

A comparative study of scientific collaborations in medical informatics, health information management, medical librarianship, and information sciences among Iranian research communities: A bibliometric study

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Abstract

Background and Aim: Scientific collaborations play a vital role in advancing research in various disciplines, including medical informatics, health information management, medical librarianship, and information sciences. This study aims to provide an overview of Iranian researchers' scientific output in three disciplines and their collaboration networks.

Methods: The study utilized data from Scopus database and analyzed 2086 records of Iranian researchers' research outcomes over 10 years. Each article's citations were averaged to determine its impact factor. The study also reviewed the number of articles and citations in the past decade.

Results: The findings show that scientific output in the disciplines of medical informatics, health information management, medical librarianship, and information sciences has significantly increased among Iranian researchers in the past decade. The analysis of collaboration networks indicates a strong connection between these disciplines, with medical informatics having the highest degree of collaboration.

Conclusion: This study provides valuable insights into the scientific collaborations among Iranian researchers in medical informatics, health information management, medical librarianship, and information sciences. The findings can be used to inform future research and collaboration initiatives in these disciplines. The results suggest that Iranian researchers in these disciplines have made significant progress in scientific output and collaboration. However, further efforts are required to improve the quality and impact of their research.

KEYWORDS

bibliometrics, informatics, Iran, journal impact factor, library science

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1 | INTRODUCTION

The development of various disciplines and trends related to the field of health in Iran is facing a wide range of complex knowledge in the current world. At present, in the disciplines of management of medical technology and information, three disciplines of Medical Informatics, Medical Librarianship and Information Sciences, and Health Information Management have a training board in the Ministry of Health of Iran and their faculty members work in departments located in 60 Iranian universities of medical sciences. They are in charge of education and research at different stages. The research information of each of the faculty members of these three disciplines is provided in the Iranian Scientometrics Information Database (ISID) of the faculty members of the Ministry of Health and Medical Education of Iran.

Education in Medical Librarianship and Information Sciences in Iran was first began in 1977 at the master's level at Iran University of Medical Sciences. After that, about 10 educational departments were set up in other prestigious medical universities to admit undergraduate and postgraduate students. With the approval of the Ministry of Health, the Iranian Scientific Library, and Medical Information Association also aimed to communications specialists and graduates in the field of Medical Librarianship and Information Sciences, keeping them up to date through publications and seminars were launched in 1993. In Iran or the Middle East, the doctoral program in this field was specifically designed and from February 2015 began admitting students to three medical universities: Tehran, Iran, and Isfahan.¹ "There are currently 48 faculty members working in this field at the Ministry of Health."

The field of health information management is a branch of information management² that works in the field of health and care in this field. For the first time in 1998, under the title of Health Information Management, student admission began. In the scientometric system of Ministry of Health (updated November 2021), 88 faculty members with the field of study of Health Information Management and in addition with the name of the field of education of Medical Records, Information Technology, Information Technology Management, and Health Information Technology, respectively, 9, 6, 2, and 10 had registered a total of 115 faculty articles.

The field of medical informatics is a multidisciplinary science that is essentially the knowledge of the application of computers and information in medical sciences and health, which discusses topics such as content standards and information exchange of electronic files, health information archiving systems, and information management in health information networks.³ Medical informatics refers to the use of computer applications in healthcare. However, the field of biomedical informatics is much broader and includes the development and implementation of structures and algorithms that enhance communication, comprehension, and management of medical information. The ultimate goal of biomedical informatics is to integrate data, knowledge, and tools that aid in decision-making related to

patient care. Unlike other medical disciplines that prioritize the content of information, biomedical informatics emphasizes the importance of the structures and algorithms necessary for managing and manipulating this information.⁴ With progress in information and communication technology, medical information has been converted to digital formats and stored and managed using computer systems. The construction, management, and operation of medical information systems and regional medical liaison systems are the main components of the clinical tasks of medical informatics departments.⁵ Health informatics is a scientific and engineering field that focuses on developing technologies and methods for obtaining, processing, and analyzing patient data from various sources and modalities. These include electronic health records, medical scans, and diagnostic test results. With the vast amount of data available in the healthcare industry, computational techniques can be used to address a wide range of issues.⁴ In the field of medical informatics in Iran, since 2009, the first master's degree program of Shahid Beheshti University of Medical Sciences, Tehran (and former Iran) was the only universities accepting students. Shahid Beheshti University and Tehran, jointly, received permission to admit students in this field. Since 2011, other universities of medical sciences such as Shiraz and Tarbiat Modares have been added to the list of universities accepting students. The field of medical informatics is different from other similar disciplines in Iran, for example, the field of Health Information Management. The main focus of this field is on managing the use of data and information in healthcare systems, but is known in the world as an independent discipline. Also, in the scientometric system, 61 faculty members with a degree in medical informatics had a pure informatics case in their profile.

This study examined and compared the productivity and research collaboration among academic staff members in Iran in the field of information activities, where there is a significant overlap in educational and research objectives. The study identified areas of overlap in collaboration between the three related disciplines. While the three disciplines share similarities in their approaches and skill sets for healthcare systems, there are also notable differences. To bridge this gap, new training programs and interdisciplinary collaborations may be necessary.

The purpose of this study is to review and draw a scientific map resulting from scientific productions with illustration techniques and analysis of cowriting patterns in the articles of three-faculty members in the Ministry of Health of Iran. To identify top authors, in addition to scientometric citation analysis indicators such as *H*-index from the Scopus database, Field-Weighted Citation Impact (FWCI) Index was used to evaluate the authors' scientific productivity.⁶ The FWCI index goes beyond description and quantity and addresses differences in research behavior across disciplines. By identifying the collaboration relations between domestic and foreign authors, the impact of cooperation with national and international institutions on the citation rate is measured and illustrated. Finally, the relationship between the coauthorship network and the scientific productivity of researchers in these three areas is examined.

1.1 | Research questions

The purpose of this work is to assess the distribution of collaborations for specific three disciplines of Iranian medical scientists. These researchers worked with affiliated universities of the Ministry of Health & Medical Education in Iran. This study follows up a previous investigation into the same group of researchers.^{7,8} The questions guiding this research are as follows:

1. What proportion of discipline (Majors) has articles in Scopus?
2. Do faculty members' collaboration have a measurable impact?
3. How do the citations received by these three disciplines' publications compare with the world average?
4. Are there differences in disciplinary collaborations in answers to the above questions?

2 | METHODS

In this study, for achieving objectives analysis with bibliometric indicators. The first phase has identified faculty members' working at the affiliated universities of the Ministry of Health & Medical Education in Iran by faculty members' Publications and Information Development Center website.* The Second phase identified bibliometrics data in the Scopus database. The third phase identified collaboration for these researchers. At the fourth phase, visualized the collaboration (Figure 1).

In the first phase of the study until October 2021, in the ISID of the faculty members of the Ministry of Health and Medical Education of Iran, a total of 48 faculty members with a degree in library and medical information, as well as 61 faculty members with a degree in medical informatics, and 115 faculty members were identified and

appointed with a degree in Health Information Management. As a result, for the initial retrieval of research articles in English and Persian language, the scientometric system of the Iranian medical universities was used, that is, through the profile of Scopus database, the number of paper, citations, *H*-index, *G*-index, self-citation was extracted and in Excel file was recorded by string. Three thousand six hundred six records from the entire faculty members of these three disciplines have been indexed in the Scopus database since 1996 (Supporting Information: 1, up to December 2, 2021, by Scopus data set).

In the second phase of this study, bibliometric data of the articles of each of the faculty members of these three disciplines were collected from the Scopus profiles. Out of 224 faculty members in the Scopus database, a total of 217 faculty members had only profiles, and for this purpose, all articles were extracted from the profiles of each of these faculty members in RIS format. Duplicate faculty articles resulting from in-house and out-of-organization collaborations were merged into Scopus (up to December 3, 2021). BibExcel[†] 2016-02-20 software was used to extract the bibliometric data of the documents of these three disciplines.

In the third phase of this study, the SciVal database was used to analyze the collaborations of the researchers, and through the EID field in the Scopus database, the information of these three disciplines was entered into SciVal on November 3, 2021. Analyzing articles were in the SciVal database for the 10-year period 2011–2020. A total of 2086 articles were analyzed through this and the Field-Weighted Index Citation Impact was calculated using SciVal database (Supporting Information: 2, up to November 24, 2021).

FWCI is the number of citations received by an entity's publications compares with the average number of citations received by all other similar publications in the data universe indicating FWCI

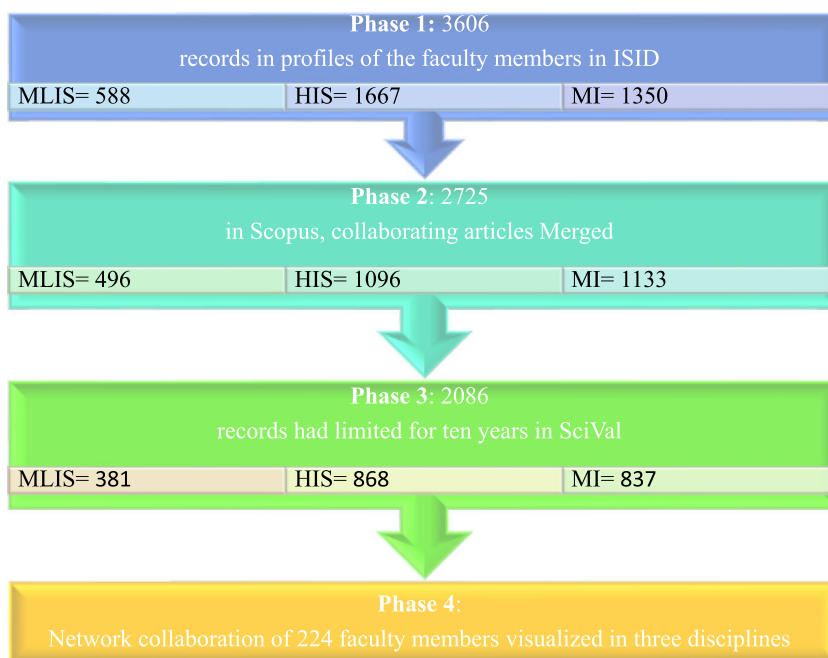


FIGURE 1 Flowchart for output of faculty members in the three sources: ISID, Scopus, SciVal (up to December 2, 2021). ISID, Iranian Scientometrics Information Database.

in SciVal. An FWCI = 1 means the output performs just as expected for the global average. An FWCI < 1 means the output is cited more than expected by the global average. This study FWCI indicates measures the relationship between the citation level of scientific outputs of particular publications of researcher groups; and, in fact, it shows the ratio of received citations to the global average in a subject field, type of article, and year of publication.

For the fourth phase, using scientific measurement methods and with the help of analytical techniques, the occurrence of scientific collaborations between researchers with VOSviewer[‡] version 1.6.17 was illustrated.^{9,10} During the illustration process, researchers utilized data normalization and clustering algorithms to establish a network of relationships between them. The matrix was then prepared for principal component analysis using VOSviewer software, with varying scales of similarity employed in different studies and data conversions used to normalize the data.

After consulting our research questions, we utilized the SPSS software version 16 to analyze the relationship between citation status and scientific collaboration. Spearman's nonparametric statistic test with a two-sided approach was performed, where a *p* value of less than 0.05 was deemed statistically significant. The Spearman correlation coefficient (*r* value) was used to interpret the strength of correlation, with values below 0.3 considered poor, 0.3–0.5 as low, 0.5–0.7 as moderate, 0.7–0.9 as high, and above 0.9 as very high. Additionally, for bibliometric analysis and visualization, BibExcel 2016-02-20 and VOSviewer 1.6.18 were employed.

3 | RESULTS

In the first phase of compiling the articles of each faculty member in the Scopus database in three disciplines without eliminating or merging many collaborations, their total number of 3606 degrees has been calculated since 1996. Therefore, the data in Table 1 includes the total frequency of publication of research articles and the number of citations received, without eliminating duplicate articles that are the result of group collaboration among 224 faculty members (Supporting Information: 1).

Table 1 shows that the faculty members of the Medical Informatics departments have the highest publication rate in three disciplines. Citing these works, followed by the average *H*-index, the *G*-index of Medical Informatics faculty members is also higher in another field. The lowest scientific output is made by the faculty members of the Medical Library and Information Sciences

departments. Of course, self-citation in articles in all three disciplines is less than 1%. In this study, the best faculty members of these three disciplines can be ranked based on *H*-Index, FWCI, citation rate, and scientific productions. Table 2 shows the top 5 academic faculty members by field based on these indicators.

According to the findings in Table 2, the best of these three disciplines in terms of the number of articles and their organizational affiliation belonged to Mazandaran, Tehran, and Mashhad Universities of medical sciences, respectively. Dr. Abbas SheikhTaheri had the highest FWCI with 4.79, which means that the works of this researcher have been cited 3.79 times more than other scientific works in this discipline.

Findings from the second phase of this study, which include articles by each of the faculty members of these three disciplines from the Scopus profiles, which repeated duplicates of internal and external collaborations were merged. That is, after merging the articles of all the documents of the faculty members of these three disciplines, there were repetition records, which could be due to interdisciplinary cooperation among the faculty members of these three disciplines. Figure 2 shows the data retrieved from the second phase of the Scopus database.

In the second phase, a total of 496 articles from the faculty members of the Medical Library and Information Sciences departments in the Scopus database, as well as a total of 1133 and 1096 articles were from the faculty members of the Medical Informatics and Health Information Management departments, respectively, by the end of December 3, 2021, in the Scopus database. Figure 2 shows an increasing trend in the publication of scientific works by researchers in three different disciplines.

The first article by faculty members of medical informatics departments is indexed with an article in 2004 in Scopus, and Figure 2 shows a higher growth rate than the other two disciplines during the two decades since the publication of medical informatics research texts. Also, the first article of the faculty members of health information management departments is indexed with two articles in 2005 in Scopus, but the first article of the faculty members of the departments of librarianship and medical information is also indexed with an article from 2007 in Scopus.

In the continuation of the second phase, that is, after merging the articles of all faculty members, as a result, from 3606 records, it reached 2725 records. All these articles from three disciplines received a total of 18,480 citations in the Scopus database, and the average number of citations per article was calculated as 7.81, of which 678 articles were without citations. The status of 1381 articles were no free access, and the other articles were in four categories of

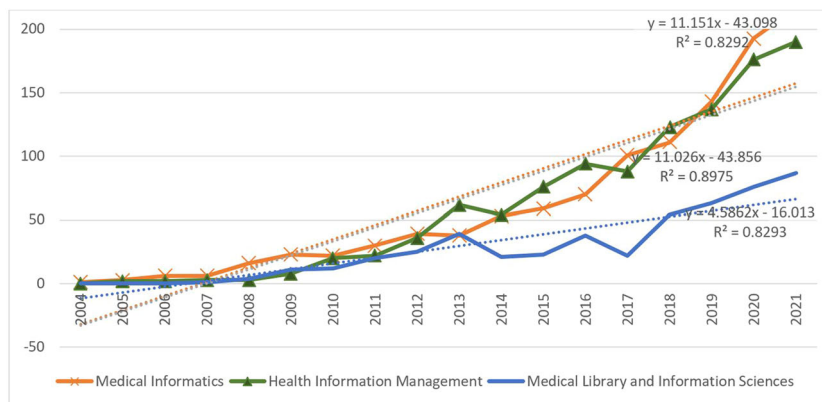
TABLE 1 Faculty members' output in the Scopus database (up to December 2, 2021).

No	Departments name	Number of faculty members	N papers (mean)	N citations	Mean H-index	Mean G-index
1	Medical Library and Information Sciences	48	588 (12.25)	3899	3.33	5.16
2	Health Information Management	115	1668 (14.50)	11854	4.08	6.52
3	Medical Informatics	61	1350 (22.13)	13041	5.87	9.51

TABLE 2 Top-authors by scholarly output in the scopus database.

Top-authors Metric	Medical library and information sciences (affiliation)				Health information management (affiliation)				Medical informatics (affiliation)			
	Scholarly output	Citation count	FWCI	H-index	Scholarly output	Citation count	FWCI	H-index	Scholarly output	Citation count	FWCI	H-index
1	Hasan Siamian (Mazandaran)				Reza Safdari (Tehran)				Saeid Eslami Hasanabadi (Mashhad)			
	41	214	1.47	8	119	830	0.75	14	173	2824	1.43	28
2	Mohammad Karim Saberi (Hamadan)				Farahnaz Sadoughi (Iran)				Amir Javadi (Qazvin)			
	38	186	0.45	10	84	788	0.56	16	71	581	0.55	10
3	Maryam Shekofteh (Shahid Beheshti)				Abbas SheikhTaheri (Iran)				Sharareh Rostam Niakan (Tehran)			
	35	78	0.49	8	79	1886	4.79	14	70	643	1.58	13
4	Hasan Ashrafi-rizi (Isfahan)				Maryam Ahmadi (Iran)				Kambiz Bahaadinbeigy (Kerman)			
	34	170	1.13	12	77	718	0.66	14	59	498	0.90	10
5	Vahideh Zarea Gavvani (Tabriz)				Marjan Ghazisaeedi (Tehran)				Reza Khajouei (Kerman)			
	30	120	0.85	7	73	436	0.80	13	53	705	0.93	14

Abbreviation: FWCI, Field-Weighted Citation Impact.

FIGURE 2 Scholarly output versus publication year for Iranian researcher in Health Information Management, Medical Informatics, Medical Library, and Information Sciences in Scopus until December 2021.

open access, of which 715 were Green, 156 were Bronze, 569 were Gold, and 86 were Hybrid.

In the continuation of the second phase, that is, after merging the articles of all faculty members, as a result, from 3606 records, it reached 2725 records, and we retrieved the information of these 2303 records again with the EID field in the SciVal database.

In the third phase, SciVal's analysis period is 10 years; therefore, from 2303 records, 2086 records were retrieved between 2011 and 2020, then these were reviewed in three disciplines with different indicators.

In the continuation of the third phase, the data of the articles of the three disciplines were merged in the SciVal database, and in the 10-year period, a total of 1780 articles remained, which was the reduction of 584 titles of the articles, probably the result of the cooperation between the faculty members of the three disciplines. A total of 5171 authors contributed to the publication of these 1780 articles, and the citation per document is 7.4, and the FWCI was calculated at 0.77 for all the articles of the faculty members of three disciplines, which means that the works of these researchers are less than other scientific works in the world received Citation.

A total of 2086 articles by researchers in the disciplines of Medical Librarianship and Information Sciences (381 articles), health information management (868 articles), and medical informatics (837 articles) contributed to a total of 2412, 3655, and 5458 authors, respectively. Also, 9.0, 8.7, and 10.4 citations were cited for each document, respectively. Faculty members of medical informatics departments had international cooperation in 25.8% of the articles. While in the faculty members of the Medical Library and Information Sciences and Health Information Management departments, 10.2% and 11.2% of their articles resulted from international cooperation, respectively (Table 3).

The subject area of the articles of the faculty members of the educational groups of three disciplines is that the library and medical information groups contribute less than the other two disciplines in the interdisciplinary and specialized disciplines of research. Also, the contribution of the university's cooperation with the industry was in the research of the faculty members in the disciplines of Medical Librarianship and Information Sciences (1.1% of articles), health information management (1% of articles), and medical informatics (1.6%).

TABLE 3 Status of articles in the three disciplines in the period 2011 to 2020 in SciVal.

Data source in SciVal	Scholarly output	Open access (%)	International collaboration (%)	Views count	Citation count	Field-Weighted Citation Impact
1 Medical Library and Information Sciences	381	30.7	10.2	25,111	3412	1.31
2 Health Information Management & Medical Records	868	44.1	11.2	57,231	7510	1.08
3 Medical Informatics	837	43.13	25.8	52,131	8715	1.22
4 Merge all Articles of Three Discipline	1780	39.94	17.0	90,706	13,260	0.77

Note: Up to 24 Nov 2021 by Scopus data set.

TABLE 4 Status of cooperation between researchers in the three disciplines in the period 2011 to 2020.

Collaboration	Metric	Medical library and information sciences	Health information management	Medical informatics
International collaboration	Scholarly output (%)	39 (10.2%)	97 (11.2%)	216 (25.8%)
	Citations	1723	2835	4601
	CPP	44.2	29.2	21.3
	FWCI	7.55	4.32	2.56
Only national collaboration	Scholarly output (%)	203 (53.3%)	492 (56.7%)	361 (43.1%)
	Citations	862	2943	2524
	CPP	4.2	6	7
	FWCI	0.48	0.65	0.76
Only institutional collaboration	Scholarly output (%)	128 (33.6%)	272 (31.3%)	258 (30.8%)
	Citations	758	1669	1562
	CPP	6.1	6.1	6.1
	FWCI	0.69	0.73	0.73
Single authorship (no collaboration)	Scholarly output (%)	11 (2.9%)	7 (0.8%)	2 (0.2%)
	Citations	42	63	28
	CPP	3.8	9	14
	FWCI	1.51	0.51	1.32

Abbreviations: CPP, citations per publication; FWCI, Field-Weighted Citation Impact.

Iranian Medical Library and Information Sciences researchers have 10.2% International collaboration. They have only national collaboration, only institutional collaboration, and Single authorship (no collaboration), 53.5%, 33.6%, and 2.9%, respectively. Iranian Health Information Management researchers have 11.2% International collaboration. They have only national collaboration, only institutional collaboration, and single authorship (no collaboration), 56.7%, 31.3%, and 0.8%, respectively. Iranian Medical Informatics researchers have 25.8% International collaboration. They have only national collaboration, only institutional collaboration, and single authorship (no collaboration), 43.1%, 30.8%, and 0.2%, respectively (Table 4).

The ratio of citation to international articles in the field of Medical Librarianship and Information Sciences and health information management had the highest ratio of 44.2 and 29.2, respectively, and the lowest ratio of citations to international articles related to medical informatics was 21.3%. The ratio of citations to intraorganizational/intra-academic articles (only Institutional Collaboration) by faculty members of educational groups in three disciplines was almost not different but in interorganizational or interuniversity articles (only national collaboration) and single author, respectively, by faculty members of informatics educational groups. Medicine, health information management, then librarianship and medical information had the highest ratio of citations to articles.

Visualization of the scientific collaboration of Iranian researchers in the Scopus database among the three normalization methods in VOSviewer software, the Association Strength method was used. The three disciplines, with 224 faculty members, published their research with a total of 8736 authors. Only 77 researchers were illustrated with more than 20 articles in 10 clusters (Figure 3). Eslami S., Safdari R., Sadoughi F., and Ahmadi M. were the most prolific researchers.

The illustration of the whole three-discipline articles shows that Iranian researchers with 229 countries, of which 94 countries participated in the publication of these articles in three clusters more than five times (Figure 4). The blue cluster in the collaboration network was principally composed of researchers from the United Kingdom, the United States, Sweden, Canada, Australia, and the Netherlands. The majority of Middle Eastern countries were situated within the red cluster, while other nations were part of the green cluster.

In this study, a significant relationship between the number of researchers and scientific productivity and efficiency, the Spearman correlation coefficient test was used. The coauthorship model shows that in this study, there was a direct and weak significant relationship between the number of researchers and the number of citations in

articles ($r = 0.087, p < 0.01$). Also, the test result shows a direct and weak relationship between the growth rate of citation to articles and the type of open access to articles ($r = 0.063, p < 0.01$). Pearson correlation coefficient test was used to determine the relationship between the growth rate of citations to articles and the growth rate of articles written with international contributors. The test result indicates a direct and weak relationship between the two ($r = 0.109, p < 0.01$).

4 | DISCUSSION

In this research, an effort was made to present a summary of Iranian researchers' scientific output in three disciplines and their collaboration network with data from Scopus database. The study findings show that 2086 records of researchers' outcomes over a decade have been indexed in citation databases, with each article receiving an average of 7.81 citations. A study by Osareh and Wilson reveals a significant increase in the number of articles and citations during the past ten years.¹¹ Tables 1 and 3 showed, members of the Iranian Medical Informatics Faculty were more productive and effective in

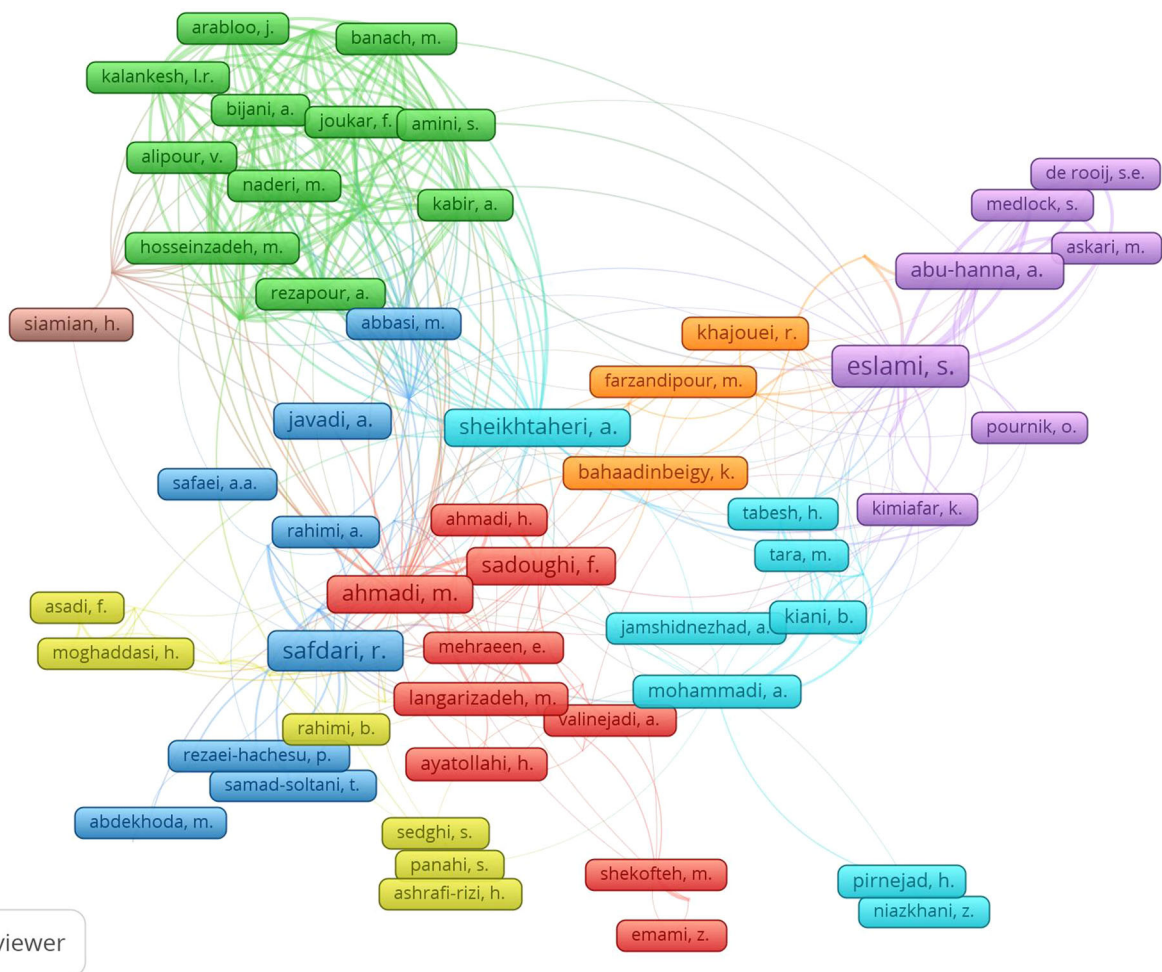


FIGURE 3 This refers to the depiction of a collaboration network among Iranian researchers in three disciplines using VOSviewer in the Scopus database.

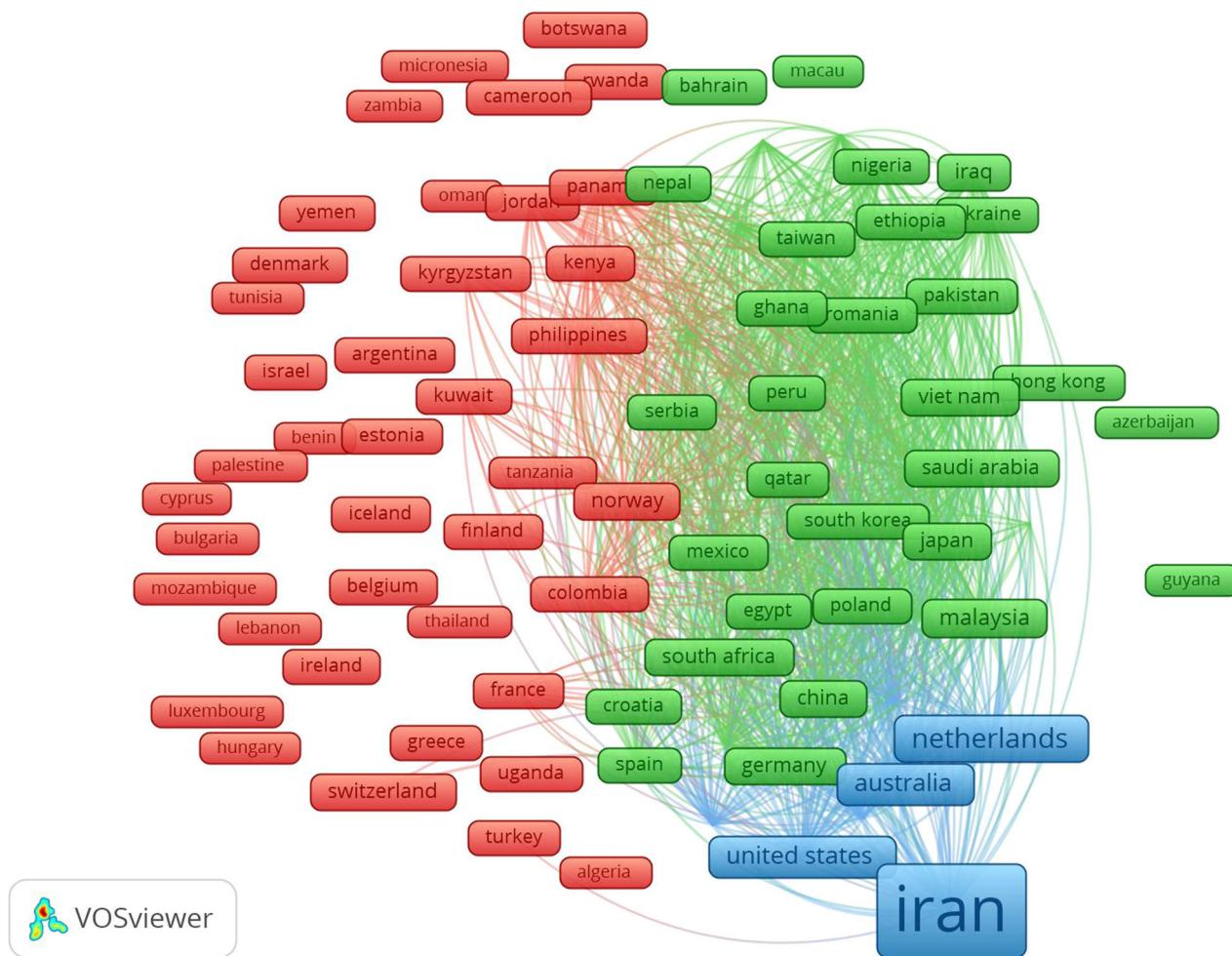


FIGURE 4 Illustration of the cooperation network of Iranian researchers with other countries around the world (VOSviewer).

publishing research than the other two disciplines. The lowest scientific output is made by the faculty members of the Medical Library and Information Sciences departments. Of course, self-citation in articles in all three disciplines is less than one percent.

The faculty members of Medical Informatics departments have the highest publication rate in three disciplines. Citing these works, followed by the average *H*-index, the *G*-index of Medical Informatics faculty members is also higher in another field. Medical informatics knowledge has been used in recording, analyzing, protecting and managing health information, and the reason for the sharp increase in medical informatics research texts is the increasing application of various methods in this field in the field of medicine. It has also facilitated patient records and medical guidance due to the transfer of information about modern healthcare and access to information.

Multiple authorship and coauthorship is one of the influential indicators on citation of articles in different studies.¹²⁻¹⁴ The study findings recommend a correlation between coauthorship and citation of scientific documents, which was apparent at multiple levels. On average, documents with international coauthorship received more citations than those authored by domestic centers. However, minor differences were detected in documents solely cited by researchers.

The study also discovered that the average citation of scientific works involving foreign coauthors was lower than those involving only domestic coauthors. Overall, the results confirm a positive relationship between international cooperation and increased citation of scientific productions.¹⁵ The findings from the Erfanmanesh study discovered that a mere 16.9% of scientific publications from Tehran University of Medical Sciences caused from international collaborations with researchers from 1281 foreign institutions. However, articles that were produced in collaboration with international researchers received more citations on average, garnered more views, were published in higher quality journals, and were more likely to be cited and converted into highly cited articles. Moreover, these articles outperformed similar ones globally in terms of citation performance. Furthermore, enhancing the university's ranking would have a positive impact on its standing in international ranking systems.¹⁶

The study of scientific collaborations in prominent databases worldwide highlights the complicated nature of coauthorship patterns over the last 20 years. Moreover, there is a distinction in the disposition toward scientific collaboration and coauthorship among groups in various scientific disciplines.^{11,17-19} Given this evidence, it is seeming that scientific collaboration plays a vital role in

enhancing researchers' productivity and increasing citation rates.^{12,13,20–22} Studies showed in the past have examined how coauthorship is related to different factors.^{13,22–25}

According to research findings, most articles are written by groups of researchers. The study revealed a correlation between coauthorship and citation of scientific documents, which can be observed at different levels. On average, documents with international coauthorship receive more citations than others, but there are slight differences in documents cited solely by researchers from national centers. The study found that the average citation of any scientific document obtained from a foreign coauthor is lower than that from a domestic coauthor. The findings confirmed the relationship between international cooperation and increased citation of scientific productions. However, Ebrahimi et al.'s study showed no significant relationship between multinational scientific cooperation and the amount of citations. Nevertheless, the study supports the notion that scientific collaborations within research groups lead to increased scientific productions.^{13,23–25} The analysis of coauthorship networks reveals Iranian researchers who are contributing to the advancement of medicine in three disciplines at a global level. These researchers have the potential to make a significant impact on the scientific progress of these fields. The study suggests that expanding research cooperation with top global institutions can improve the quality of scientific outputs and research rankings, given the capabilities of scientific cooperation. The most significant knowledge flow in collaborative networks is related to international scientific cooperation with 229 countries worldwide, indicating wide-ranging collaborations by researchers. Collaborating with powerful scientific countries in emerging fields demonstrates our country's scientific and competitive potential, highlighting its valuable capabilities in this field.

The increasing capabilities of network communication technologies have made it possible to expand international interactions beyond spatial constraints, enabling wider geographical reach.^{7,26} Studying the status and context of international cooperation can provide new insights into scientific communication behaviors. Applying these findings can help in formulating policies and strategies for managing research, as well as facilitating cooperation among researchers across multiple disciplines.^{27,28} Thus, the study's results can inform decision-making regarding incentives and guidance, research evaluations, and research policy formulation.

The study's outcomes can aid in the identification of leading researchers in three fields, using more specific indices such as FWCI and granting them special privileges.

5 | CONCLUSION

The research conducted highlighted the scientific output and collaborative model among researchers in three medical disciplines in Iran. The study aimed to enhance knowledge exchange, evaluate the impact of international cooperation and interaction with leading countries, promote interdisciplinary collaboration

through scientometric indicators and network analysis. While increasing collaborations among authors are crucial, additional efforts are required to improve the visibility of scientific publications in target journals of these disciplines. This includes changes in citation behavior and the promotion of research findings sharing on scientific social networks.

5.1 | Suggestions

The section of Iran's comprehensive scientific map that outlines required macroindicators for science and technology includes "teamwork" as a subheading, which measures the number of valid scientific articles with multiple authors. Under the "International Partnership" subheading, the metric is the number of joint articles with other countries, particularly those within the Islamic region. These indicators suggest that policymakers, academic administrators, and researchers should consider leveraging the potential benefits of collaboration among Iranian researchers across the three medical disciplines. This could serve national interests and draw from the insights gained through this study regarding the conditions conducive to such cooperation.

AUTHOR CONTRIBUTIONS

Hasan Siamian: Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; resources; software; supervision; validation; visualization; writing—original draft; writing—review and editing. **Fatemeh Ramezani-Pakpour-Langeroudi:** Conceptualization; data curation; investigation; methodology; project administration; resources; supervision; validation; writing—original draft; writing—review and editing. **Aboozar Ramezani:** Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; resources; software; validation; visualization; writing—original draft; writing—review and editing. **Hamed Mehdizadeh:** Conceptualization; writing—original draft; writing—review and editing. All authors have read and approved the final version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

All data generated or analyzed during this study are included in this published article. All authors have read and approved the final version of the manuscript had full access to all of the data in this study and takes complete responsibility for the integrity of the data and the accuracy of the data analysis. The data that support the findings of this study are available from the corresponding author (Aboozar Ramezani), upon reasonable request.

ETHICS STATEMENT


This study approved by Mazandaran University of Medical Sciences Ethical Committee with the code: IR.MAZUMS.REC.1401.334.

TRANSPARENCY STATEMENT

The lead author Aboozar Ramezani affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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ENDNOTES

* Source of data: Scientific Publications and Information Development Center in Deputy of Research & Technology of Iranian Ministry of Health & Medical Education.

† BibExcel is designed to assist in analysis of bibliographic data. This tool-box can generate data files that can be imported to Excel, or any program that takes tabbed data records, for further processing. Bibexcel is a free-ware for academic nonprofit use. Available at: <https://liu.cwp.libguides.com/c.php?g=225325&p=4966525>

‡ VOSviewer is a software tool for constructing and visualizing bibliometric networks. These networks may for instance include journals, researchers, or individual publications, and they can be constructed based on citation, bibliographic coupling, co-citation, or co-authorship relations. VOSviewer also offers text mining functionality that can be used to construct and visualize cooccurrence networks of important terms extracted from a body of scientific literature. Available at: <https://www.vosviewer.com/>

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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