Mapping the Scientific Landscape of Surgical History Articles through Citation and Thematic Analysis

Boraghi F. MD[1*], Barzin S. S. MD[1]

Abstract:

Background and Objective: Mapping the scientific output related to the history of Iranian surgery aims to assess the current status and scientific standing of this field at both national and international levels. The purpose of this measure is to identify strengths and weaknesses, determine research priorities, and improve the quality and quantity of scientific productions in the history of surgery.

Materials & Methods: This applied research employed documentary analysis and word co-occurrence analysis methods. The study population comprised all articles indexed in the Web of Science database by Iranian researchers from 1960 to 2024, with a focus on the history of surgery. The desired maps were generated using VOSviewer software.

Results: An analysis of scientific maps and collaboration networks in the field of Iranian surgical history from 1960 to 2024 reveals significant thematic diversity and scientific depth. Key research areas include cardiovascular surgery, cancer, bariatric surgery, neurology and pediatric diseases, case studies, and epidemiology. The emphasis on the terms "surgery" and "Iran" highlights a particular focus on local issues and the country's health needs. Additionally, diverse clustering and strong interconnections among various topics indicate scientific maturity and a shift toward interdisciplinary research. Regarding international collaboration, Iran serves as a central hub for scientific production in this field, maintaining extensive interactions with advanced countries such as the United States, the United Kingdom, Germany, and Canada, which has enhanced research quality and facilitated knowledge transfer. At the organizational level, medical universities in Tehran, Shiraz, Tabriz, and other specialized centers play an important role in advancing the country's scientific research and development by fostering extensive cooperative networks. Overall, these trends suggest a promising future for elevating Iran's scientific standing in surgery and global medicine, providing a foundation for the development of interdisciplinary research and improved responses to community health needs.

Conclusion: The analysis of scientific maps and collaboration networks in the field of Iranian surgical history reveals a diverse range of topics, scientific maturity, and extensive national and international cooperation. These trends are expected to enhance Iran's scientific standing in surgery, promote interdisciplinary research, and improve responses to the community's health needs.

Keywords: *Research Personnel, Iran, Publications, Surgical Procedures, Operative*

[1]Assistant Professor, Department of History, Payam Noor University, Tehran, Iran
Received: 28/04/2025
Accepted: 04/10/2025

Corresponding Author: Dr. Fazlollah Boraghi

Tel: 07635244088

E-mail: fboraghi@pnu.ac.ir
E-mail: s.barzin@pnu.ac.ir

Background and Objective

Surgery in Iran has a rich and ancient history. Since the earliest periods of human civilization, evidence of the skills of Iranian surgeons has been apparent. One of the oldest known examples of surgery worldwide comes from the Burnt City (Shahr-e Sukhteh) in Sistan, where the skull of a teenage girl was surgically treated by trepanation to alleviate hydrocephalus. In ancient Iran, surgeons held a high social status, and their knowledge and expertise are documented in ancient texts such as the Avesta. The establishment of Jundi-Shapur University during the Sassanid era, which integrated Iranian, Greek, and Indian medical knowledge, marked a new phase in the development of surgery in Iran. During the Islamic period, physicians such as Razi and Avicenna made significant contributions to advancing surgical science through their scholarly works. In the modern era, the foundation of the Iranian Surgical Association and the introduction of specialized training programs fostered the development of modern surgery in the country. Today, Iran holds a prominent position in surgical knowledge and expertise within the region.

The goal of every country is to achieve independence and self-sufficiency. Achieving this largely depends on attaining a superior scientific status and advancing scientific development. Scientists and experts consider scientific activities to be the most influential factor in development. Scientific outputs, as indicators of a country's scientific system, form the foundation for decision-making in research and development.[1] According to various classifications, one subfield of scientometrics is the study of the structure and evolution of scientific knowledge. This involves, first, defining the structure and specialized domains across all sciences and technologies, and second, focusing on each specific discipline. Simply put, by reviewing the topics addressed in diverse fields over time or within specific periods, the volume of study per topic and the relationships between these topics are scientifically and clearly analyzed using mathematical and statistical methods. Based on this analysis, scientific maps are graphically produced for various scientific and technological fields to illustrate their interrelations, facilitating a fundamental understanding of the roots of science and technology. Scientific maps can be used to analyze the scientific outputs of a particular field from different perspectives, providing a comprehensive overview of that discipline. By tracking patterns of change and evolution through these maps, areas with the greatest or least proximity to each other can be identified. Consequently, individuals can discern not only the characteristics and relationships between subdomains of a field but also the most influential researchers and research organizations within that area.[2]

The concept of spatially visualizing science has a long history. For example, Bush described the spatial mapping of scientific disciplines. Additionally, in the 1970s, attention was drawn to mapping the structure of science within the social sciences, human geography, and sociology (Peshotni and Asareh, 2009). Numerous scholars have mapped the structure of various scientific domains based on their literature, employing cluster analysis and multidimensional scaling techniques.[3]

Mapping the structure of science across different disciplines and monitoring its latest developments is of great interest to scientists, scientometricians, philosophers, policymakers, and publishers. Scientific texts serve as the primary foundation for these mappings. When mapping the structure of science, three components are considered: individual elements, the interconnected elements that form a network, and the interpretation of the relationships between these elements.[4]

Over recent decades, the study of scientific maps has become a crucial aspect of scientometric research, gaining importance across multiple scientific disciplines. The primary objectives of scientific maps are to present a macro-level overview of past research activities, illustrate the interconnections between different fields, and provide insight into the growth

and development of these domains over time. These maps are generated using various techniques and methods, one of which is the co-occurrence analysis of keywords (Figure 1).

Content analysis using the co-word approach was first implemented in the 1980s in France at the Center for Sociology of the École as an alternative to citation-based methods to map the dynamics of science. While co-citation maps reflect the awareness and knowledge of citers, co-word analysis gained popularity for revealing semantic networks among citations. Researchers in scientometrics have found that keywords in texts are distinct entities that share similarities with citation indices. Each scientific field can thus be identified by a set or combination of key keywords, and its concepts can be represented using a few major keywords.[5] Co-occurrence analysis of keywords enables the extraction of scientific topics and the direct discovery of their relationships from thematic content.

Numerous studies have utilized various software tools to generate scientific maps across different fields. For example, one study aimed to identify and analyze the vocabulary structure and concepts within "Information Science and Knowledge Studies" articles by creating co-word scientific maps based on data from the Web of Science database. The results revealed that keywords such as "information," "web," "research," "citation analysis," "knowledge," "library," "journals," and "technology" constituted the core concepts explored in this discipline. These concepts were organized into thirteen clusters, with primary thematic areas including: "education and learning; information literacy," "information and knowledge organization," "web-based information resources and social networks," "professional ethics in information science," "informatics; communication and health information services," "information management; information systems; knowledge management and innovation," and "scientometrics and informetrics studies." Another study focusing on thematic trends within knowledge management articles in the field of information science and knowledge studies found, through thematic maps, that knowledge sharing exhibited higher centrality compared to other article groups.[6]

Another study employing co-occurrence keyword analysis investigated the subdomains of informetrics, revealing that concepts such as information science, library science, bibliometric analysis, innovation, and text mining are among the most frequently applied topics internationally within informetrics.[1] Toklilzadeh Ravari's research demonstrated that, linearly, with the publication of over 250 documents across various medical science topics, new subjects emerge and expand the network. The results indicated that, contrary to some beliefs, the expansion of scientific topics is dynamic and proceeds linearly without interruption.[7] Furthermore, Toklilzadeh and Najabtian concluded that marriage psychology topics within biomedical sciences can be divided into five clusters; by comparing two resulting cluster maps, they examined changes in relationships both within and between these fields.[8] Asadi and Farooni Shamili found that effective collaboration does not exist between the seminary, a major research center for the humanities, and other universities. Despite close proximity and thematic overlaps among three humanities research institutes located in Tehran, scientific collaboration between these institutions is almost negligible. Among external collaborating organizations, Tarbiat Modares University has cooperated with all three institutes, with the most collaboration occurring with the Institute of Humanities and Cultural Studies and the least with the Humanities and Social Studies Institute of Jihad Daneshgahi.[9] Nik Kar, Alijani, and Karami mapped the thematic structure of scientific outputs in the field of surgery using VOSviewer software. Their results showed that thematic topics such as management, complications, and others formed "hotspots" within the map, indicating that these clusters have stronger connections to other topics and contain more publications.[10] Additionally, Raisizadeh

and Karami demonstrated that the thematic structure of scientific productions related to military trauma has changed over time and evolved dynamically, influenced by military needs and experiences from recent wars. Their results further revealed a steady upward trend in scientific outputs within the military trauma domain indexed in MEDLINE between 2000 and 2017.[11] Based on the above, the present study aims to use VOSviewer software and data from the ISI citation database to map the thematic structure of scientific outputs concerning the history of surgery in Iran.

Materials and Methods

This study employed a documentary research method combined with co-occurrence analysis of keywords. It is applied research in terms of its objective. The research population comprises all articles on the history of surgery in Iran, authored by Iranian researchers and indexed in the Web of Science database from 1960 to 2024. The required data were extracted exclusively from the Web of Science database and include only English-language articles. For data collection, the Web of Science database was accessed, and the following search formula was used in the advanced search section to retrieve information related to the history of surgery:

WC=Surgery and History CU=Iran

Moreover, the publication years were limited to the period between 1960 and 2024. The data were saved using the "Save to Other File Formats" option in the tab-delimited (Win, UTF-8) format. Subsequently, the desired scientific maps were generated using VOSviewer software.

Study Limitations

The research data were extracted exclusively from the Web of Science database, which does not include Persian articles or certain other scientific sources. Therefore, the study is limited to articles published in other languages and indexed within this database, and it does not provide a comprehensive overview of all published articles in the field of the history of surgery. This limitation means that a significant portion of scientific output in Persian or indexed in other databases are not included in this analysis, resulting in a thematic map that does not fully represent the entire scientific landscape of the field. Additionally, the temporal scope of the analysis (typically a specific period, such as 1960 to 2024) along with restrictions on the types of published documents selected, may affect the results and fail to capture developments outside these time frames or document types. Furthermore, exclusive reliance on the bibliographic and citation data available in Web of Science may be influenced by technical issues, indexing inconsistencies, and data quality concerns, all of which can impact the accuracy and validity of the analysis.

Findings

The thematic map of scientific publications on the history of surgery in Iran from 1960 to 2024.

Image 1 presents a co-occurrence map of keywords extracted from scientific publications on the history of surgery in Iran between 1960 and 2024. During this period, 1304 keywords were identified from the titles and abstracts of articles across two relevant fields. Related keywords were then standardized and compiled into a corresponding file. After standardization, 854 related keywords were imported into VOSviewer software. This map illustrates the relationships among various topics related to surgery in Iran.

Overall Map Analysis: Centrality of Keywords: The term "surgery" occupies the central position on the map and forms the largest node, highlighting its importance and central role in studies concerning the history of surgery in Iran. Topical Connections: Lines connecting nodes represent relationships between topics, with thicker and more numerous lines indicating stronger connections. Clustering: Nodes are color-coded into clusters that represent related topical groups.

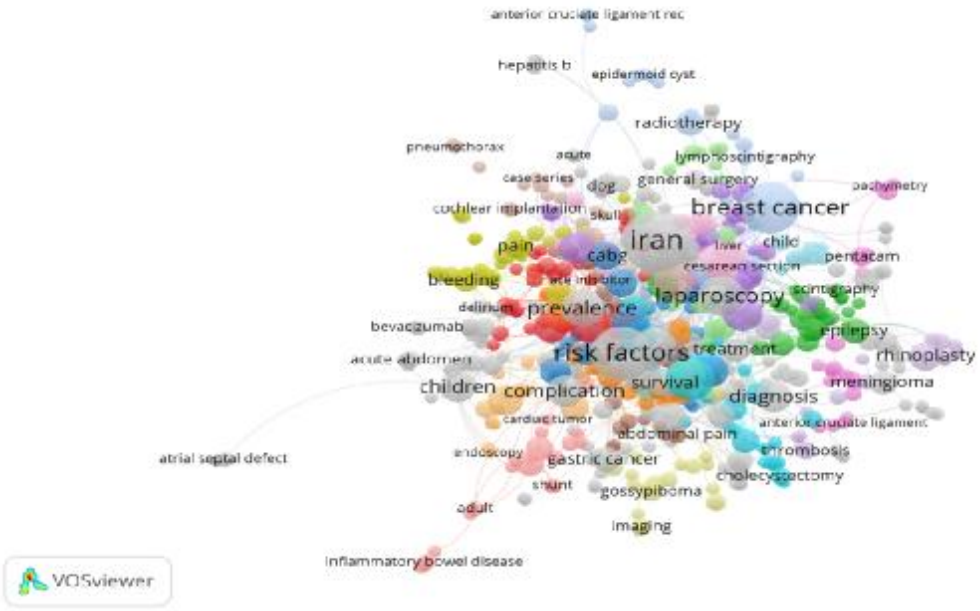

Figure 1- The thematic map of scientific publications on the history of surgery in Iran from 1960 to 2024.

Key Clusters and Related Topics: Green cluster (Surgery and Related Diseases) includes terms such as "complications," "hydrocephalus," "history of medicine in Iran," "quality of life," and "diagnosis." This cluster encompasses various aspects of surgery, including its history, disease diagnosis, and patient outcomes. Orange cluster (Case Studies) contains keywords such as "case report," "epidemiology," "risk factors," and "laparoscopy," focusing on case studies and epidemiological research. Red cluster (Cardiovascular Diseases) includes terms such as "coronary artery bypass," "cardiovascular disease," "outcomes," and "angiography," and is dedicated to topics related to heart and vascular surgery.

Blue cluster (Cancer and Obesity) includes terms such as "breast cancer," "obesity," "bariatric surgery," and "stomach cancer," focusing on cancer treatment and obesity-related surgery. Yellow cluster (Neurology and Pediatric Diseases) comprises terms such as "epilepsy," "pediatrics," and "meningioma," emphasizing neurological and pediatric conditions.

Notable Points: The keyword "Iran" is prominently visible, indicating the studies' focus on the surgical context within the country. Connections among various topics reveal interdisciplinary interactions, such as links between cardiac surgery, cancer, and patient quality of life. This map can be used to analyze scientific trends in the field of surgery in Iran; it helps identify popular or underexplored topics, highlight future research priorities, and illustrate interdisciplinary links to foster collaborative research. Overall, this tool provides researchers with a comprehensive overview of the scientific landscape regarding the history of surgery in Iran.

How has the international collaboration network between Iranian researchers and their counterparts from other countries evolved in the field of the history of surgery in Iran from 1960 to 2024?

Table 1- Top ten countries in scientific collaboration in this field

Row	Countries	Frequency	Percentage%
1	USA	113	8.315
2	Canada	21	1.545
3	England	18	1.325
4	Germany	14	1.03
5	France	10	0.736
6	Italy	9	0.622
7	Netherlands	9	0.622
8	Australia	8	0.589
9	India	7	0.515
10	China	7	0.515

In Image 2, the country collaboration network in scientific production across the two studied fields, based on data from the Web of Science citation database, is depicted. This network map illustrates international collaborations involving Iranian authors in the history of surgery. Each node represents a country, with the node size indicating the number of publications or collaborations associated with that country. The lines connecting nodes represent collaborations between countries, and the thickness of these lines reflects the strength of the cooperation.

Key Points: Iran is prominently positioned as the central hub of this network, indicating that the core of historical surgery research in Iran is concentrated within the country itself. The large size of Iran's node reflects a high volume of publications and collaborations related to it. United States of America is the second-largest node on the map, highlighting its role as a significant partner for Iranian researchers in the history of surgery. Strong collaborations are evident from the thickest lines connecting Iran with the USA, as well as with countries such as the UK, Germany, and Canada, demonstrating the most robust partnerships in this field. Other countries, including France, Italy, Australia, and Middle Eastern nations such as Lebanon and Jordan, also appear in the network, although their collaborations tend to be less extensive.

What is the structure of the inter-organizational scientific collaboration network for research on the history of surgery in Iran between 1960 and 2024?

Table 2- Top ten universities or organizations

Row	Universities or Organizations	Frequency	Percentage%
1	Tehran University of Medical Sciences	440	32.377
2	Shahid Beheshti University of Medical Sciences	257	18.911
3	Iran University of Medical Sciences	182	14.128
4	Mashhad University of Medical Sciences	134	9.86
5	Shiraz University of Medical Sciences	117	8.609
6	Islamic Azad University	86	6.328
7	Isfahan University of Medical Sciences	76	5.592
8	Tabriz University of Medical Sciences	60	4.415
9	Guilan University of Medical Sciences	50	3.679
10	Farabi Hospital	36	2.649

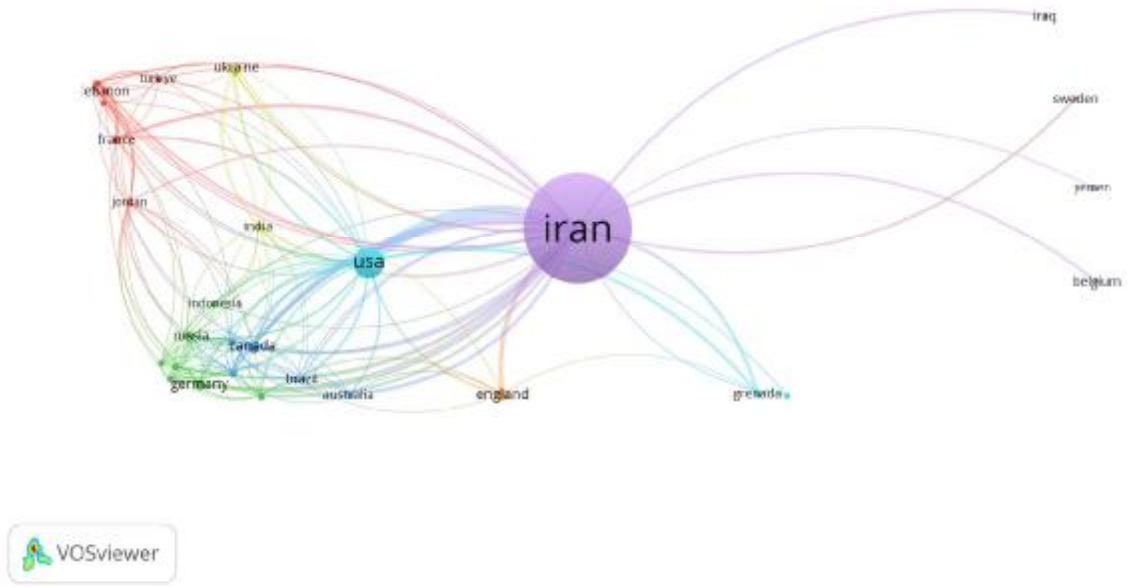

Figure 2- The international collaboration network in scientific publications on the history of surgery in Iran from 1960 to 2024.

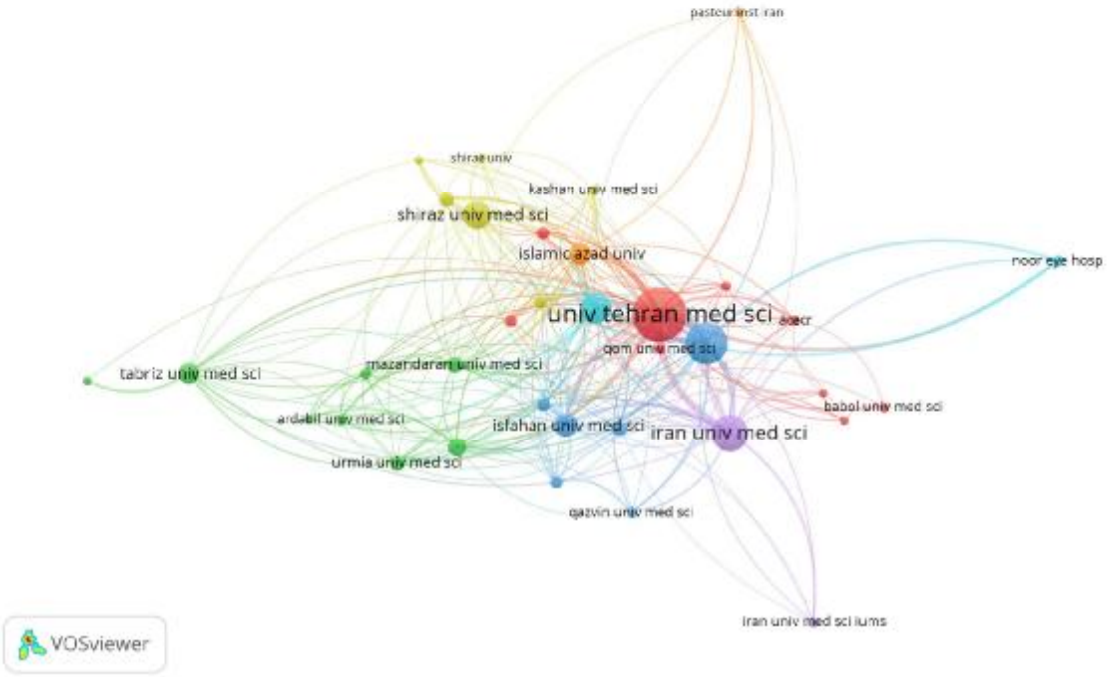

Figure 3- The inter-organizational collaboration network in scientific production in the field of the history of surgery in Iran from 1960 to 2024.

In Image 3, the network of organizational collaboration in the two studied fields, based on the Web of Science citation database, is illustrated. Each node represents a university or research institute. The size of the nodes corresponds to the number of articles published by that institution. Colors indicate clusters of institutions grouped according to scientific collaboration. Lines between nodes indicate the level of collaboration between different institutions. Prominent Institutions: Tehran University of Medical Sciences is the largest node on the map, indicating the pivotal role in surgical research in Iran. It has the most connections with other universities, including Iran University of Medical Sciences, Shiraz University of Medical Sciences, and Isfahan University of Medical Sciences. Shiraz University of Medical Sciences is a major center with extensive collaborations, likely active in fields such as general surgery and laparoscopy. Tabriz University of Medical Sciences plays a key role in regional research and collaborates with universities such as Ardabil and Urmia. Specialized Institutions: Noor Ophthalmology Hospital and the Pasteur Institute of Iran are also identified as specialized centers on the map.

What does the scientific collaboration network of Iranian researchers in the history of surgery from 1960 to 2024?

This scientific map illustrates authors in the field of surgery in Iran and was created using VOSviewer software. The analysis of the map is as follows: Each node represents an individual author. The size of the nodes indicates the number of articles published or the scientific impact of the author within the field of surgery. Different colors represent clusters of authors grouped based on joint collaborations or similar research topics.

Table 3- Top ten authors in this field

Row	Authors	Frequency	Percentage%
1	Hashemi H	21	1.545
2	Karimi A	18	1.325
3	Khabazkhoob M	14	1.03
4	Jalali A	13	0.957
5	Pazouki A	13	0.957
6	Kermansaravi M	11	0.809
7	Khosravi A	11	0.809
8	Sadeghian S	11	0.809
9	Kajbafzadeh AM	10	0.736
10	Mohammadi A	10	0.736

Connection Lines: Lines between nodes indicate scientific collaboration among authors. The thickness of these lines represents the strength of collaboration or the number of co-authored articles. Author clustering: Blue cluster includes authors such as "Pazouki, Abdolreza" and "Rezapanah, Alireza." This cluster likely focuses on surgeries related to obesity and laparoscopy. Red cluster includes authors such as "Jalali, Arash" and "Abbasi, Seyed Hesameddin." This group appears to concentrate on cardiovascular diseases and associated surgical procedures.

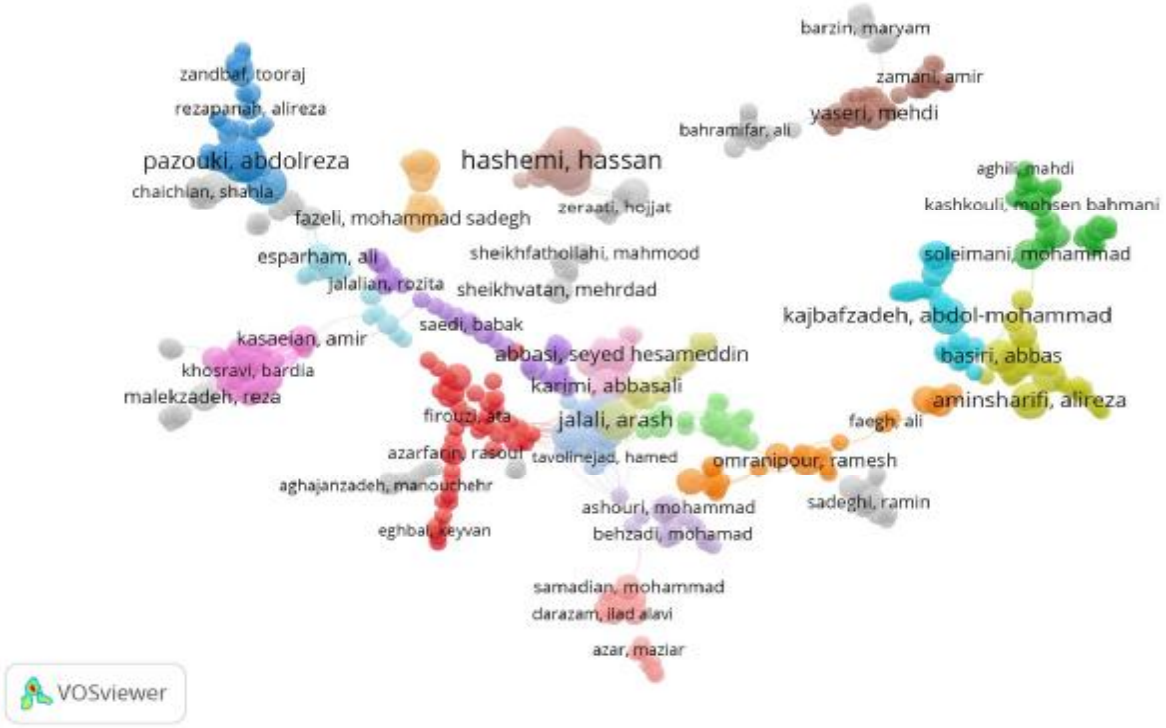

Figure 4- The scientific collaboration network of Iranian researchers in the field of the history of surgery during the years 1960 to 2024.

The green cluster includes authors such as "Kajbafzadeh, Abdol-Mohammad" and "Aminsharifi, Alireza." This cluster is probably devoted to urology and surgeries related to the kidneys and urinary tract. The orange cluster comprises authors such as "Hashemi, Hassan" and "Zeraati, Hojjat." This group may specialize in ophthalmology and vision-related surgeries. The purple cluster features individuals such as "Kasaeian, Amir" and "Malekzadeh, Reza." This cluster likely covers broader or multidisciplinary research in surgery.

Highlights on the map include authors such as "Pazouki, Abdolreza" and "Hashemi, Hassan," who have larger nodes, indicating a higher impact or a greater number of publications. The density of lines in certain areas indicates a high level of collaboration among specific authors, suggesting the presence of strong research teams. Conversely, the dispersion of some nodes indicates more independent activity by certain authors or fewer connections to others.

Conclusion

The analysis of scientific maps and collaboration networks in the history of surgery in Iran from 1960 to 2024 reveals several key insights. First, the thematic map of scientific output demonstrates that research in this field is both diverse and comprehensive, encompassing topics such as cardiovascular surgery, cancer, bariatric surgery, neurology and pediatric diseases, case studies, and epidemiology.

The centrality of the term "surgery" and the prominence of the word "Iran" on the map indicate a focus on local issues and the country's health needs. The presence of diverse thematic clusters and strong

interconnections among them indicates the growth and maturity of this field, as well as a shift toward interdisciplinary research. Regarding international collaborations, the country collaboration network shows that Iran serves as the main hub for scientific production in the history of surgery and maintains its strongest collaborations with advanced countries such as the United States, the United Kingdom, Germany, and Canada. These collaborations have not only enhanced the scientific quality of articles but also facilitated the transfer of knowledge and international expertise.

The inclusion of countries from Europe, Australia, and the Middle East in this network reflects the broad scope of scientific interactions and Iran's growing prominence on the global stage. At the organizational level, Tehran, Shiraz, and Tabriz Universities of Medical Sciences, along with other prominent national centers, play pivotal roles in scientific production and the development of domestic collaboration networks. These institutions have established extensive connections with other universities and specialized centers, providing a conducive environment for joint research and elevating the country's scientific standards. Furthermore, the contributions of specialized institutions such as the Pasteur Institute of Iran and specialized hospitals in advancing clinical and applied research is clearly evident. Overall, these analyses indicate that the history of surgery in Iran has experienced remarkable thematic growth over recent decades, accompanied by a progressive increase in national and international scientific collaborations. This structure can help identify popular and underexplored topics, set future research priorities, and strengthen both domestic and international scientific networks. These trends promise a bright future for enhancing Iran's scientific standing in the fields of surgery and medicine worldwide and can promote interdisciplinary research and better address the healthcare needs of society.

References:

1. Sedighi M. Using of co-word analysis method in mapping of the structure of scientific fields (case study: The field of Informetrics). 2015; 30 (2): 373-396.
2. Makkizadeh F, Hazeri A, Hosininasab S, Soheili F. Thematic Analysis and Scientific Mapping of Papers related to Depression Therapy in PubMed. jha. 2016; 19 (65): 51-63.
3. Osareh Faridah, Marfat Rahman. Participation of Iranian researchers in the production of global science in Medline (the field of basic and interdisciplinary medical sciences). Rahyaft. 1384, 2022; (35): 39-44.
4. Paul, R. J. Visualizing a knowledge domain's intellectual structure. Research Feature. Available at: ww. pages. drexel. edu/ papers/ copruter. Html. 2001. Accessed 13 Sep, 2017.
5. Mostafavi I, Osareh F, Heidari G, Tavakolizadeh-Ravari M. Analysis and Comparison of Interdisciplinary Relations of Library Science and Information Science Based on Citation Clustering in The Period of Before and After the Appearance of the Web. Journal of Information Processing and Management. 2016; 31 (3): 675-703.
6. Moradi, S, Study of the thematic tendencies of knowledge management articles in the field of information science and dentistry with the citation analysis approach, Yazd University, M.A Thesis, 2016.
7. Tavakolizadehravari, M. The Growth of Medical Sciences Subjects: A Correlation Analysis between Development of MeSH and Medline. Health Information Management, 2008; 4 (2): 185.
8. Tavakolizadeh Ravari, M., Nejabatian, M. Document-Term Clustering: Proximity of Subjects Correspond with Psychology of Marriage in Biomedicine Literature during the Years “1990-99” and “2000-2008”. Health Information Management, 2010; 7 (2).
9. Asadi, S., Ferouni Shamili, N. Analysis and visualization of collaboration among Iranian research institutes for humanities. Knowledge Retrieval and Semantic Systems, 2016; 3 (6): 60-80.
10. Nickar, M., Alijani, R., Karami, N, Drawing the Scientometric Map of Scientific Field of Surgery using VOS Viewer Software, Iranian Journal of Surgery, 2018; 25 (4): 47.
11. Raeeszadeh M, Karamali M. Scientific Mapping of Military Trauma Papers using Co-Word Analysis in MEDLINE. J Mil Med. 2018; 20 (5): 476-487.