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Comparative study of mapping scientific relationships of Iranian researchers in the field of infectious diseases and its pioneers

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Abstract

The objective of this study is to create a visual representation of the collaboration networks among authors, universities, and research centers, as well as international relations, and to draw a subject map based on the documents indexed in Scopus about infectious diseases in Iran. This is compared with the leading country in this field, the United States. The study employs a quantitative approach to applied research using scientometric techniques with an approach of social network analysis. Documents were retrieved through the search strategy that contained equivalent phrases of infectious diseases and had been contributed to by at least one Iranian or United States researcher. These included 1804 documents authored by 88,846 Americans and 24,379 by 6,790 Iranians. The findings revealed that 'Roya Kelishadi' from the 'Isfahan University of Medical Sciences' and 'Endocrinology And Metabolism Research Center, Endocrinology And Metabolism Clinical Sciences Institute' were the most prolific Iranian entities. However, they were ranked differently regarding the number of citations. 'Peter J. Hotez,' as an author, and 'Harvard Medical School,' as an institution, were the most productive entities within the American scientific network. In addition, the link strength of 'Farshad Farzadfar' was the highest among Iranian authors, while that of 'Ifeoma Ulasi' was the highest among American authors. Furthermore, the United States, the United Kingdom, and India were identified as having high link strength in the Iranian collaboration networks. In contrast, the United Kingdom, Australia, and Canada were identified as having high link strength in American collaboration networks. The subject map visualization of Iranian research indicates that the field is broad but shallow, while the subject map of the United States is denser. The results of this study suggest that Iranian scientific policy makers of infectious diseases can provide a suitable direction for Iranian researchers by comparing with the United States.

Introduction

The field of scientometrics, as defined by Derek J. De Solla Price as 'science about science,'(1) is now recognized as a quantitative method for evaluating

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scientific literature within a specific field. In scientometrics, statistical and mathematical tools are employed to identify research patterns, conduct quantitative studies of various sciences, and examine the relationships and policies of those sciences. It is important to note that the primary research areas within the field of scientometrics include the sociology of science, the measurement of the impact of research outputs, the analysis of scientific and university publications, the understanding of scientific citations, and the utilization of these measurements in the formulation of policy (2). Furthermore, it involves mapping the various scientific sub-branches and visualizing the collaboration network among countries, research institutions, individuals, and consequently, managing research in various sciences. A subset of these scientometric studies examines co-authorship among participating entities in publishing scientific documents, including researchers, academic institutions, countries, and so forth (3, 4). Indeed, they view co-authorship as a formal and recorded symbol of scientific collaboration when a joint work is co-authored by creators (5). Another area of scientometric study concerns the co-occurrence of terms across various information resources. This approach permits the monitoring of scientific advancements, the influence of other domains on a specific topic, and the identification and formulation of policies regarding the structure, concepts, and components of the knowledge fields within a discipline (6-8).

In this context, a review of the existing literature reveals that evaluating scientific communication trends and collaboration among various entities in scientific publications across different subject areas has been conducted in a novel way. Some researchers have employed a scientometric approach to examine multiple disciplines. Examples of such research include studies in the field of zoonotic diseases (9), climate change (10, 11), gas turbine maintenance (8), robotics in education (12), the Coronavirus (6, 13), rabies research (14), coastal governance (15), onchocerciasis (16), augmented reality (17), microbiology (18), or other fields; all approached from a scientometric perspective. Some other researchers have concentrated their efforts on the scientific outputs of particular geographical areas. These studies include research conducted on the South African region (19, 20), e-learning in Iran (21), industry 4.0 in China (22), and others. Some researchers have conducted scientometric examinations based on various document types, including theses, journals, and other sources. Among the most relevant of these is the research by Krauskopf (23), which examined outputs published in the 'Journal of Infection and Public Health' between 2008 and 2016. Therefore, a review of the existing literature reveals that scientometric studies have attracted the attention of numerous researchers across diverse fields. Researchers have employed a variety of scientometric indicators to identify the factors influencing scientific publications across diverse disciplines.

In this regard, it is essential to note that scientometric reviews in various studies have identified a positive trend of scientific growth in infectious diseases (19, 24-29). Lu & Ren (17), in their examination of 851 articles related to infectious diseases from the Web of Science (WoS) database published between January 1991 and September 2021, found that the number of publications has increased over the past 30 years. This study predicts that the number of publications in this field will continue to rise due to the current pandemic of new infectious diseases (such as COVID-19) and the persistence of older infectious diseases (such as dengue and influenza). Additionally, Bliziotis et al. (25) demonstrated that the United States and Western Europe collectively account for a remarkable 80% of global research publications in infectious diseases, both in quantity and quality. Nevertheless, all regions of the world have shown a gradual increase in the publication of infectious diseases, with the currently lower-ranked areas exhibiting the highest growth rate. These studies illustrate the dynamic nature of research in infectious diseases, reflecting the global community's response to emerging health threats.

Furthermore, these studies emphasize the necessity of sustained investment in infectious disease research to address both current and prospective challenges. In this regard, it is of critical importance to understand the current trends and patterns in research publications to enhance the research capacity of Iranian scholars in the field of infectious diseases on a global scale. Additionally, it is essential to examine the pattern of scientific collaboration in publications. Furthermore, it is crucial to compare these aspects with those of the leading countries, as identified in previous studies on infectious disease publication. Previous research with a scientometric approach has often demonstrated that the United States is one of the leading publishers and collaborators of science in the field of infectious diseases in the world (19, 25-30).

Consequently, a comparative study of science entities' features in the field of infectious diseases in Iran and the United States can provide insights into scientometrics for Iranian researchers. While general analyses have documented global infectious diseases research trends and patterns, no study has specifically addressed the scientific relationships that govern the pioneers of this field or compared them with those in other countries. Therefore, the integration of interdisciplinary research and a scientometric approach with the scientific outputs of infectious diseases offers significant benefits for the advancement of Iranian researchers' knowledge. This interdisciplinary approach to scientometrics provides a comprehensive, evidence-based understanding of complex phenomena, facilitating innovation and collaboration and ensuring the fundamental connection of research findings.

The objective of this study is to create a visual representation of collaboration networks among authors, interactions between universities and research centers, and international relations, and to map various dimensions of the subject from documents indexed in Scopus. This study concerns the field of infectious diseases in Iran, with a comparison to the leading country in this field, the United States. This research outlines explicitly the trends and patterns of collaboration in scientific and research outputs related to infectious diseases from the first publication year to the end of April 2024 in Iran and the United States. In other words, the objective is to represent the scientific communications reflected in the research of this field. Moreover, maps will be constructed from these Iranian and American research communication networks in infectious diseases. Furthermore, the study identifies the authors, research institutions, universities, and countries that have collaborated significantly with Iran and the United States in this field, employing scientometric techniques. This study is designed to demonstrate the application of scientometric analysis, thereby providing valuable insight into using keywords in Iranian research and the impact of collaboration in infectious disease research. It is, however, essential to note that the field of infectious diseases is dynamic and constantly evolving.

1. Consequently, it is imperative to conduct continuous scientometric analysis to remain abreast of emerging trends and developments. To complete previous research and elucidate the scientific map, the present study has comprehensively and without limitation studied the co-authorship network of researchers, countries, and institutions collaborating with Iranian and American researchers in infectious diseases based on valid indexed scientific records in Scopus. The present study is distinguished from previous studies by the cases examined and the comparative nature of the research. Accordingly, the research questions that are addressed in this study are as follows:

2. What are the differences between the co-authorship map's features of Iranian researchers in infectious diseases and those of United States researchers?

3. What are the differences between the co-authorship map features of Iranian research institutions in infectious diseases and the collaboration map between United States research institutions?

4. Which countries do Iran and the United States collaborate with on infectious diseases at the international level?
5. How is the scientific map of infectious diseases for Iranian and American researchers?

Material and methods

The present study fell into the category of applied research in its objective and was conducted with a quantitative approach using scientometric techniques and social network analysis. Social network analysis, which is based on graph theory, allows us to identify the core nodes and central entities in collaboration networks. In this context, we can study different forms resulting from relationships and collaborations among authors, research centers, universities, research institutions, countries, and the co-occurrence of terms. These elements form a communicative network constituting an academic society (31). The entities of this network are explained in more detail in the findings section. The database used to collect the data for this study was Scopus. This database is a valid platform for accessing bibliographic records of valid reference sources and citations of scientific documents in various fields belonging to the prestigious international publisher Elsevier. This database was selected because it covers the scientific results in Persian with English abstracts of Iranian publications globally. In this regard, it can provide a better and more complete view of the work done by Iranian researchers compared to other citation databases such as WoS or PubMed.

The keywords for this search were extracted from the existing subject literature, the opinion of experts in the field, and Medical Subject Headings (MeSH) and were finalized with five phrases representing the concept of infectious diseases. Based on this, the phrase and search strategy entered in this subject area included the following formula:

(TITLE-ABS-KEY ('infectious condition*') OR TITLE-ABS-KEY ('communicable diseas*') OR TITLE-ABS-KEY ('transmissible diseas*') OR TITLE-ABS-KEY ('contagious diseas*') OR TITLE-ABS-KEY ('infectious disorder*') AND AFFILCOUNTRY (Country Name))

In this search strategy, the TITLE-ABS-KEY code was used for the advanced search command of the subject phrase in any of the title, abstract, and keyword fields of all documents in the database mentioned above. The parenthesis character was used to combine search phrases, the quote character was used to maintain the order and sequence of words in a phrase composed of several words, and the asterisk character was used to search for various truncations of words such as condition, conditions, and so on. Meanwhile, the Boolean operators OR and AND were used for the advanced search command 'or' and 'and' in the database, respectively, where the former refers to the retrieval of all documents containing one or both search terms, while the latter denotes the retrieval of all records containing both search terms.

The AFFILCOUNTRY code was used for the advanced search command for documents from a specific country, in which case the name of the country Iran or the United States was used instead of the phrase Country Name.

In this search, in addition to research articles, other types of documents such as reviews, case reports, editorials, conference proceedings, etc. that focus on infectious diseases and related topics were included in this study. This search strategy was applied to the database without limiting the documents to any specific field, such as language, publication date, and other elements. This search strategy resulted in 1804 and 24,379 documents, respectively, containing terms related to infectious disease that at least one Iranian or American researcher had contributed. Therefore, research results that had any of the above phrases related to infectious diseases in their subject and were indexed in Scopus were based on the research objectives and questions, the basis and unit of analysis of this study. Data extraction and

review were conducted in the first decade of May 2024. To have a comprehensive understanding of infectious diseases, the entire statistical population of this research was analyzed using the census method without sampling. For data analysis, Microsoft Excel software was used to present descriptive statistics and frequencies of collected data. VOSviewer software was employed to create visual representations of scientific maps and collaboration networks among various factors, utilizing a social network analysis approach.

Results

A search for documents related to infectious diseases that do not restrict the search to a specific country yielded 106,371 records. The United States ranks first with 24,379 records. Meanwhile, Iran, with 1,804 records indexed in Scopus, ranks 17th in the world regarding scientific records about infectious diseases. These documents were written by 26,402 authors, meaning approximately one author per article. The analysis and review of these documents shows that the majority of the retrieved documents are in the form of articles, accounting for 84 percent of all data, and after articles, review articles account for 8 percent of the data.

In response to the research questions in the first stage, based on the analysis of collaboration among authors, networks were mapped from the collaboration among Iranian or United States authors who had participated in research in the form of co-authorship and joint scientific output from the same or different organizations. In visualizing these collaboration networks among authors, using the graph theory approach in mathematics, each node in the network is considered to represent an author, and the occurrence of co-authorship, i.e., the relationship of each author with a co-author in joint authorship, is shown by lines between nodes. The closer these nodes are to each other, the stronger the connection between the authors. Each author has links that represent the degree of connection with other authors. The sum of these links is the total link strength of each author, and the total link strength of each author is the link strength of the entire network. In this type of map, the size of each node refers to a weight, which in the present study is calculated based on the number of published documents. The software also performs the color coding of each group of nodes based on the principle of similarity and correlation theory. In these maps, similarly colored or similar nodes are placed in a group or cluster. Based on this, in Figure 1, the collaboration network is drawn among researchers who have at least one person with organizational affiliation from Iran infectious diseases and have at least ten records in this field. This number of published documents has been taken as the threshold for more obvious collaboration maps, without disturbing density, better display and more precise understanding of the collaboration of high-publishing individuals.

As shown in Figure 1, based on the applied threshold, 64 authors appeared in the formation of the network. This network has 6 clusters, and its link strength was 2626. The most productive author in this network is ‘Roya Kelishadi’ with 77 documents, followed by ‘Farid Najafi’ with 75 and ‘’Yahya Pasdar with 66.

Figure 2 also illustrates the collaboration among infectious disease researchers, highlighting those with at least one organizational affiliation in the United States and at least ten publications.

As shown in Figure 2, based on the applied threshold, 254 authors appeared in the formation of the network. This network has 13 clusters, and its link strength was calculated to be 2735. The author with the most publications in this network is ‘Peter J. Hotez’ with 69 documents. ‘Peter Daszak’ follows with 45 documents, and ‘Rifat Atun’ ranks third with 43 documents.

Based on the total link strength calculated for individuals, Table 1 shows the top 10 most influential authors in establishing collaborations for co-authorship.

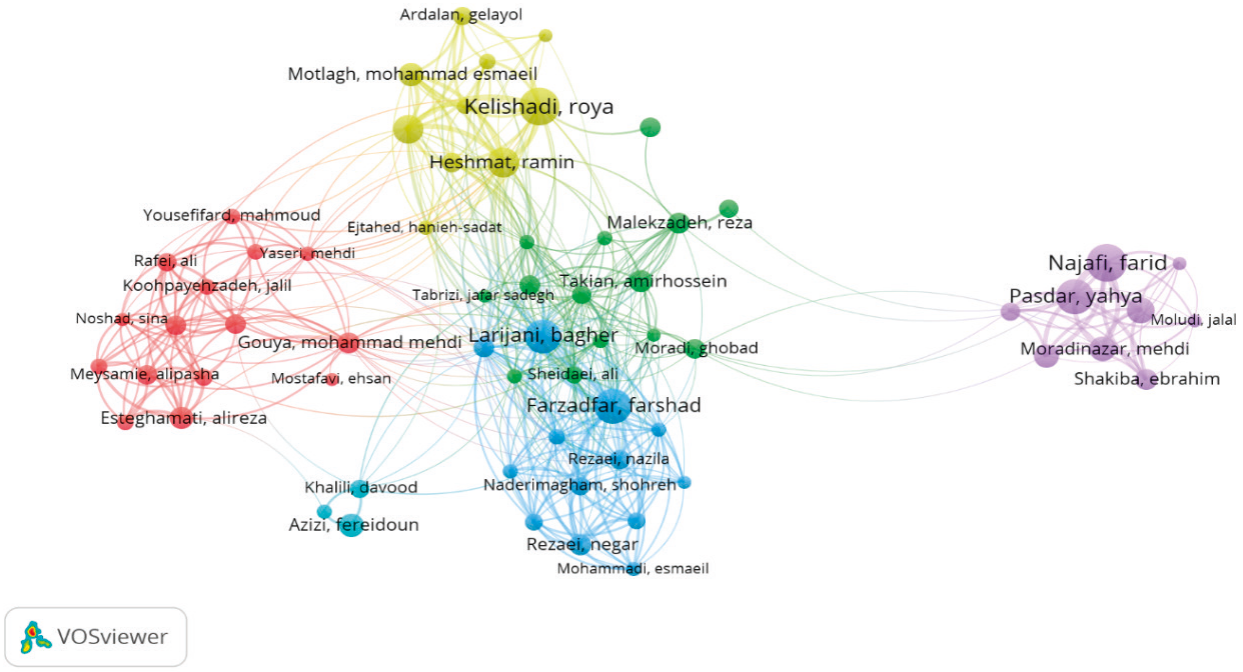

Fig. 1. Collaboration network between Iranian authors in the field of infectious diseases

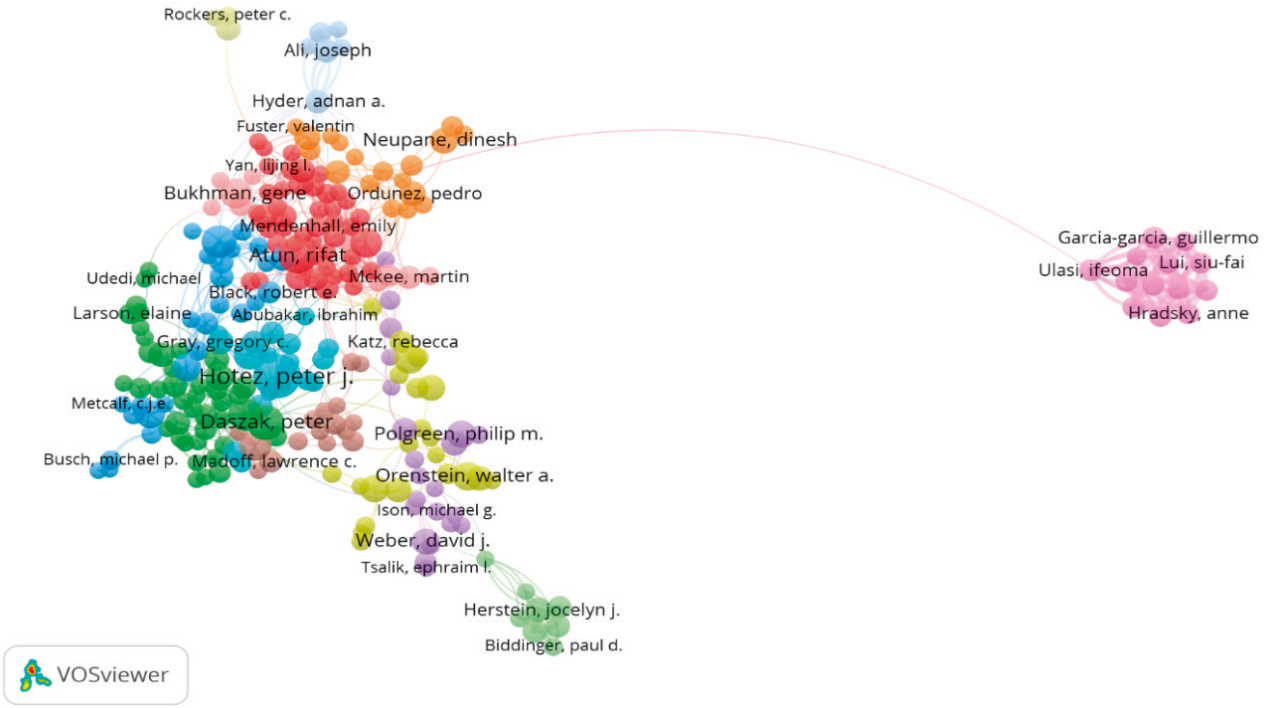

Fig. 2. Collaboration network between United States authors in the field of infectious diseases

Table 1- The influential authors of the collaboration network in the field of infectious diseases in Iran and the United States

Iran							United States					
Row	Author	Affiliation	cluster	Total Link Strength	Records .No	Citation .No	Author	affiliation	cluster	Total Link Strength	Records .No	Citation .No
.1	Farshad Farzadfar	Tehran University of Medical Sciences	3	262	64	1960	Ifeoma Ulasi	University of Nigeria	9	178	18	155
.2	Bagher Larijani	Endocrinology and Metabolism Research Institute	3	242	61	1181	Guillermo Garcia-Garcia	Universidad de Guadalajara	9	176	17	3142
.3	Ramin Heshmat	Tehran University of Medical Sciences	4	215	46	884	Anne Hradsky	International Society of Nephrology	9	176	16	54
.4	Roya Kelishadi	Isfahan University of Medical Sciences	4	210	77	1711	Kamyar Kalantar-Zadeh	UCI School of Medicine	9	175	16	51
.5	Farid Najafi	Kermanshah University of Medical Sciences	5	209	75	635	Sharon Andreoli	Indiana University School of Medicine	9	175	15	51
.6	Yahya Pasdar	Research Center for Environmental Determinants of Health, Kermanshah University of Medical Sciences	5	209	66	583	Latha Kumaraswami	Tamilnad Kidney Research (TANKER) Foundation	9	175	15	51
.7	Mostafa Qorbani	Alborz University of Medical Sciences	4	188	44	825	Ziyoda Rakhimova	World Kidney Day Office	9	175	15	51
.8	Behrooz Hamzeh	Kermanshah University of Medical Sciences	5	143	36	481	Gamal Saadi	University of South Carolina	9	175	15	51
.9	Negar Rezaei	Tehran University of Medical Sciences	3	132	24	273	Strani Luisa	World Kidney Day Office	9	175	15	51
.10	Mohammad Esmaeil Motlagh	Ahvaz Jundishapur University of Medical Sciences	4	128	28	600	Lui Siu-Fai	Chinese University of Hong Kong	9	167	15	56

As can be seen from Table 1, the first rank in total link strength among Iranian researchers belongs to 'Farshad Farzadfar,' with 64 documents and a link strength of 262. The second-ranking individual is 'Bagher Larijani,' with 61 documents and a link strength of 242. The third-ranking individual is 'Ramin Heshmat,' with 46 documents and a link strength of 215. These values for researchers from the United States are equivalent to 'Ifeoma Ulasi' with 18 documents and a link strength of 178; 'Guillermo Garcia-Garcia' with 17 documents and a link strength of 176; and 'Anne Hradsky' with 16 documents and a link strength of 176, ranking first, second, and third, respectively.

From another perspective, based on the number of citations, the scientific outputs of infectious diseases with the highest number of citations are presented in Table 2.

Table 2- Highly cited authors in the collaboration network in the field of infectious diseases

Iran							United States					
Row	**Author**	**Affiliation**	**cluster**	**Total Link Strength**	**Records .No**	**Citation .No**	**Author**	**Affiliation**	**cluster**	**Total Link Strength**	**Records .No**	**Citation .No**
.1	Farzadfar Farshad	Tehran University of Medical Sci ences	3	262	64	1960	Alan D. Lopez	Institute for Health Metrics and Evaluation	3	16	17	18496
.2	Alireza Esteghamati	Tehran University of Medical Sciences	1	104	25	1772	Christopher J. L. Murray	University of Washington School of Medicine	3	28	18	13759
.3	Roya Kelishadi	Isfahan University of Medical Sciences	4	210	77	1711	Majid Ezzati	Imperial College London	3	31	19	11985
.4	Mehrshad Abbasi	Tehran University of Medical Sciences	1	73	15	1477	Jonathan A. Patz	University of Wisconsin-Madison	2	1	15	11263
.5	Alireza Delavari	Tehran University of Medical Sciences	2	49	12	1227	Peter Daszak	EcoHealth Alliance	2	34	45	10473
.6	Bagher Larijani	Endocrinology and Metabolism Research Institute	3	242	61	1181	Robert E. Black	The University of Western Australia	3	4	17	8003
.7	Fereshteh Asgari	Iranian Ministry of Health and Medical Education	1	112	20	1137	Christopher J.L. Murray	University of Washington School of Medicine	3	24	13	6209
.8	Alipasha Meysamie	School of Pharmacy	1	84	20	1094	Alessandro Vespignani	Northeastern University	2	14	19	5840
.9	Nizal Sarrafzadegan	Isfahan University of Medical Sciences	2	8	20	924	Zulfiqar A. Bhutta	University of Melbourne	3	4	11	5416
.10	Omid Khalilzadeh	Harvard Medical School	1	48	13	911	Cécile Viboud	University of Strathclyde	2	18	19	5239

As Table 2 shows, 'Farshad Farzadfar,' 'Alireza Esteghamati,' and 'Roya Kelishadi' are among the most cited authors in the collaborative network of Iranian researchers in infectious diseases, with 64 scientific documents and 1960 citations, 25 documents, and 1772 citations, and 77 documents and 1711 citations, respectively. Among all these ten people, 'Farshad Farzadfar' has the most considerable total link strength in the network. On the other hand, based on these results, it is clear that 'Alan D. Lopez,' 'J. L. Murray Christopher,' and 'Majid Ezzati' are among the most cited authors in the collaborative network of United States researchers in infectious diseases, with 17 scientific events and 18496 citations, 18 documents and 13759 citations, and 19 documents and 11985 citations, respectively. Among all these ten people, 'Peter Daszak' has the highest total link strength in the network.

In the stage of studying the collaborative network among organizations, universities, and research institutions active in infectious diseases for the publication of joint results in this field, the organizational affiliation of authors recorded in the bibliographic information of indexed results in the database was used. Based on this, it was found that in the scientific publication of infectious diseases in which at least one Iranian author participated, 5,618 organizations worldwide have collaborated. 73,373 organizations worldwide have collaborated on infectious disease research in scientific publications, with at least one American contributor. Figures 3 and 4, respectively, present maps resulting from collaborations between organizations in which at least one Iranian or American research center participated in publishing a work with at least ten scientific outputs indexed in Scopus. In drawing the map resulting from the collaboration network from these data, each node represents an organization, and the lines of communication between organizations represent the inter-organizational collaboration for publishing a scientific output. A set of nodes that have more similarity and proximity to each other form a group, which has a different color in the drawn map and indicates the cluster related to itself.

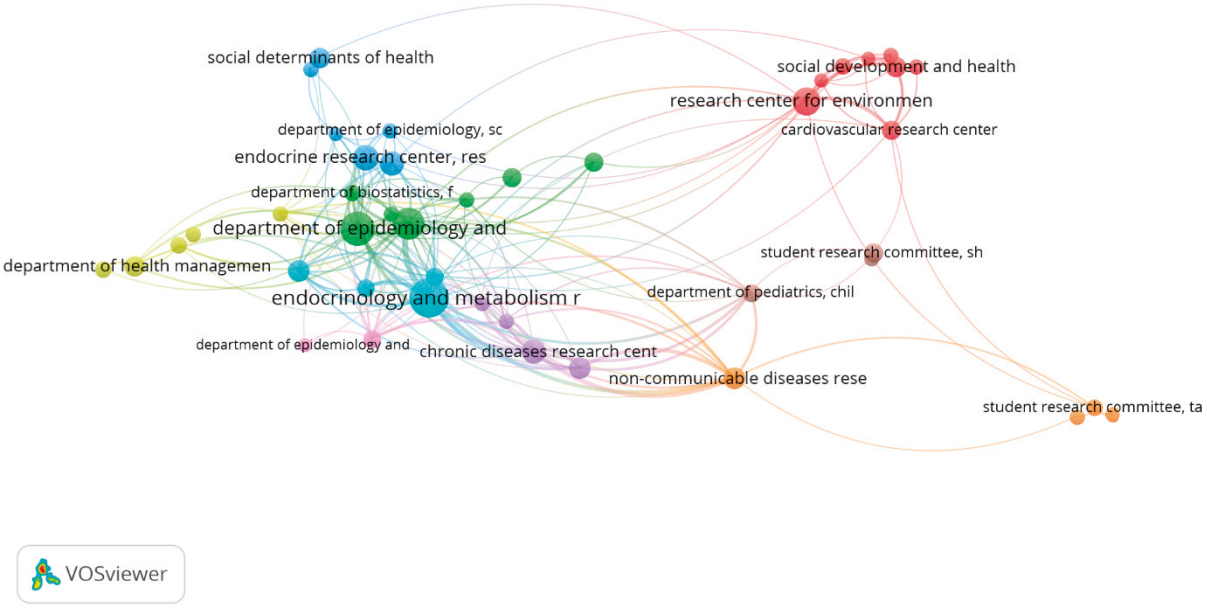

Fig. 3. Collaboration network between Iranian research organizations in the publication of the field of infectious diseases

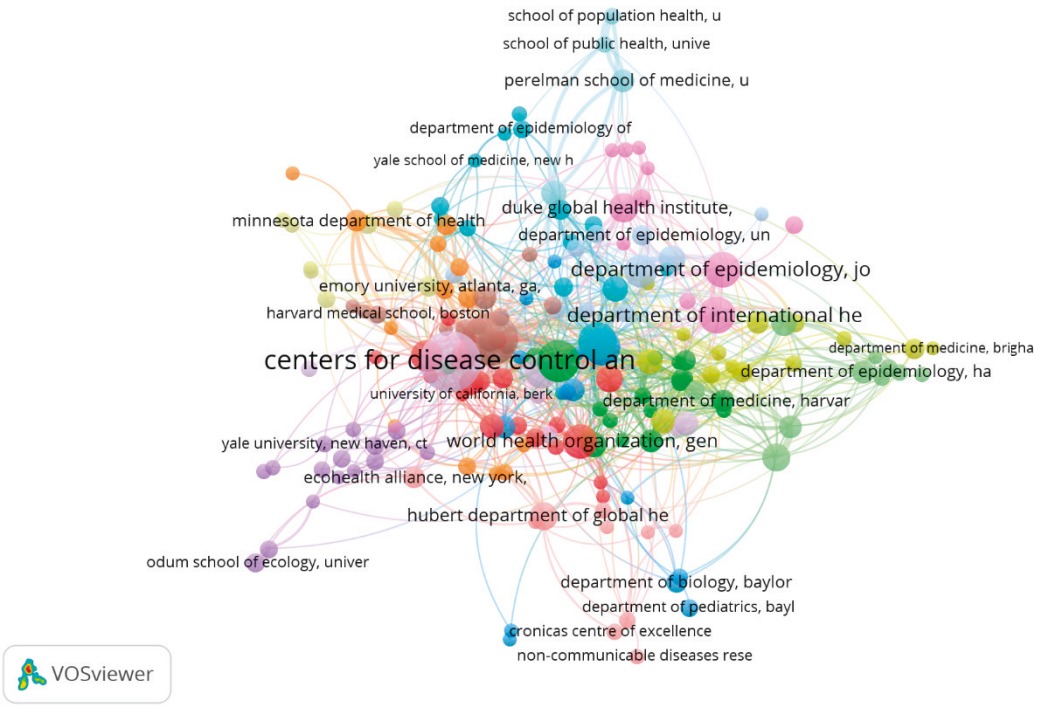

Fig. 4. Collaboration network between American research organizations in the publication of the field of infectious diseases

As shown in Figure 3, based on the applied threshold, 43 organizations (0.001 percent of organizations collaborating with Iranian organizations) appeared in the network formation in 9 clusters with a link strength of 585 to Iranian scientific publications. In this map, cluster 7, represented by the 'Non-Communicable Diseases Research Center, Alborz University of Medical Sciences, Karaj,' and colored in orange, 8, represented by the 'Department of Pediatrics, Child Growth and Development Research Center, Research Institute for Primordial Prevention of Non-Communicable Diseases, Isfahan University of Medical Sciences, Isfahan,' and colored brown, and 1, represented by the 'Research Center for Environmental Determinants of Health (RCEDH), Health Institute, Kermanshah University of Medical Sciences, Kermanshah,' and colored red, are located further away from the center of the collaborative network compared to other clusters. The centrality of this network is seen in cluster 2, colored green, represented by the 'Non-Communicable Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, Tehran. Figure 4 indicates that, under comparable circumstances, 188 organizations (0.002% of those engaged in collaborative relations with Iranian entities) were identified as part of the network formation in 15 clusters with a link strength of 1318 to scientific publication. This collaborative network has a high level of centrality, with most clusters interconnected in the center.

Table 3 shows the top ten Iranian and American organizations with the highest link strength.

Table 3- Iranian and American research organizations with high link Strength in the field of infectious diseases

Iran						United States				
Row	Organization	cluster	Total Link Strength	Records .No	Citation .No	Organization	cluster	Total Link Strength	Records .No	Citation .No
.1	Endocrinology And Metabolism Research Center, Endocrinology And Metabolism Clinical Sciences Institute, Tehran University Of Medical Sciences, Tehran, Iran	6	152	73	847	Harvard Medical School, Boston, United States	8	102	138	3424
.2	Non-Communicable Diseases Research Center, Endocrinology And Metabolism Population Sciences Institute, Tehran University Of Medical Sciences, Tehran, Iran	2	90	49	920	London School Of Hygiene And Tropical Medicine, London, United Kingdom	2	73	87	14155
.3	,Chronic Diseases Research Center Endocrinology And Metabolism Population Sciences Institute, Tehran University Of Medical Sciences, Tehran, Iran	5	86	29	422	Centers For Disease Control And Prevention, Atlanta, Ga, United States	14	67	177	7558
.4	Department Of Epidemiology And Biostatistics, School Of Public Health, Tehran University Of Medical Sciences, Tehran, Iran	2	84	58	959	Partners In Health, Boston, Ma, United States	4	60	33	700
.5	Non-Communicable Diseases Research Center, Alborz University Of Medical Sciences, Karaj, Iran	7	70	22	256	Fogarty International Center, National Institutes Of Health, Bethesda, Md, United States	6	49	71	5907
.6	Department Of Pediatrics, Ahvaz Jundishapur University Of Medical Sciences, Ahvaz, Iran	5	54	23	496	Institute For Health Metrics And Evaluation, University Of Wash-ington, Seattle, Wa, United States	3	47	65	8052
.7	Obesity And Eating Habits Research Center, Endocrinology And Metabolism Clinical Sciences Institute, Tehran University Of Medical Sciences, Tehran, Iran	9	43	15	66	,University Of Basel, Basel Switzerland	11	47	39	1239
.8	Diabetes Research Center, Endocrinology And Metabolism Clinical Sciences Institute, Tehran University Of Medical Sciences, Tehran, Iran	6	40	15	135	Public Health Foundation Of India, New Delhi, India	15	46	31	7300
.9	Research Center For Environmental Determinants Of Health (Rcedh), Health Institute, Kermanshah University Of Medical Sciences, Kermanshah, Iran	1	39	36	195	Department Of Global Health, University Of Washington, Seattle, Wa, United States	12	45	53	3788
.10	Prevention Of Metabolic Disorders Research Center, Research Institute For Endocrine Sciences, Shahid Beheshti University Of Medical Sciences, Tehran, Iran	3	38	27	239	Swiss Tropical And Public Health Institute, Basel, Switzerland	11	44	25	1210

As shown in Table 3, in Iran, the 'Endocrinology and Metabolism Research Center' ranks first with 73 records and a total link strength of 152. The 'Non-Communicable Diseases Research Center' ranks second with 49 records and a total link strength of 90, while the 'Chronic Diseases Research Center' ranks third with 29 records and a total link strength 86.

Among these, the 'Endocrinology and Metabolism Research Center, Endocrinology and Metabolism Clinical Sciences Institute, Tehran University of Medical Sciences, Tehran' has the highest scientific publication in infectious diseases with 73 documents, a total link strength of 152, and 847 citations. Following this, the 'Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Tehran,' with 58 documents, a total link strength of 84, and 959 citations, and the 'Non-Communicable Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, Tehran' with 49 documents, a total link strength of 90, and 920 citations are ranked second and third respectively.

Among them, 'Endocrinology and Metabolism Research Center, Endocrinology and Metabolism Clinical Sciences Institute, Tehran University of Medical Sciences, Tehran' has the highest scientific publication in infectious diseases with 73 documents, a total link strength of 152, and 847 citations. The following two institutions are the 'Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Tehran,' with 58 documents, a total link strength of 84, and 959 citations, and the 'Non-Communicable Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, Tehran,' with 49 documents, a total link strength of 90, and 920 citations.

Similarly, in the United States, 'Harvard Medical School, Boston, MA,' ranks first with 138 records and a total link strength of 102. The 'London School of Hygiene and Tropical Medicine, London,' is second with 87 records and a total link strength of 73, and the 'Centers for Disease Control and Prevention, Atlanta, GA,' is third with 177 records and a total link strength of 67. Among these, the 'Centers for Disease Control and Prevention, Atlanta, GA,' has the highest publication in infectious diseases with 177 records, a total link strength of 67, and 7558 citations. The next two institutions are the 'Harvard Medical School in Boston, Massachusetts,' with 138 records, a total link strength of 102, and 3424 citations, and the 'London School of Hygiene and Tropical Medicine' in London, with 87 records, a total link strength of 73, and 14155 citations.

In comparison, the 'Harvard School of Public Health, Boston, MA' has 19,674 citations for 34 records and a total link strength of 29. The 'World Health Organization (WHO), headquartered in Geneva, Switzerland,' has 16,683 citations for 59 records and a link strength of 34. The 'London School of Hygiene and Tropical Medicine (LSHTM), located in London, United Kingdom,' has 14,155 citations for 87 records and a link strength of 73. These three institutions are the three most cited research institutions involved in science publications by Iranian researchers in infectious diseases.

In analyzing the data for extracting a collaboration network based on the geographical distribution of Iranian researchers' publications indexed in Scopus in infectious diseases, 136 countries were identified as collaborating with Iran. The collaboration among these countries, by setting the minimum number of published documents from each country to 15, out of these 136 countries, 24 countries (18 percent of the total) have formed a collaboration network in the authorship of Iranian scientific outputs in infectious diseases (Figure 5).

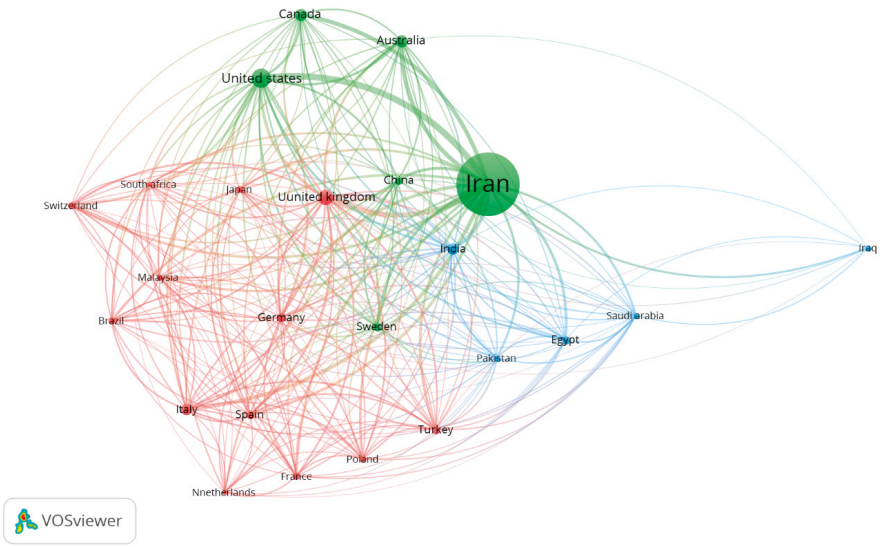

Fig. 5. Collaboration network between countries in the Iranian publication in the field of infectious diseases

As can be seen in Figure 5, this network consists of three clusters, which are distinguished by different colors. Cluster 1, with 13 countries, represents the most significant number of countries compared to the other clusters.

Based on the analysis of data to extract the collaboration network based on the geographic distribution of scientific outputs of American researchers indexed in Scopus in infectious diseases, 515 countries were identified as collaborating with the United States. Of these 515 countries, 121 countries (23 percent of the total) formed a collaboration network in the authorship of scientific outputs in infectious diseases (Figure 6).

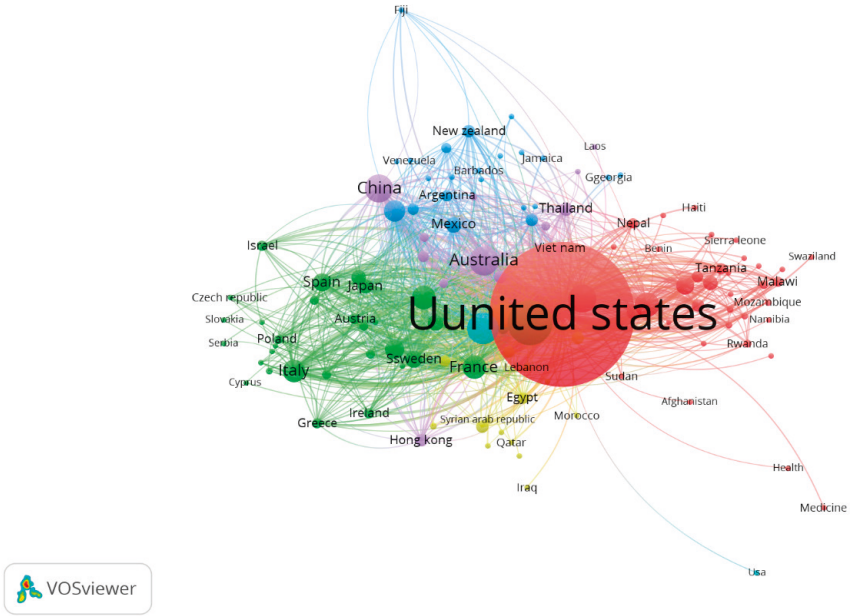

Fig. 6. Collaboration network between countries in the American publication in the field of infectious diseases

Table 4 shows the top ten countries with the highest total link strength, along with information on the number of published documents and citations for records of infectious diseases by Iranian and American researchers.

Table 4- Countries with high link strength in the Iranian and American collaboration network to publish in the field of infectious diseases

	Iran					United States				
Row	**Country**	**Clus-ter**	**Total Link Strength**	**Records .No**	**Citation .No**	**Country**	**Cluster**	**Total Link Strength**	**Records .No**	**Citation .No**
.1	United states	2	445	160	9939	United kingdom	2	8472	2330	208620
.2	Uunited kingdom	1	384	100	7422	Australia	5	4349	1023	114419
.3	India	3	240	53	3326	Canada	6	4131	1199	96698
.4	Australia	2	230	70	5060	Switzerland	1	3976	914	109497
.5	Italy	1	220	53	2387	South Africa	1	3229	762	48920
.6	Germany	1	202	41	3338	India	4	3180	761	52044
.7	Canada	2	191	65	3052	Germany	2	3079	649	53988
.8	China	2	164	34	4559	France	2	2926	661	58583
.9	Spain	1	157	30	747	China	5	2682	922	79493
.10	Italy	2	2677	589	44066	Turkey	1	157	30	2269

As Table 4 shows, the United States, the United Kingdom, and Australia are the top three countries with the highest link strength with Iran. In this map, Iran collaborates with 23 countries with a link strength of 931. However, the United States, in collaboration with other countries for the publication of infectious diseases, has accepted the United Kingdom, Canada, and Australia as the principal collaborators, with a link strength of 8472, 4131, and 4349, respectively.

Finally, based on the collected data, a scientific and subject map of infectious diseases was drawn based on the co-occurrence of terms used by Iranian and American researchers in this field in scientific publications indexed in Scopus. The co-occurrence of terms indicates the repetition of keywords in different and related areas of infectious diseases among researchers. In this network, the repetition of keywords is an essential factor in the formation of the network. In the resulting map, the graph network consists of nodes representing keywords and connecting lines indicating the relationship between these keywords. The size of the groups, also called the weight of the nodes, is based on the number of frequencies in the collected data. The more times a keyword is repeated, the greater its weight and size. Figure 7 shows the resulting map from the scientific drawing of the field of infectious diseases of Iranians.

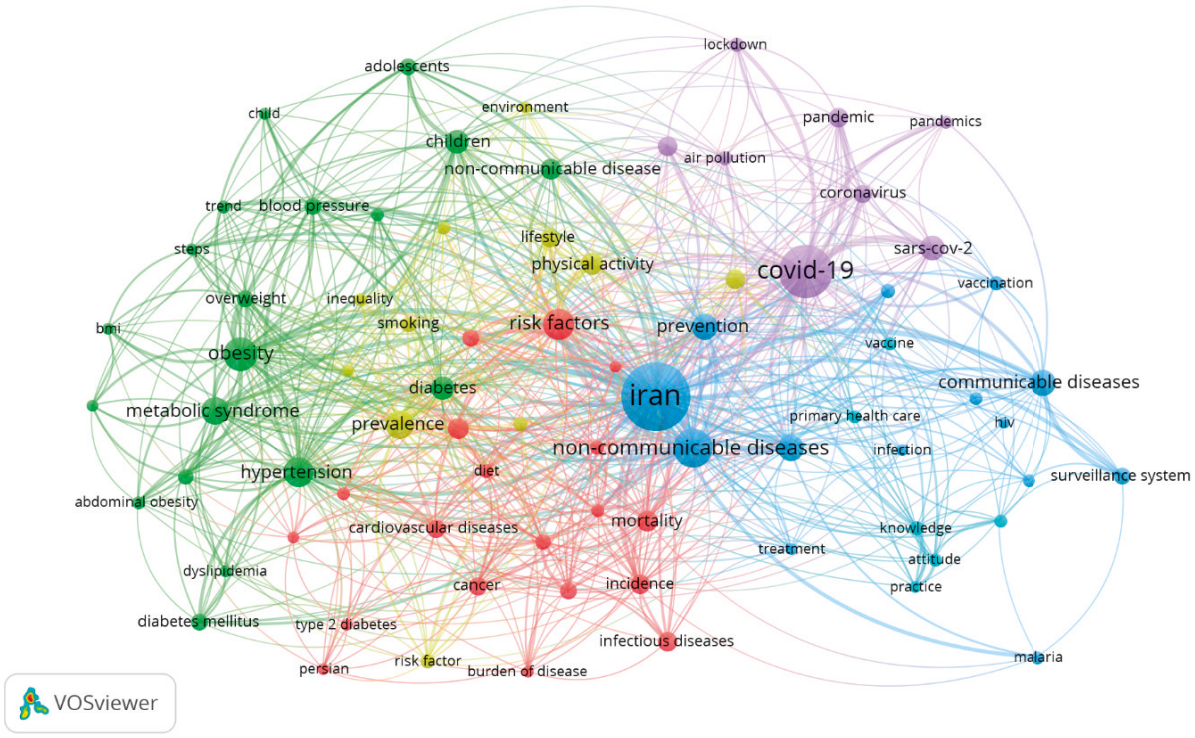

Fig. 7. Iranian's Scientific map of the field of infectious diseases based on word co-occurrence with other fields

As Figure 7 shows, among the 1804 publications of Iranian researchers in infectious diseases indexed in Scopus, 3666 keywords have been used by different researchers. By setting the minimum repetition of each keyword to 10, 77 keywords appear in the network. This network is composed of 6 clusters. Logically, the centrality of this network is in the keyword section of infectious diseases. Clusters 1 and 2, which contain 19 keywords, represent 24 percent of the network's vocabulary and 0.51 per-

cent of the total vocabulary in this field, the most significant proportion among all clusters. Overall, this network does not exist discretely; it does not contain irrelevant topics. Instead, its topics are somewhat interconnected, showing both density and centrality. The keyword 'Iran' with 348 frequency, is one of the most frequently used keywords in this network, followed by 'COVID-19' with 202 frequency in second place, 'non-communicable diseases' with 110 frequency in third place, 'obesity' with 84 frequency in fourth place, and 'risk factors' with 71 frequency in fifth place among the keywords, indicating the recurring topics in infectious diseases. Figure 8 shows the map resulting from the scientific visualization of infectious diseases in the United States.

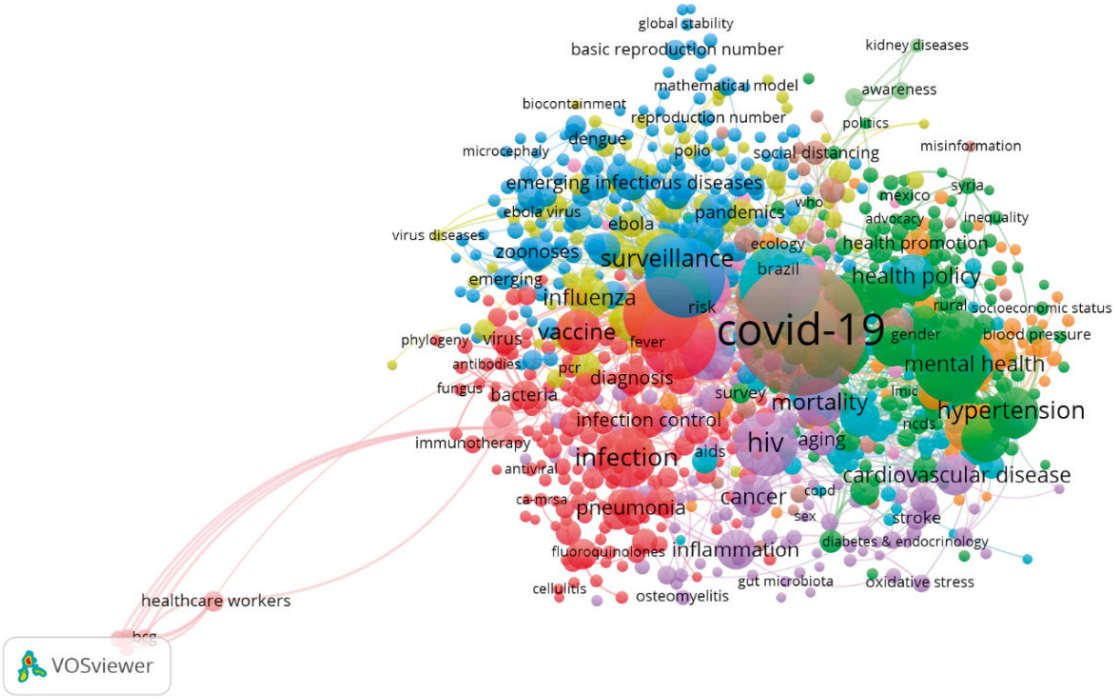

Fig. 8. American's Scientific map of the field of infectious diseases based on word co-occurrence with other fields

As shown in Figure 8, among the 24,379 publications by American researchers in infectious diseases indexed in Scopus, 25,986 keywords were used by different researchers. By setting the minimum repetition of each keyword to 10, 852 keywords appear in the network, indicating the high diversity of fields related to this area. The network consists of 11 clusters. Logically, the centrality of this network is infectious diseases. Cluster 1, with 168 keywords, i.e., 19 percent of the vocabulary of the network and 0.64 percent of the total vocabulary of this field, contains the highest number of keywords among the other clusters. Cluster 10, colored in pink, is further away from the center. The keyword 'COVID-19' with 1,420 frequencies, is one of the most used keywords in this network, followed by 'public health' with 546 frequencies in second place, 'epidemiology' with 532 frequencies in third place, 'infectious diseases' with 479 frequency in fourth place and 'infectious disease' with 462 frequency in fifth place among the keywords, indicating the recurring topics in infectious diseases.

In the visualization of the subject map of the field of

infectious diseases based on the network approach, hot topics of the field can be identified by providing a density view of the keyword structure. In this section, as the color spectrum changes from cool to warm colors, i.e., from blue to red, hot topics in the field become apparent. However, topics in the yellow and blue spectrum are not necessarily less critical. They may be emerging topics in the related field that have not yet created suitable study opportunities for researchers. Therefore, the density map indicates the recurrence rate and depth of influence of different fields in the study area. As the colors move from red to yellow, green, and blue, the influence in the cluster decreases. Also, keywords that have more connections with each other are placed closer together, and keywords that have fewer connections with each other are placed further apart. Figure 9 shows the most popular and influential topics in infectious diseases for Iranians.

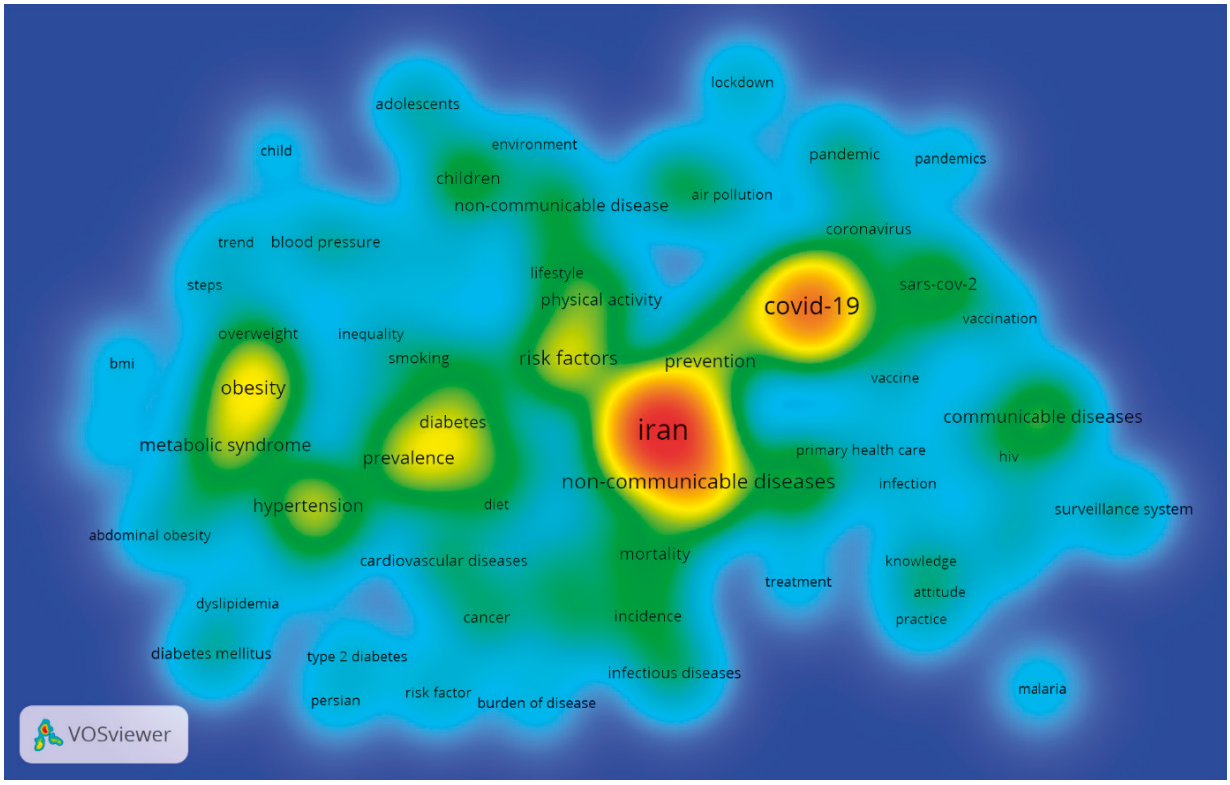

Fig. 9. Iranian researchers' thematic map of the field of infectious diseases based on the density network of related topics

As shown in Figure 9, the clustering around infectious diseases is deeper. Also, the keywords 'Iran,' 'disease,' and 'infectious diseases' are in the red and hot area of this field; the keywords 'non-communicable diseases,' 'risk assessment,' and 'COVID-19' are in the orange area; the keywords 'risk factor,' 'obesity,' 'diabetes,' 'prevalence,' 'cardiovascular disease,' 'hypertension,' and 'metabolic syndrome' are in the yellow area. Figure 10 shows the hot and influential topics in infectious diseases in the United States.

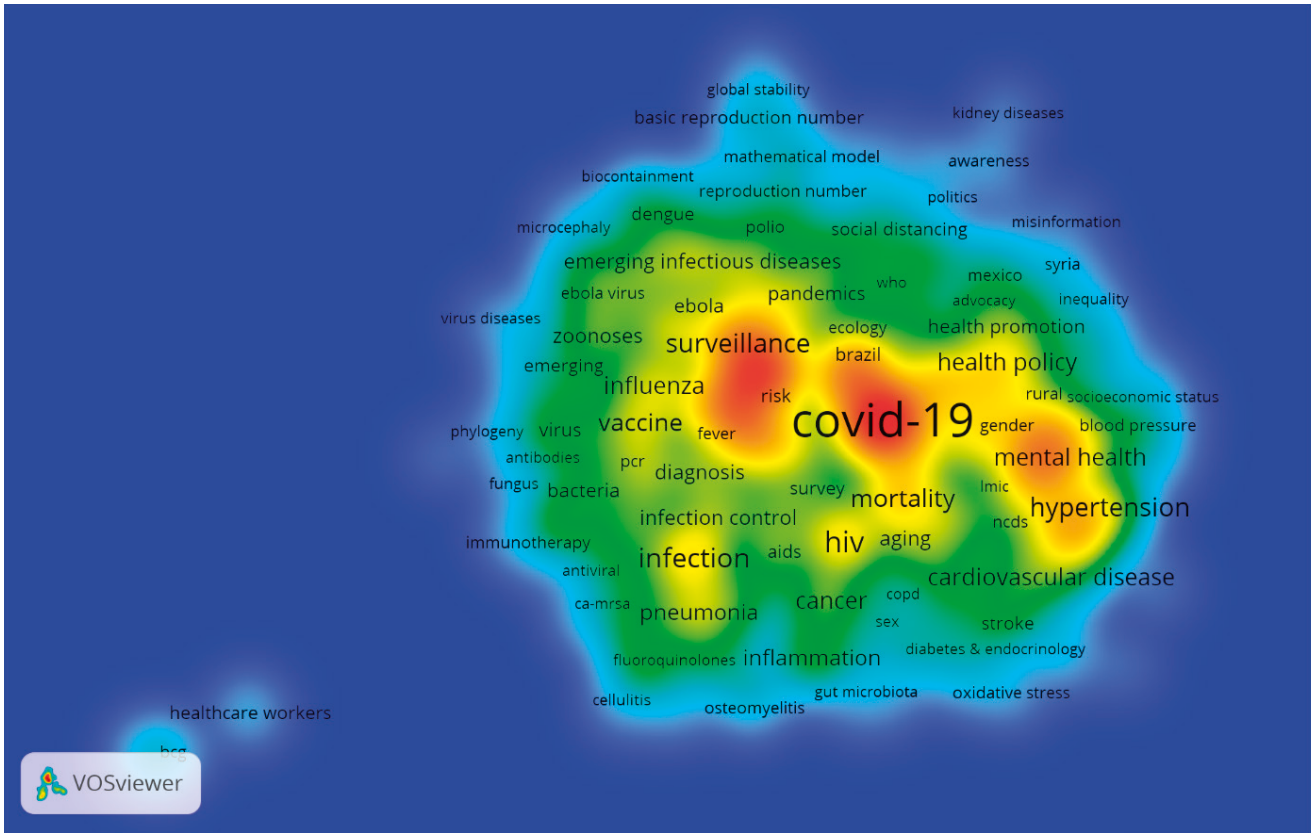

Fig. 10. American researchers' thematic map of the field of infectious diseases based on the density network of related topics

As shown in Figure 10, the clustering of American researchers around infectious diseases is also more pronounced. The keywords 'COVID-19,' 'contagious diseases,' 'prevention,' 'education,' 'epidemiology,' 'communicable diseases,' 'public health practice,' 'meta-analysis,' 'burden,' 'training,' 'cost-effectiveness' are also in the red and hot area of this field; keyword. s 'surveillance,' 'public health surveillance,' 'coronavirus,' 'sars-cov-2,' 'immunization,' 'cattle,' 'risk,' 'impact,' 'monitoring,' 'model,' 'efficacy,' 'infectious disease,' 'public health,' 'big data,' 'stigma,' 'collaboration,' 'pandemic,' 'oncology,' 'diseases,' 'developing countries,' 'development,' 'community,' 'public health,' 'training,' 'cost-effectiveness,' 'development,' 'community,' 'screening,' 'oral health,' 'social determinants of health,' 'Mediterranean diet,' 'sustainability,' 'care,' 'non-communicable diseases,' 'women,' 'disparities,' 'COVID-19 pandemic,' 'sub-Saharan Africa,' 'mental health,' 'diabetes' are in the orange area; The keywords 'ebola,' 'malaria,' 'influenza,' 'vaccine,' 'PCR,' 'fever,' 'ecology,' 'mortality,' 'aging,' 'HIV,' 'gender,' 'health policy,' 'rural,' 'lmic,' 'infection,' 'pneumonia' are in the yellow area. In the area of hot topics, the spectra of different topics of interest to Iranian and American infectious disease researchers in recent years are presented in Table 5.

Table 5- Different thematic areas of infectious diseases in Iran and America in recent years.

2018				2019				2020-2022			
United States		Iran		United States		Iran		United States		Iran	
Keyword	Frequency	Keyword	Frequency	Keyword	Frequency	Keyword	Frequency	Keyword	Frequency	Keyword	Frequency
COVID-19	202	COVID-19	1420	Non-Communicable Diseases	110	Non-Communicable Disease	325	Iran	348	Non-Communicable Diseases	459
Sars-Cov-2	45	Sars-Cov-2	273	Air Pollution	110	Hypertension	221	Obesity	84	Obesity	193
Public Health	29	Pandemic	251	Knowledge	37	Diabetes	200	Risk Factors	71	Global Health	182
Pandemic	27	Coronavirus	182	Physical Activity	37	Physical Activity	120	Hypertension	64	Health Policy	148
Coronavirus	24	Mental Health	147	Trend	33	South Africa	65	Metabolic Syndrome	53	Nutrition	106
Noncommunicable Diseases	22	Lockdown	109	Cardiovascular Disease	33	Low- And Middle-Income Countries	53	Communicable Diseases	49	Aging	81
Systematic Review	22	Depression	103	Cardiovascular Disease	33	Health Disparities	53	Epidemiology	49	Diagnostics	74
Lockdown	17	Telemedicine	76	Mortality	33	Microbiome	52	Children	40	Antimicrobial Stewardship	74
Infectious Diseases	15	COVID-19 Pandemic	75	Health	30	Nepal	44	Non-Communicable Disease	32	Health Systems	72
Pandemics	13	Pandemics	62	Surveillance System	30	Qualitative Research	43	Infectious Diseases	27	Diet	68
COVID-19 Pandemic	13	Systematic Review	60	Meta-Analysis	27	Pediatric	34	Lifestyle	25	One Health	65
Persian Cohort	12	Anxiety	55	Incidence	27	Survey	34	Adolescents	22	Diabetes Mellitus	60
Socioeconomic Factors	12	Social Media	54	Physical Activity	25	Community Health Workers	34	Body Mass Index	20	Noncommunicable Disease	56
Dietary Inflammatory Index	11	Social Distancing	49	Cardiovascular Diseases	25	Blood Pressure	30	Smoking	19	Primary Health Care	45
Risk Assessment	11	Machine Learning	48	Cardiovascular Diseases	25	Air Pollution	30	Nutrition	16	Adolescents	43
Steps	11	Telehealth	45	Cancer	25	Awareness	27	Stroke	12	Bangladesh	43
Socioeconomic Status	11	Social Determinants Of Health	44	Mortality	22	Microbiota	27	Inequality	12	Type 2 Diabetes	41
Type 2 Diabetes	11	Exercise	37	Surveillance System	22	Universal Health Coverage	25			Zika Virus	41
Persian	11	NCDS	33	Meta-Analysis	19	Knowledge	25			Asthma	39

2018				2019				2020-2022			
United States		Iran		United States		Iran		United States		Iran	
Keyword	Frequency	Keyword	Frequency	Keyword	Frequency	Keyword	Frequency	Keyword	Frequency	Keyword	Frequency
Environment	10	Health Equity	33	Cancer	19	Personal Protective Equipment	24			Overweight	38
		Artificial Intelligence	31	Air Pollution	17	Child Health	24			Zika	38
		COVID	30	Vaccination	17	Mobility	24			Refugee	37
		Older Adults	30	Vaccination	16	Breast Cancer	23			Mhealth	35
		Implementation Science	28	Knowledge	16	Access	23			Equity	34
		Deep Learning	26	Dyslipidemia	16	Food Security	23			Metabolic Syndrome	31
		Sustainable Development Goals	24	Health	16	Syria	23			Intervention	29
		Vaccine Hesitancy	24	Vaccine	14	Population Health	23			Chronic Kidney Disease	29
		Non-Pharmaceutical Interventions	22	Qualitative Study	14	Global Burden Of Disease	22			Gender	29
		Quality Of Life	20	Non-Communicable Diseases	14	Heart Failure	22			Alcohol	28
		Resilience	20	Vaccine	14	Dementia	22			Detection	27
		Multimorbidity	19	Practice	14	Public Health Preparedness/Response	21			Medical Education	27
		Primary Healthcare	19	Treatment	13	Governance	21			Oxidative Stress	27
		Monkeypox	19	Trend	13	Saudi Arabia	21			Isolation	26
		Mediterranean Diet	18	Qualitative Study	12	Non-Communicable Diseases ((NCDS	20			Trauma	26
		Kidney Diseases	17	Attitude	12	Implementation	20			Urbanization	26
		Coronavirus Disease 2019	17	Attitude	11	Integrated Care	18			Iran	23
		COVID-19 Lockdown	17	Treatment	11	Palliative Care	18			Comorbidity	22

2018				2019				2020-2022			
United States		Iran		United States		Iran		United States		Iran	
Keyword	Frequency	Keyword	Frequency	Keyword	Frequency	Keyword	Frequency	Keyword	Frequency	Keyword	Frequency
		Social Support	16	Incidence	10	Health Behavior	18			Next-Generation Sequencing	21
		Food Insecurity	16	Dyslipidemia	10	Human Mobility	18			Critical Care	20
		Lmics	16	Practice	10	Stewardship	18			Ageing	20
		Injuries	15			Sleep	17			Rural Health	20
		Lmic	15			Metagenomics	17			Epigenetics	20
		Digital Health	15			Pandemic Preparedness	17			Ebola Virus Disease	19
		Twitter	14			Workforce	17			Adherence	19
		Sugar-Sweetened Beverages	14			MERS	16			Economic Evaluation	19
		Disparities	14			Surgery	16			Inequality	19
		Well-Being	14			Cardiovascular	16			NCD	19
		Loneliness	14			Forecasting	16			Disability	18
		Opioid Use Disorder	13			Global Health Security	16			Tanzania	18
		Diabetes & Endocrinology	13			Health System	16			Public Health Policy	18
		Psychological Distress	12			Health Literacy	16			Social Determinants	17
		Dysbiosis	12			Cervical Cancer	15			Autophagy	17
		Ultra-Processed Food	12			Spillover	15			RSV	17
		Qualitative	12			Risk Perception	14			Americas	17
		College Students	12			Maternal Health	14			Mobile Health	16
		Google Trends	11			Built Environment	14			Antibiotic Stewardship	16
		Gut Microbiota	11			Precision Medicine	14			Barriers	15
		Particulate Matter	11			Probiotics	14			Risk Communication	15

2018				2019				2020-2022			
United States		Iran		United States		Iran		United States		Iran	
Keyword	Frequency	Keyword	Frequency	Keyword	Frequency	Keyword	Frequency	Keyword	Frequency	Keyword	Frequency
		Violence	11			DNA Methylation	13			Socioeconomic Factors	15
		Advocacy	11			COPD	13			Impact	15
		Health Behaviors	11			Myocardial Infarction	13			TB	15
		Prevention Strategies	11			Community Engagement	12			Lebanon	15
		Wastewater	11			Oncology	12			Alzheimer's Disease	15
		Commercial Determinants Of Health	11			Uncertainty	12			Type 1 Diabetes	15
		Misinformation	11			Lifestyle Medicine	11			Curriculum	15
		Sedentary Behavior	11			Collaboration	11			Cohort Study	15
		COVID19	11			Type 2 Diabetes Mellitus	11			Testing	15
		Double Burden Of Malnutrition	11			Transcriptomics	11			Health Outcomes	14
		Food Industry	10			Jordan	11			Natural Language Processing	14
		Air Quality	10			Health Services Accessibility	11			Assessment	14
		Planetary Health	10			Pollution	11			Bioinformatics	14
		Bariatric Surgery	10			Behavior Change	11			Adolescent Health	14
		Ultra-Processed Foods	10			CVD	11			Contagion	14
		University Students	10			Cognition	11			Infectious Disease Medicine	13

2018				2019				2020-2022			
United States		Iran		United States		Iran		United States		Iran	
Keyword	Frequency	Keyword	Frequency	Keyword	Frequency	Keyword	Frequency	Keyword	Frequency	Keyword	Frequency
		Diagnostic Stewardship	10			Fellowship	10			Long-Term Care	13
		Scoping Review	10			Dietary Patterns	10			Quality	13
		HIV & AIDS	10			Low-And Middle-Income Countries	10			Chronic Illness	13
						Comorbidities	10			Interventions	13
						Challenges	10			Respiratory Infections	13
						Clinical Microbiology	10			Trends	13
						Point-Of-Care Testing	10			Low-Income Countries	13
						Trend	10			MSM	13
						Inflammasome	10			Influenza Virus	13
						Medication Adherence	10			Policy Analysis	13
						Caribbean	10			Emerging Viruses	13
						Displacement	10			Migrants	13
										Food Policy	13

As it is clear from Table 5, today, most of the subject areas of infectious diseases among Iranian researchers are generally separated from previous years and towards areas such as 'Non-Communicable Diseases,''Obesity,' 'Global Health,' 'Health Policy,' 'Nutrition,' etc., while in previous years, in addition to the issue of 'Non-Communicable Disease' topics like 'Hypertension,' 'Diabetes,' 'Physical Activity,' 'South Africa' or 'Low-And Middle-Income Countries' or previously topics like 'COVID-19,' 'Sars-Cov-2,' 'Pandemic,' 'Coronavirus,' 'Mental Health,' etc. were hot and popular topics. Meanwhile, for the American researchers' document indexed in Scopus for a similar time, most areas such as 'Iran,' 'Obesity,' 'Risk Factors,' 'Hypertension,' 'Metabolic Syndrome' or 'children is discussed.' Certainly, both Iran and the United States are currently researching topics such as 'inequality,' 'Iran,'

'metabolic syndrome,' and 'Non-communicable diseases.' However, the priority and frequency of these research topics vary between the two countries. Also, as it is clear from the mentioned table, in recent years, the variety of topics studied by Iranians in infectious diseases is much more scattered and diverse than the research fields of their American counterparts.

Discussion

It seems that scientometric analysis can play an essential role in understanding the research perspectives of infectious diseases and provide valuable insights in this field. In other words, scientometric analysis is a powerful tool for examining the prospects of scientific research in various fields, including infectious diseases. In infectious diseases, this study aims to describe and analyze the knowledge links among Iranian researchers and compare them with those of American researchers. This comparison is facilitated by communication between individuals, research organizations, and countries for scientific collaboration. In addition, this study reviews the scientific publications in this field and finally visualizes the scientific map of this field. This visualization is based on the co-occurrence of words with other related fields, as shown in the scientific documents indexed in Scopus. The results showed that in Iran, Roya Kelishadi from Isfahan University of Medical Sciences is the most productive person among Iranian authors, with 77 scientific documents about infectious diseases. She also ranks third in the number of citations to her work. Peter J. Hotez, with 69 records, is the most productive person among American authors, while in the number of citations received to his works, he is ranked twenty-five. Meanwhile, Farshad Farzadfar holds the highest link strength among Iranian authors, while Ifeoma Ulasi holds the same position among American authors. In addition, Farshad Farzadfar leads among Iranian authors, and Alan D. Lopez leads among American authors in publishing the most cited documents in the field.

Although the review of previous research showed that the field of infectious diseases is one of the essential scientific fields in recent years, these research follow an upward trend; so far, no comprehensive study has been carried out that shows the collaboration network between various Iranian entities and the leading country in this field, the United States, or draws its scientific map and identifies essential areas based on scientific results. To the collaboration network between organizations, universities, research institutions, etc., active in infectious diseases, this research, while drawing a collaboration map, found that for each document published in Iran and the United States of America, nearly three organizations have contributed to the publication of documents, which indicates that most organizations have published several documents in this field. As it is clear from the results of this section, most of the linking strength among Iranian data is in the hands of organizations from within the country. On the other hand, among the organizations collaborating for the publications of the United States of America, organizations from abroad such as the United Kingdom, India and Switzerland are also observed. In Iran, the 'Endocrinology and Metabolism Research Center, Endocrinology and Metabolism Clinical Sciences Institute of the University of Tehran' has the highest level of collaboration and the most significant number of documents in conjunction with other organizations in infectious diseases. These documents are valid for indexing in Scopus. Conversely, in the United States, 'Harvard Medical School, Boston, MA,' with a link strength of 102, has the highest level of collaboration with other organizations in infectious diseases and has published the most documents valid for indexing in Scopus.

Meanwhile, the Centers for Disease Control and Prevention in Atlanta, GA, holds the most significant scientific documents in this field among all American entities. In this regard, it should be noted that in previous studies, it has been emphasized that some international rankings of research centers such as The Times, Scimago, and UAS News pay attention

to the level of international collaboration, in which case the formation of a research team of researchers with influential people from organizations introduced in this study at the global level, it is recommended to raise the rank of the organization to which they belong. In this regard, the research organizations with the most scientific collaboration with Iranian researchers have been identified in the current research, which should be matched with the presented approach, and a new policy should be adopted.

Regarding the countries that collaborate with Iran in publishing infectious diseases, it is clear that the United States is the first choice. However, this relationship is one-way, and the opposite is not valid. Iran's international partners in this field are mainly from European and Asian countries. In contrast, the international partners of the United States are mainly developed countries such as the United Kingdom, Australia, Canada, Switzerland, etc., which are at the forefront of collaboration. It would benefit Iran to carefully balance the selection of partner countries to advance in the publication of infectious disease documents. On the other hand, the level of participation in the number of published documents varies significantly among partner countries. While the United States can publish over 2000 documents in collaboration with other countries, Iran has collaborated on only 160 items, and for most items has collaborated with other countries on fewer than 100 documents.

On the other hand, visualizing the subject map of Iranian and American researchers focused on infectious diseases, it seems that Iran has a broader distribution in different years than the topics studied by Americans. As a result, the research of Iranians in the mentioned field is wide but shallow, while the subject map of the United States is denser. In this context, although thematic commonalities have been identified, almost all areas of Iranian research in infectious diseases do not follow the most productive country in the world in this subject. The reasons for this should be investigated in future studies.

Conclusion

Both Iran and the United States have made significant advances in the production of infectious disease science in recent decades, which may be due to changes in policy, focus on interest areas, cultural and economic differences, as well as global influences. The results of his study indicate that the scientific relationships of Iranian infectious disease researchers differ from those of leaders in the field. There are several reasons for this difference. This applies to various aspects, including researchers, organizations, countries, and subject maps. This research presented the top entities of all three levels in terms of a number of documents, link strength, and citation for Iran and the United States. Collaborations in publication can contribute to developing knowledge and scientific progress of infectious diseases in both countries. Future research should identify the reasons for these differences and propose solutions. In addition, these findings suggest that selection criteria for research collaborators should include factors such as the number of publications, citations, and the extent of an individual's collaboration. Identifying these individuals will also help to train young researchers and newcomers to the field of infectious diseases, and the formation of relevant courses in the field of research will help to increase scientific publications on infectious diseases, which is also emphasized in other studies. On the other hand, encouraging isolated people to collaborate with the people introduced in this research will increase the strength of the collaborative network, and also being recognized as a research partner at the international level will significantly help to improve the quality of scientific output.

In addition, this study presented a visualized subject map of the co-occurrence of keywords in scientific documents related to infectious diseases in the two countries during different recent time periods. The map highlights hot topics and emerging scientific fields. Based on these findings and a comparison of the results presented in Table 5, it was determined that Iran's infectious disease studies have a more

diverse and dispersed influence from other fields than those in the United States. It is evident that, in some instances, both countries have focused on the same research subjects in their documents. However, based on the presented frequency, it is evident that even the same research subjects exhibit varying intensity levels. This has resulted in Iran's density network of related subjects being insular, scattered, and limited, whereas the density network map of the United States is cumulative and compact. It is expected that Iranian researchers will prioritize important topics in their research by more accurately identifying the fields related to infectious diseases.

Finally, it must be emphasized that although scientometrics is a powerful tool and this research has provided essential points for the continuation of the work of Iranian researchers in infectious diseases, it is also necessary to consider its limitations and the importance of qualitative assessment in understanding the value and impact of research. Therefore, the study results should be interpreted cautiously due to the following limitations.

In addition, this study focused on documents that were directly related to the phrase 'infectious diseases' or its synonyms, as reflected in their subject headings, abstracts, titles, or keywords. Since there may be a record that implicitly addresses this topic or examines specific issues in this area, it may not be reflected in the results of this research. Therefore, it is suggested that other studies using terms related to this area, such as non-communicable diseases, Coronavirus, public health, etc., be extracted from related thesauruses and considered in future research.

On the other hand, while this research focuses on records indexed in a reliable database, it's important to note that most records were in English. This could potentially introduce a bias toward records published in English. Previous studies have shown that scientific outputs in other languages, such as Arabic or Persian, which are relatively less covered in Scopus, are a barrier to retrieval in systematic reviews or citations. Therefore, this study generally does not discuss the publishing and research productivity of countries, research organizations, and authors whose output is published in languages other than those fully covered by Scopus. Future researchers can use other bibliographic and citation databases such as WoS, Islamic World Sciences & Technology Citation, etc. to complete the results of this study and compare them with the current results. Also, the search included only indexed scientific documents and did not include grey literature.

In addition, examining infectious disease outcomes in the field of altmetrics or altmetric, which deals with the social impact of this research on society, or conducting a systematic review of outcomes could be suggestions for future research. The publication of evidence-based guidelines based on these findings could add more depth to the current analysis.

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Ethical approval
Not applicable.
Conflict of Interests
The authors have no conflicts of interest to declare.

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