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Mapping and Analyzing the Co-authorship and Thematic Networks of Kurdistan University of Medical Sciences in the Science Citation Database from 2011-2016

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Abstract

Background: Considering the importance of co-authorship and thematic networks in expanding specialization and improving the quality of scientific works, the purpose of this research is to map and analyze the co-authorship and thematic networks of the Kurdistan University of Medical Sciences in the Science Citation Database between years 2011-2016.

Method: Research society of scientific publications in Kurdistan University of Medical Sciences, indexed in the science citation database between years 2011-2016. In order to analyze the data, Excel and HistCite software, and to map the networks and analyze them the Citespace and Gephi software were used.

Findings: The number of scientific publications of Kurdistan University of Medical Sciences during the studied years is 518 papers with 4914 citations. The average number of citations for each paper was 9 and the dominant co-authorship pattern in these years is a five-author pattern. The collaboration index for the years under examination is 5.66, the degree of collaboration is 0.99 and the collaboration coefficient is 0.98. The researchers' desire to create a co-authorship network between years 2011-2016 has increased and the largest international collaboration of university researchers was with Canada. In the mapping thematic network, among the subjects under the study of the university, environmental health, public and professional, the highest degree of centrality, and pharmacy and pharmacology had the highest betweeness centrality.

Conclusion: Considering the high level of collaboration and co-authorship between researchers of Kurdistan University of Medical Sciences, it is recommended to create the essential ground for initiating and consolidating international and national collaboration and setting up scientific and expert colleague groups.

Keywords: Scientific Collaboration, Co-authorship Network, Kurdistan University of Medical Sciences

Introduction

The interdisciplinarity of science, the complexity and cost of research are due to the fact that researchers are turning to scientific collaboration [1, 2]. Scientific collaboration is one of the criteria for assessing the quality of work of researchers and research groups and is considered an effective way of acquiring advanced science and technology in developing countries [2]. Therefore, the greater the degree of cooperation between scientists, the quality of research and scientific development will increase [2]. One of the most prominent and documented difficulties of scientific collaboration is co-authorship [3].The phenomenon of scientific collaboration creates a network of knowledge sharing and the collaboration of researchers in the production and development of science and the emergence of a social network of researchers, that is a co-authorship network. Researchers from different fields via participating in research can overcome the breadth and complexity of science and take steps to promote the country's scientific development [3].The study of co-authorship and thematic networks will measure the scientific collaboration of researchers [4]. In co-authorship research, co-authorship patterns that represent the level of participation or the number of collaborative researchers in the scientific publications of different years are determined. The most important co-authorship indicators are the two collaboration index (CI)[1], namely, the degree of collaboration (CC)[2] and the collaboration coefficient. [5, 6]

"Collaboration Index" is the average number of researchers per article and the "degree of collaboration" represents the ratio of articles by several authors. The value of this numeric index is between zero and one which, if it goes toward one, indicates the high number of articles by several writers in relation to the entire number of articles. In this index, articles with one writer are rated zero [7]. The "Collaboration Coefficient" also reflects the relationship between the authors of the articles. The value of this index is also between zero and one. If the numerical value of this index is toward one, it indicates the degree of greater collaboration and toward zero indicates the priority of articles with one writer [5]. The average received citations refer to average received citations for each year and the purpose of network structure is to determine the network disruption and continuity and to determine the centrality indices [8]. The centrality index refers to the position of specific nodes inside the network. The centrality index includes the centrality of degree and betweeness. The centrality of degree index is the simplest type of centrality where the value of each node is obtained by counting the number of its neighbors. The number of neighbors is determined by the interfaces connected to that node. The higher the level of one person's centrality, the more communication and networking is available for her/him and is more effective [8]. Betweeness centrality indicator, as a structural feature of the nodes, indicates the importance of the node in terms of location and information transmission in the network. One with the highest centrality of betweeness is between many other nodes and the communication paths of other nodes

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1. Collaboration index is showing the average number of authors per article.

2. The degree of collaboration is between zero and one, this index gives zero weight to single author articles and articles with higher number of authors are in higher ranks.

pass through it [5,9]. A discrete network is a network in which the connection between links is in a low Figure, or the number of lines or corresponding links is less than the number of vertices. The continuous network is a network in which the number of lines and Links in a Figure is greater than the number of vertices [8].

According to the research activities of about 250 faculty members and a large number of researchers and graduate students in Kurdistan University of Medical Sciences, annually, a significant number of articles are published in various subject areas of medicine, health, and other related fields, in various journals. Evidences suggest that scientific publications from interdisciplinary and intergroup collaborations have a higher academic credibility than individual articles and the likelihood of the publication of such articles in more authoritative journals is greater, subsequently publication of articles in journals with higher quality indicators will promote the scientific status of researchers and the university [3]. Via identification of the status of collaborations and scientific networks and the vacuum in the scientific networks, encouraging the creation of national, and international interdisciplinary and intergroup collaboration networks, and enhancing the expertise in new publications, will cause in more qualified research. Therefore, the purpose of this study was to map and analyze the co-authorship and thematic networks created between the years 2011 to 2016 by researchers of Kurdistan University of Medical Sciences. The present study was designed by the researchers of Kurdistan University of Medical Sciences to examine the status and process of co-authorship in various subject areas. In order to provide the necessary support conditions for further collaborations between researchers and subject areas at the university, this study will be effective.

The complexities of scientific activities have attracted researchers to networking and collaborative research which has exacerbated the phenomenon of co-authorship as the most significant form of scientific collaboration [5, 7]. At the same time, due to the importance of scientific collaboration, quantitative and qualitative study of such collaborations is also a topic that has been the subject of scholarly research for decades [6, 10-13]. A study of scientific collaboration between researchers was first examined by Price in the book "Great Science, Small Science" [14]. Since then, numerous studies have been conducted on co-authorship, thematic networks and scientific collaboration in thematic areas and database indexes in Iran [3, 5, 15-25] and abroad [30-26]. The present study intends to analyze the co-authorship indices via mapping co-authorship networks (collaboration index, degree of collaboration and collaboration coefficient) among researchers of Kurdistan University of Medical Sciences in the Science Citation Database between years 2011 and 2016.

Method

The present research community, which has been conducted via science survey approach, were all articles indexed in the Science Citation Database, from the years 2011 to 2016 which at least one of its researchers has organizational affiliation to Kurdistan University of Medical Sciences. The collection of information with the correct organizational affiliation was carried out on 2017, June 2, using the following search strategy in the advanced search section.

> **(OG = Kurdistan University of Medical Sciences) AND (documents type = Articles) AND (Indexes = SCI-EXPANDED Timespan=2011-2016)**

Recovered records (518 records) were stored in Full Record format in plain text files, with a .txt and .isi suffix and then mapping of the networks were conducted using the CiteSpace and Gephi software and network analysis using the Gephi and Excel software. Given the total number of researchers in each year, we had to choose the threshold. The threshold limits the number of network nodes based on the number of citations received, eliminates weak relationships, so maintains essential nodes, and network analysis becomes more accurate. After examination of the various thresholds, the threshold 3.3.20 was chosen. The threshold values are respectively from left-to-right indicates the number of citation, co-citation and cosine coefficient of co-citation. In the maps, the number of nodes is researchers who passed through these thresholds (For example, between years 2011 and 2016, 55 nodes (author) have a co-citation cosine coefficient of 20 and the value of 3, and more than 3 are number of citation and co-citation). Then, the collaboration index, the degree of collaboration, and the collaboration coefficient were calculated first for each year and then in total, according to the formula of the indices and through the Excel software.

* The collaboration index (CI) represents the average number of authors per article and is calculated as follows[1]:

$$CI = \frac{\sum_{j=1}^{K} j * f_j}{N}$$

* The degree of collaboration (DC) represents the ratio of articles with several authors. The value between zero and one, which gives the single-authored articles rank zero and articles with higher number of authors higher rank and are calculated by the following formula[2]:

$$DC = 1 - \frac{f_1}{N}$$

* The collaboration coefficient (CC) indicates the ratio of collaboration among researchers. It should be noted that the more this index goes toward one, the degree of collaboration is higher

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1. f_j =Number of articles with j authors published in a given time period in one area /N = The total number of articles published during the same period in that area /K = total number of authors per article in one area.

2. f_j=Number of articles by single author /N = total number of articles

and the index toward zero indicates the priority of single-authored articles. This index is calculated as follows[1]:

$$CC = 1 - \left\{ \sum_{j=1}^{k} \left(\frac{1}{j} \right) F_j / N \right\}$$

In order to analyze the research data, Histcite and Excel software were used.

Findings

The number of scientific publications of Kurdistan University of Medical Sciences indexed in the science citation database between the years of 2011-2016 was recorded. In the period under examination, the highest amount of scientific publications was related to the articles of 5 authors with 119 papers (22.97%) and the number of single- authored articles with 4 papers (0.99%) had the least frequency among the articles studied.

Table1- Average of Cited per Paper among the Scientific Publications of Kurdistan University of Medical Sciences in the years 2011-2016

Year of Publication	2011	2012	2013	2014	2015	2016	total
Number of citations	395	255	468	1013	2516	267	4914
Number of articles	36	40	59	83	111	189	518
average of cited per paper	10.9	6.4	7.9	12.2	22.7	1.4	9.48

The total numbers of citations received in the 518 articles of the Kurdistan University of Medical Sciences in the years 2011-2016 were 4914 citations and the average of cited per paper was 9. Scientific publications of 2015 with 22.7 and 2014 with 12.2 citations received the highest average citation received, and scientific publications of 2016 with 1.4 had the lowest average citation per paper (Table 1).
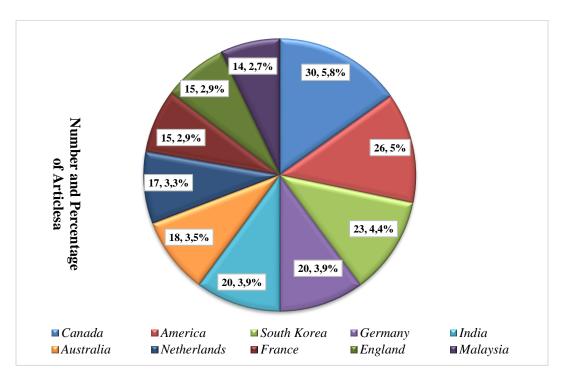
Among the high-producing researchers of the Kurdistan University of Medical Sciences, "Maleki", "Gharibi" and "Hassanzadeh" ranked first to third, and the most prominent researchers in the articles for citation in the Kurdistan University of Medical Sciences were, "Gapta", "Amini" and "Kaol".

Table 2 - Co-authorship Indices in Kurdistan University of Medical Sciences in the Years 2011-2016

Year of Publication	2011	2012	2013	2014	2015	2016	Total Years
Collaboration index	5.41	5.15	5.71	6.18	5.76	5.75	5.66
Degree of Collaboration	1	1	0.97	1	0.99	0.99	0.99
Collaboration coefficient	0.97	0.98	0.98	0.99	0.98	0.98	0.98

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1. f_j=The number of articles with j authors published in a given time period in one area /N = The total number of articles published during the same period in that area /A = The number of authors per article in one area.

The collaboration index in the years under review was 5.66 and the average number of researchers per article was approximately 6 people (5.66).The degree of collaboration was 0.99 and the collaboration coefficient was 0.98 (Table 2).
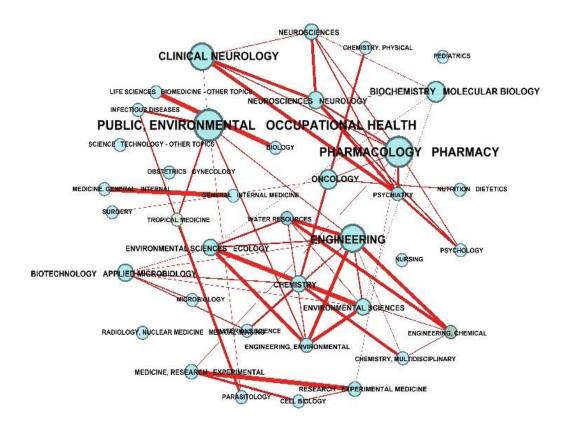

Figure 1- Countries with the Highest Collaboration in Publications of Kurdistan University of Medical Sciences in Years 2011 to 2016

Canada with 30 paper and 5.8 percent of co-authorship international papers has the highest collaboration with Iranian scholars. After Canada, the United States with 26 paper (5%) is ranked second and South Korea with 23 paper (4.4) ranked third (Figure 1).

The co-authorship network of researchers from Kurdistan University of Medical Sciences during the years 2011 to 2016 consisted of 55 nodes and 98 links. Salehi, Akhondzadeh, Rezaie, Gharibi, Tabrizi, Nadafi, Maleki, Hosseini, Farzadfar and Amini, were the researchers of the highest centrality of degree. Gharibi, Hakhamaneshi, Nadafi, Jalili, Nikkhoo, Maleki, Hassanzadeh, Ghaderi, Alayi and Darai, had the most centrality of betweeness in the co-authorship network of researchers in the Kurdistan University of Medical Sciences during the years 2011 to 2016. Akhundzadeh, Tabrizi, Rezaie, Salehi, Farrokhnia, Hosseini, Yeketaz, Ashrafi, Modbernia and Amini also had the most co-authorship relationships in the co-authorship network of researchers of Kurdistan University of Medical Sciences during the years 2011 to 2016.
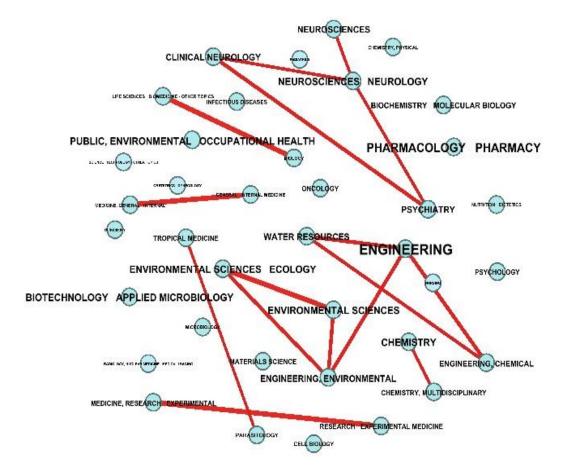
The Kurdistan University of Medical Sciences articles thematic network consists of 38 nodes and 61 links from 2011 to 2016. Engineering; pharmacology and pharmacy; public health;

occupational health; neuroscience and neurology; biomedical microbiology; chemistry; biotechnology; ecology and the environment; water resources and clinical neurology had the highest centrality of degree.

Figure 1. Thematic Network of Articles of Kurdistan University of Medical Sciences during the Years 2011 to 2016 Based on the Centrality of Betweeness Index

Larger circles with more prominent letters represent subjects which had higher betweeness centrality. Pharmacology and Pharmacy; Public Health; Occupational Health; Tumorology; Molecular Biology; Clinical Neurobiology; Engineering; Chemistry; Biological Microbiology; Neuroscience and Neurology; Biological Sciences; Ecology and Environment had the highest betweeness centrality (Figure 1).

Figure 2. Thematic Network of Articles from Kurdistan University of Medical Sciences during the Years 2011 to 2016 based on the strongest co-thematic relationships (16 stronger relationships)

Red lines represent the strongest co-thematic relationships. Engineering; Neuroscience and Neurology; Environmental Sciences; Psychiatry; Pharmacology and Pharmacy; Biological Sciences; Environment and Ecology; Clinical Neurology; Chemistry; Water Resources had the highest co-thematic relationships in the authorship network of Kurdistan University of Medical Sciences researchers during the years 2011 to 2016 (Figure 2).

Discussion and Conclusion

According to the findings of the study, the number of scientific productions of Kurdistan University of Medical Sciences during the studied years was 518 papers with 4914 citations. The researchers of Kurdistan University of Medical Sciences tend to write articles with more than 5 authors (119 papers) and articles by a single author have made up a small percentage of articles in these years which indicate the fact that there is sufficient potential as a ground for collective scientific participation. The examined researches [15, 31-40], same as the present study, confirm the willingness of researchers in the fields of medicine and paramedics to co-authorship and multiple authorship patterns. In studies of Shekhofteh et al. [31] and Basir Ghafouri et al. [32], as in the present paper, the largest amount of collaboration in scientific publications was related to

articles with more than five authors in pharmacology, pharmacy and medicine, respectively. Investigating the pattern of scientific collaboration among Kurdistan University of Medical Sciences researchers in Scopus Citation Database by Rasoulabadi et.al [35] indicated that the collaborative model of four or five authorship was the dominant pattern among the researchers. In another study, based on the results of the Hayati and Didgah [34], the pattern of co-authorship of the articles in the journal of "Research in Medicine" was also a four-authored model [38].

The development of higher education in the country and the effective presence of research policies that have led to an increase in the number of scientific publications have provided the field more than ever for the publication of scientific articles. This issue also affects the status of the co-authorship pattern [35]. The results of the research indicated that the collaboration index in the studied years was 5.66, the degree of collaboration 0.99 and the collaboration coefficient was 0.98 which clearly indicate an increase in the willingness to co-authorship and the growing trend for scientific collaboration among researchers of Kurdistan University of Medical Sciences, especially in 2016. Calculating the collaboration coefficient in thestudy of Heydari and Safavi on Medical Sciences Articles [35] and the research of Osareh in the field of pharmacology and pharmacy articles indexed in the Science Citation Database [40] also yielded similar results to this study with the difference that the growing trend of willingness to scientific collaboration in Kurdistan University of Medical Sciences has accelerated pace and intensity with respect to the two mentioned studies.

In the mapped thematic network from the research topics, given the centrality indices, Environmental Health, Public Health and Occupational Health had the highest centrality of degree. In the sense that this subject area has more communication and networking and is more influential. With some reflection, it can be observed that this is due to the long course of the School of Health, the existence of the Environmental Health Research Center at this faculty and the ability of researchers in this field at Kurdistan University of Medical Sciences. Overall, based on the findings of this study and the research of Rasoulabadi et.al [35], which were conducted on scientific products of researchers of Kurdistan University of Medical Sciences, it can be concluded that the level of scientific collaboration and collaboration of researchers varies in different subject areas and in different situations, and the desire for team collaboration among researchers of some fields is more than others. Another point which can be understood from the thematic network is the result of centrality of betweeness examination; that indicates the importance of pharmacology and pharmacy in terms of positioning and information transmission in the network and we can conclude that this between fields has a large number of other nodes and the communication paths of other nodes pass through it.

According to the findings of this study and the research by Rasoulabadi et al. [35], Kurdistan University of Medical Sciences researchers are keen on national collaborations more than international collaborations. Therefore, strengthening incentives and encouraging policies, organizing workshops and periodic reports, creating specialized fields and team collaboration, setting up faculty and university collaboration networks to create and enhance scholarly collaborations and creating co-authorship platforms will enhance quality and quantity of the scientific publications of the university and researchers. Considering the high level of scientific

and internal co-authorship collaborations and low international scientific collaborations among researchers of Kurdistan University of Medical Sciences, it seems that the university's greater attention to planning and policy making for researchers is to use study opportunities abroad, participating in national and international seminars can lead to increased transnational, international and national partnerships. Considering that one of the indicators of entrance into international ranking systems is the level of international and national scientific collaborations of university researchers, this issue will also contribute to the entry and promotion of university rankings in international and national rankings. It is recommended that researchers with the highest indexes of centrality and highest citation and publications (centrality of degree and betweeness) be introduced and encouraged due to creation of information flows in the university's co-authorship networks. On the other hand, given the high level of scientific collaboration and co-authorship among researchers of Kurdistan University of Medical Sciences, it is recommended to create the necessary grounds for the initiation and consolidation of international and national collaborations and the creation of scientific and expert groups.

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