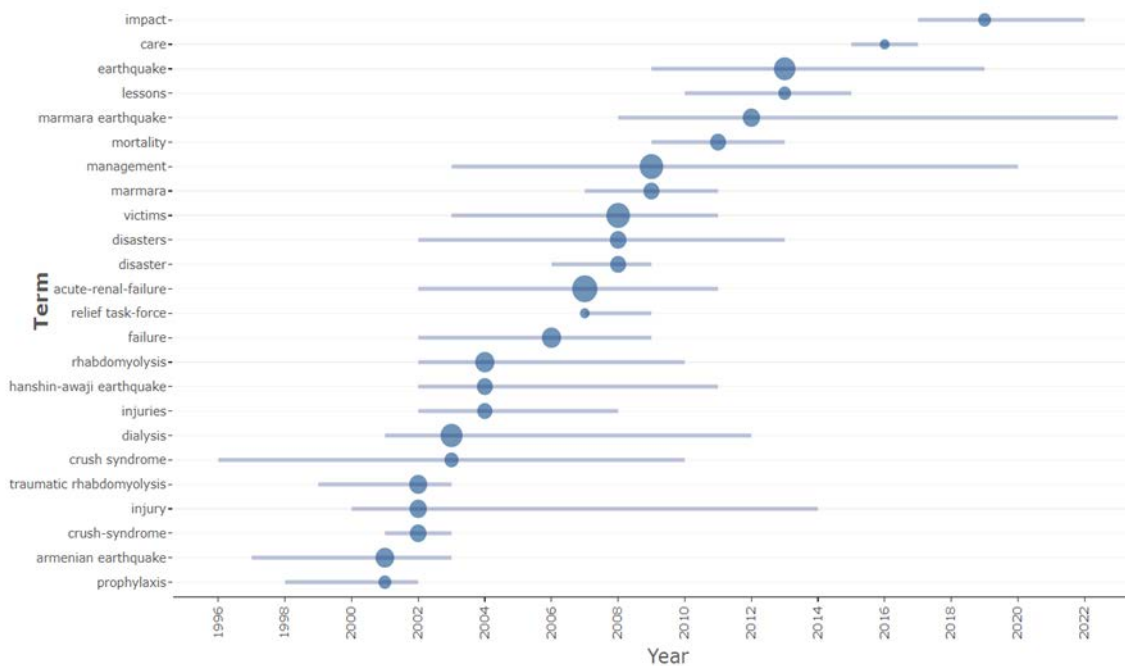
The most frequently used words in the articles within the scope of the research were visualized through a word cloud analysis using the Biblioshiny program. The sizes of the points



### Three-Field Plot



### 5d. Thematic Development



### 5e. Trending Headlines

Figure 5. Formation of Keywords, Thematic Evolutions and Keyword Analyses

Analyses of the most frequently used keywords in the articles were conducted using two different programs (Biblioshiny and VOSviewer), and there were variations in the frequency of keyword usage between the two programs. In the analysis conducted with the VOSviewer program (Figure 5b.), the top three most frequently used keywords were found to be "crush

syndrome" (n:27), "dialysis" (n:22), and "acute-renal-failure" (n:17), followed by "earthquake" (n:15). In the analysis performed with the Biblioshiny program (Figure 5c.), the top three most frequently used keywords were "acute-renal-failure" (n:29), "management" (n:24), and "victims" (n:24), followed by "dialysis" (n:20) and "earthquake" (n:19).

The analysis of the evolution of keywords used by authors in their publications was conducted based on three distinct periods. According to the analysis results, during the period from 1989 to 2002, the most frequently used keywords in the research were "Armenian earthquake," "acute-renal-failure," and "crush syndrome." In the first segment years (2003-2010), the most Common keywords shifted to "acute-renal-failure," "disaster," and "Marmara earthquake." In the second segment years (2011-2015), the preferred keywords changed to "acute-renal-failure," "earthquake," "injury," "Hanshin-Awaji earthquake," and "lessons." Finally, in the years 2016-2023, a shift in preferred keywords was observed, with "earthquake" taking the lead, followed by "rhabdomyolysis," "dialysis," "care," "victims," and "acute kidney injury" as the preferred keywords (Figure 5d.).

### **Trend Headings**

The analysis table of trend headings for articles related to the study from 1996 to 2022 is presented in Figure 6e. Upon detailed examination of the trend headings, a decrease in interest in the subject is observed after 2014. The most trending headings over the years were identified as "acute-renal-failure," "victims," "management," "dialysis," and "earthquake" (Figure 5e.).

### **Discussion and Conclusion**

The management and trends of earthquakes and dialysis are systematically analyzed and presented with numerical and visual maps. This study presents a comprehensive bibliometric analysis of studies on earthquakes and dialysis. The research results provide information about the authors and countries that produce the most publications, the most frequently used keywords, and the changes in keywords over the years, along with the highest citation rates.

A total of 94 articles published between 1989 and 2023 were examined in the study. In the WoS publication category, Urology Nephrology ranked first, and it was determined that the most publications were made in 2009. A total of 464 authors collaborated on these articles. In the analysis of authors in the publications, it was observed that the author with the most publications, "Vanholder R.," is also the author with the most publications and citations. Additionally, the second place was taken by a Turkish author. Furthermore, in the network map of joint author citations, the situation changed, and in the ranking of the top three authors with

the most joint citations, "Sever M.S., Better O.S., and Vanholder R." were identified, unlike the previous authors.

When analyzing the institutions to which the authors conducting studies on earthquakes and dialysis are affiliated, it was observed that seven of the top ten institutions with the most publications are Turkish. Although Istanbul University ranked first in the list of institutions with the most publications, Ghent University ranked first in the list of institutions with the most citations. When analyzing the countries where the studies were conducted, Türkiye ranked first, followed by Belgium and Japan. This ranking is thought to be influenced by the fact that Türkiye and Japan are in earthquake-prone zones and frequently experience earthquakes.<sup>(6,7,29)</sup> Moreover, it was determined that Türkiye and Belgium have the most collaboration among countries. Türkiye has experienced numerous earthquakes causing significant destruction and loss of life due to its geological structure and tectonic position.<sup>(2,3)</sup> It is known that over a million individuals have received dialysis treatment with a diagnosis of crush syndrome in earthquakes that have occurred in Türkiye from the past to the present.<sup>(12,13)</sup> Especially in the recent earthquake centered in Kahramanmaraş, a total of 1373 people were diagnosed with crush syndrome, and 728 of them received hemodialysis treatment.<sup>(30)</sup> Türkiye's location in the earthquake zone and the fact that it has experienced devastating earthquakes of high intensity in recent years have led to an increase in the interest of institutions in the country and more studies on this issue.

The analysis of keywords was performed using two different programs, and it was observed that there is a difference in the common keywords at the end of both programs. In the Vosviwer program, the most frequently used keyword was "crush syndrome," while in biblioshiny, it was "acute-renal-failure." The frequency of keyword usage was evaluated in three periods between 1989 and 2002, revealing a shift in the most used keywords. While "armenian earthquake" was the most frequently used keyword between 1989 and 2002, "acute-renal-failure" was preferred in the first and third periods, and "earthquake" was the leading keyword in the last period. The analysis of trend headings for articles published between 1996 and 2022 indicates a decrease in interest in the subject after 2014, and the most trending headings over the years were identified as "acute-renal-failure," "victims," "management," "dialysis," and "earthquake."

This study provides a thorough examination of the research area intersecting earthquakes and dialysis, making significant contributions to the existing body of knowledge in this field. The research highlights the increase in the number of studies conducted in this



area, particularly influenced by Türkiye's high-risk earthquake zones and the recent occurrence of high-intensity earthquakes. From a nursing perspective, this study underscores the importance of nurses being knowledgeable about earthquakes and dialysis, emphasizing the need for further research in this domain. Understanding the role of nurses in post-earthquake emergency management, crush syndrome, and dialysis treatment is crucial. Enhancing education and training in these areas will improve the effectiveness of healthcare services in future disaster scenarios.

Like any study, this study also has some limitations. The limitations of this study can guide future research. First of all, the study used the concepts of "dialysis" and "earthquake" as keywords, and these concepts were scanned in the Web of Science database. In future studies, it is recommended to enrich the keywords used with additional concepts and to search in different databases such as PubMed, Embase, Scopus, SpringerLink, Google Scholar, and ScienceDirect. In the analysis part of the study, "R" and "Vosviewer" programs were used. For future studies, it is recommended to use programs such as CiteSpace or SciMAT to increase visibility or observe the difference between analysis programs. Obtaining more generalizable findings with different inclusion criteria and a different sample size is also recommended.

### **Relevance for Clinical Practice**

The data obtained from this bibliometric analysis are crucial for informing clinical practices, particularly in earthquake-prone regions. By integrating the study's findings into clinical protocols, healthcare providers can enhance their readiness and response to earthquake-induced health emergencies, ultimately improving patient outcomes. Furthermore, the study's results are expected to contribute to the establishment of collaborations among institutions, countries, and researchers, especially for those planning to work in this field.

### **Acknowledgments**

None.

### **Conflict of Interest**

All the authors declare that they have no conflict of interest.

### **Ethics Statement**

Ethical approval was not needed because this is a bibliometric analysis.

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