Drawing a scientific map of surgical history articles based on citation and thematic analysis

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Abstract:

Background and Objective: **Drawing a scientific map of the scientific productions of Iranian surgical history is to examine the current status and scientific position of this field at the national and international levels. The aim of this measure is to identify strengths and weaknesses, determine research priorities, and improve the quality and quantity of scientific productions in the field of surgical history**.

Materials & Methods: **The present study was conducted using documentary and word co-occurrence analysis methods. This study is also applied in terms of its purpose. The research population consisted of all indexed articles by Iranian researchers in the Web of Science database during the years 1960 to 2024 in the field of Iranian surgical history. The desired maps were also drawn using VOSviower software**.

Results: **Analysis of scientific maps and networks of collaboration in the field of Iranian surgical history from 1960 to 2024 shows that this field has a significant thematic diversity and scientific depth. Topics such as cardiovascular surgery, cancer, bariatric surgery, neurology and pediatric diseases, case studies, and epidemiology are among the main research axes. Focusing on the words "surgery" and "Iran" indicates special attention to local issues and the country's health needs. Also, diverse clustering and strong connections between different topics indicate scientific maturity and a move towards interdisciplinary research. In terms of international cooperation, Iran plays a role as the central core of science production in this field and has the most interactions with advanced countries such as the United States, the United Kingdom, Germany, and Canada, which has led to improved quality and knowledge transfer. At the organizational level, the universities of medical sciences in Tehran, Shiraz, Tabriz, and other specialized centers play an important role in advancing the country's scientific research and development by creating extensive cooperation networks. In general, these trends promise a bright future for improving Iran's scientific standing in the field of surgery and global medicine, and provide the basis for the development of interdisciplinary research and better response to the health needs of the community**.

Conclusion: **The results of the analysis of scientific maps and cooperation networks in the field of Iranian surgical history show that this field has a variety of topics, scientific maturity, and extensive national and international cooperation. These trends will pave the way for improving Iran's scientific standing in surgery and developing interdisciplinary research and better response to the health needs of the community**.

***Keywords:** Scientific productions, Iranian researchers, drawing a scientific map, surgical history*

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Background and Objective

Surgery in Iran has a very ancient, historical, and valuable origin. Since the earliest periods of human civilization, signs of the skills of Iranian surgeons have been evident. One of the oldest known surgical evidences worldwide relates to the Burnt City (Shahr-e Sukhteh) in Sistan, where the skull of a teenage girl was surgically treated by trepanation to cure hydrocephalus. In ancient Iran, surgeons held a high social status, and their knowledge and expertise are mentioned in ancient texts such as the Avesta. With the establishment of Jundi-Shapur University during the Sassanid era, which integrated Iranian, Greek, and Indian medical knowledge, surgery in Iran entered a new phase. During the Islamic period, physicians such as Razi and Avicenna played a significant role in advancing surgery through their scientific works. In the modern era, with the foundation of the Iranian Surgical Association and the establishment of specialized training courses, modern surgery developed in the country. Today, Iran holds a prominent position in surgical knowledge and skills within the region.

The goal of every country is to achieve independence and self-sufficiency. Achieving this is largely dependent on attaining superior scientific status and advancing scientific development. Scientists and experts regard scientific activities as the most influential factor in development. Scientific outputs, as indicators of the country's scientific system, form the basis for decision-making in research and development.[1] According to various classifications, one of the subfields of scientometrics is the study of the structure and updates of scientific knowledge. This involves, firstly, defining the structure and specialized domains for all sciences and technologies, and secondly, for each specific discipline. More simply put, after reviewing the chapters addressed in diverse fields over time or within specific periods, the volume of study per chapter and the relationships between these chapters are scientifically and clearly analyzed using mathematical and statistical methods. Based on this, scientific maps are graphically produced separately for various scientific and technological fields to illustrate their interrelations, helping to gain 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 an overall view of that discipline. Through these maps and by tracking patterns of change and evolution, areas with the greatest or least proximity to each other can be distinguished. Accordingly, each individual can identify, in addition to characteristics and relationships between subdomains of a field, the most influential researchers and research organizations in that particular area.[2]

The idea that science can be spatially visualized has a long history. For example, Bush described spatial mapping of scientific disciplines. Additionally, in the 1970s, attention was drawn to mapping the structure of science in social sciences, human geography, and sociology (Peshotni and Asareh, 2009). A large number of scholars have mapped the structure of various scientific domains based on their scientific literature and through the use of cluster analysis and multidimensional scaling techniques.[3]

Mapping the structure of science for different disciplines and monitoring their latest changes is a subject of interest to scientists, scientometricians, philosophers, policymakers, and publishers. Scientific texts constitute the main foundation for these mappings. In mapping the structure of science, three components are considered: individual elements, interconnected elements that form a network, and the interpretation of relationships between these elements.[4]

Over recent decades, the study of scientific maps has become one of the most important aspects of scientometric research, gaining significance across multiple scientific fields. Presenting a macro-level picture of past research activities and the interconnections between different areas, as well as awareness of growth and

development of these domains over time, are the main objectives of scientific maps. These maps are created using various techniques and methods, one of which is 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 citers' awareness and knowledge, co-word analysis became popular to reveal 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 listed 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 been conducted using various software tools to produce scientific maps in different fields. For instance, a study aiming to identify and analyze the vocabulary structure and concepts of "Information Science and Knowledge Studies" articles was conducted using co-word scientific maps from the Web of Science database. The results revealed that keywords such as "information," "web," "research," "citation analysis," "knowledge," "library," "journals," and "technology" formed the core concepts studied in this discipline. The concepts were grouped into thirteen clusters, with main 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 domain of information science and knowledge studies found through thematic maps that knowledge sharing held higher centrality among all article groups.[6]

Another research using co-occurrence keyword analysis investigated the subdomains of informetrics, showing that concepts like information science, library, bibliometric analysis, innovation, and text mining are among the most frequently applied topics internationally in informetrics.[1] Toklilzadeh Ravari's research demonstrated that linearly, with the publication of over 250 documents across various medical sciences topics, new subjects emerge and add to the network. The results indicated that contrary to some beliefs, scientific topic expansion is dynamic and proceeds linearly without cessation.[7] Furthermore, Toklilzadeh and Najabtian concluded in their study that marriage psychology topics within biomedical sciences could be divided into five clusters, and by comparing two resulting cluster maps, they examined changes in relationships within and between these fields.[8] Asadi and Farooni Shamili's findings showed that effective collaboration does not exist between the seminary as a major research center for 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 being 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, meaning 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 was conducted using a documentary research method and co-occurrence analysis of keywords. The study is applied in terms of its objective. The research population consists of all articles in the field of the history of surgery in Iran authored by Iranian researchers and indexed in the Web of Science database during the years 1960 to 2024 in the domain of Iranian surgical history. The required data for this research were extracted from the Web of Science database. The data were exclusively retrieved from the Web of Science and do not include non-English articles. For data collection, the Web of Science database was accessed, and in the advanced search section, the following search formula was used to retrieve information related to the history of surgery:

WC=Surgery and History CU=Iran

Moreover, the publication years were limited 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 solely from the Web of Science database, which does not include Persian articles and some other scientific sources. Therefore, the study data are limited to articles published in other languages and indexed in this database, and do 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 productions in Persian or those indexed in other databases are not included in this analysis, resulting in the thematic map that does not fully represent the entire scientific landscape of this field. Additionally, the temporal limitation 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 cover changes in other time frames or types of content. Complete reliance on the bibliographic and citation data available in Web of Science may be influenced by technical issues, indexing discrepancies, and data quality, 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 between the years 1960 and 2024.

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

Overall Map Analysis: Centrality of Keywords: The term "surgery" is at the center of the map and forms the largest node, indicating its importance and central role in studies related to the history of surgery in Iran. Topical Connections: Lines between nodes represent relationships between topics. Thicker and more numerous lines indicate stronger connections. Clustering: Nodes are color-coded into clusters representing related topical groups.

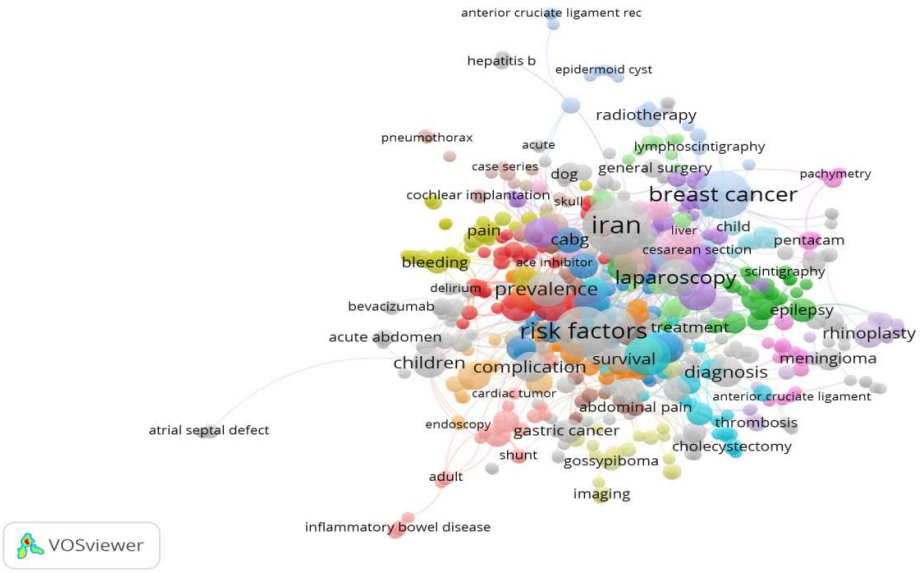

Figure 1- The thematic map of scientific productions on the history of surgery in Iran between the years 1960-2024.

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 covers various aspects of surgery including history, disease diagnosis, and outcomes. Orange Cluster (Case Studies): Contains keywords like "case report," "epidemiology," "risk factors," and "laparoscopy," focusing on case studies and epidemiological research. Red Cluster (Cardiovascular Diseases): Includes "coronary artery bypass," "cardiovascular disease," "outcomes," and "angiography," dedicated to heart and vascular surgery topics.

Blue Cluster (Cancer and Obesity): Features "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," concentrating on neurological and pediatric conditions.

Notable Points: The keyword "Iran" is prominently visible, indicating the studies' focus on the surgical context in Iran. Connections among different 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 for developing collaborative research. Overall, this tool provides researchers with a comprehensive view of the scientific status of the history of surgery in Iran.

How is the international collaboration network between Iranian researchers and researchers from other countries in the field of the history of surgery in Iran between 1960 and 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 productions in the two studied fields, based on data from the Web of Science citation database, can be seen. This network map shows the international collaborations involving Iranian authors in the history of surgery. Each node in the map represents a country, and the size of the node indicates the number of publications or collaborations related to that country. The lines between nodes represent collaboration between countries, and the thickness of the lines indicates the strength of the cooperation.

Key Points: Iran: Significantly positioned as the central hub of this network, indicating that the central core of history of surgery research in Iran is concentrated within the country itself. The large size of Iran's node reflects the high volume of publications or collaborations related to it. United States of America: The second largest node on the map, showing that the USA is an important partner for Iranian researchers in the history of surgery. Strong Collaborations: The thickest lines between Iran and the USA, as well as between Iran and countries such as the UK, Germany, and Canada, demonstrate the strongest collaborations with Iran in this field. Other Countries: Other nations, including France, Italy, Australia, and Middle Eastern countries like Lebanon and Jordan, also appear in the network, though their collaborations may be less extensive.

How is the inter-organizational scientific collaboration network of scientific productions in the field of 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

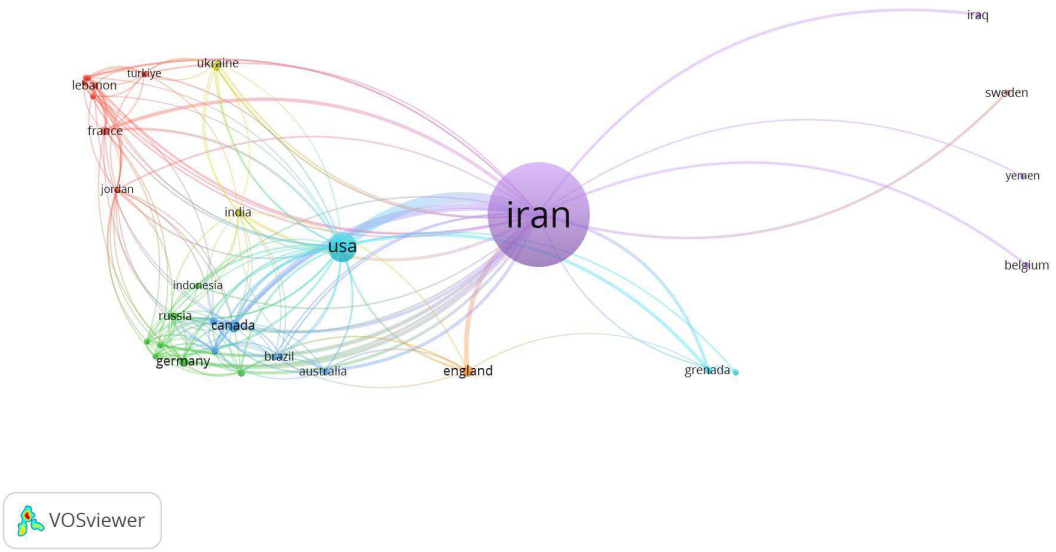

Figure 2- The international collaboration network in scientific productions on the history of surgery in Iran between 1960 and 2024.

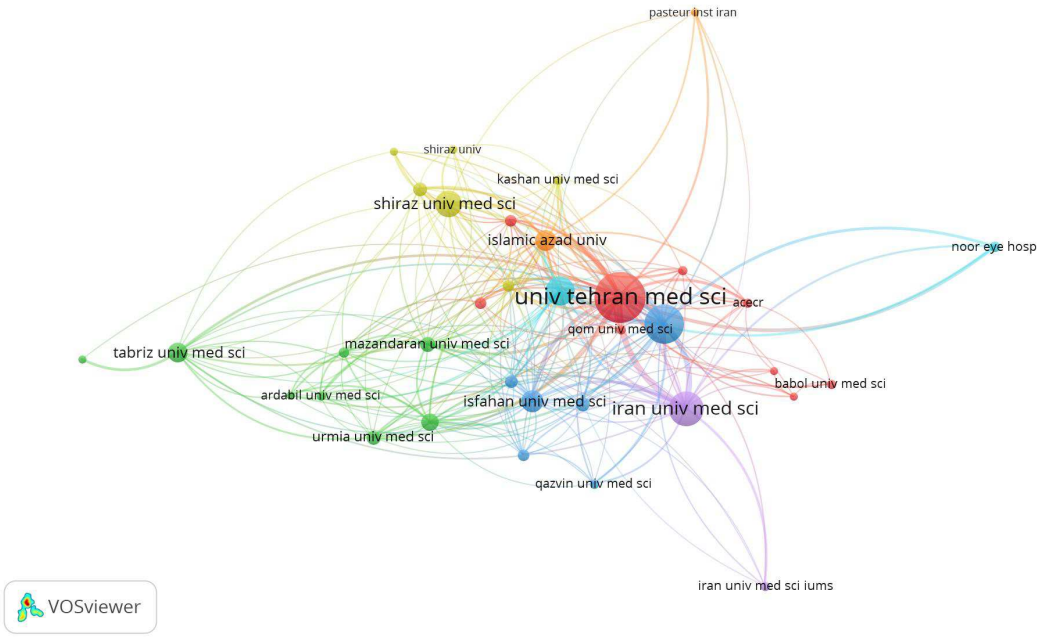

Figure 3- The inter-organizational collaboration network in scientific productions in the field of the history of surgery in Iran between 1960 and 2024.

In Image 3, the network of organizational collaboration in the two studied fields, based on the Web of Science citation database, can be observed. Nodes (Institutions): Each node represents a university or research institute. The size of the nodes indicates the number of articles published by that institution.Colors (Clustering): Colors represent clusters of institutions grouped based on scientific collaboration. Connection Lines: Lines between nodes indicate the level of collaboration between different institutions. Prominent Institutions: Tehran University of Medical Sciences: The largest node on the map, indicating the pivotal role of this university in surgical research in Iran. It has the most connections with other universities such as Iran University of Medical Sciences, Shiraz University of Medical Sciences, and Isfahan University of Medical Sciences. Shiraz University of Medical Sciences: One of the major centers with extensive collaborations with other universities, 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 like Ardabil and Urmia. Specialized Institutions: Noor Ophthalmology Hospital and Pasteur Institute of Iran are also identified as specialized centers on the map.

How is the scientific collaboration network of Iranian researchers in the field of the history of surgery from 1960 to 2024?

This scientific map relates to authors in the field of surgery in Iran and was prepared using VOSviewer software. The analysis of this map is as follows: General map analysis: Nodes (Authors): Each node represents an author. The size of the nodes indicates the number of articles or the scientific impact of that author in the field of surgery. Colors (Clustering): Different colors represent clusters of authors grouped based on joint collaborations or similar 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 between authors. The thickness of the lines represents the strength of collaboration or the number of joint articles. Author clustering: Blue cluster: Includes authors such as "Pazouki, Abdolreza" and "Rezapanah, Alireza." This cluster likely relates to surgeries associated with obesity and laparoscopy. Red cluster: Includes authors such as "Jalali, Arash" and "Abbasi, Seyed Hesameddin." This group may focus on cardiovascular diseases and related surgeries.

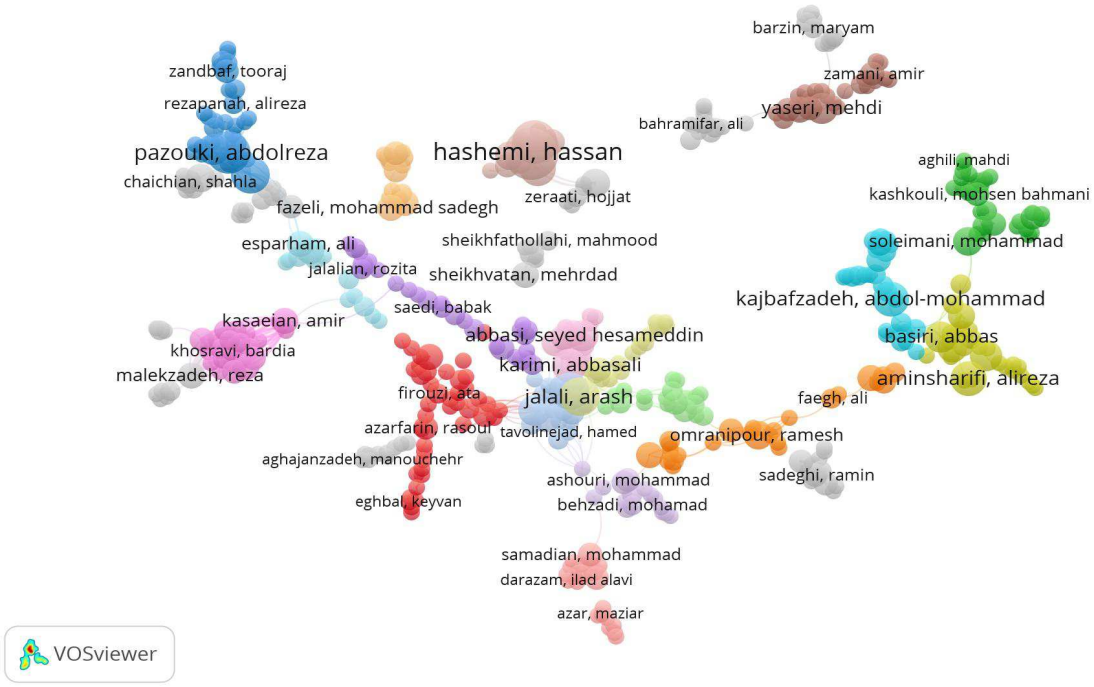

Figure 4- The scientific collaboration network of Iranian researchers in the field of the history of surgery during the years 1960 to 2024.

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. Orange cluster: Includes authors like "Hashemi, Hassan" and "Zeraati, Hojjat." This group may focus on ophthalmology and surgeries related to vision. Purple cluster: Includes individuals such as "Kasaeian, Amir" and "Malekzadeh, Reza." This cluster likely covers broader or multidisciplinary research in surgery.

Highlights on the map: Some authors like "Pazouki, Abdolreza" and "Hashemi, Hassan" have larger nodes, indicating higher impact or a greater number of articles. The density of lines in certain areas indicates a high level of collaboration among specific authors, suggesting the presence of strong research teams. The dispersion of some nodes indicates more independent activity by certain authors or less connection to others.

Conclusion

The results from the analysis of scientific maps and collaboration networks in the field of the history of surgery in Iran between 1960 and 2024 highlight several key points. First, the thematic map of scientific productions shows that research in this field has considerable diversity and depth, covering multiple topics such as cardiovascular surgery, cancer, bariatric surgery, neurology and pediatric diseases, case studies, and epidemiology.

The centrality of the term "surgery" and prominence of the word "Iran" in the map indicate a focus on local issues and the health needs of the country. The presence of diverse thematic clusters and strong interconnections among them indicates the

growth and maturity of this field and a movement toward interdisciplinary research. Regarding international collaborations, the country collaboration network shows that Iran acts as the main hub for scientific production in the history of surgery and maintains the 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 experience.

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 position in the global arena. At the organizational level, Tehran, Shiraz, and Tabriz Universities of Medical Sciences and other prominent national centers play pivotal roles in scientific production and in developing domestic collaboration networks. These institutions have established extensive connections with other universities and specialized centers, providing a conducive environment for joint research and raising the scientific standards of the country. Furthermore, the role of specialized institutions like the Pasteur Institute of Iran and specialized hospitals in advancing clinical and applied research is clearly visible. Overall, these analyses indicate that the history of surgery in Iran has experienced remarkable thematic growth over recent decades, accompanied by a progressive trend in national and international scientific collaborations. Such a 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.

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