Original Article

Social Network Analysis of Iranian Researchers on Medical Parasitology: A 41 Year Co-Authorship Survey

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Abstract

Background: The aim of this study was to survey the Iranian Parasitology researchers' performance, and analyse and visualize the scientific outputs of their co-authorship network.

Methods: This study was conducted using scientometric method and social network analysis (SNA). The data extracted from the Web of Science (WoS) databases in July 10th 2014. Totally, 1048documents of all types in research area of Parasitology during 1972-2013 by Iranian researches retrieved. The co-authorship map was drawn utilizing NETDRAW, Coauthor.exe, and UCINET softwares and was analysed based on SNA measures.

Results: The researchers' co-authorship network consisted of 78 authors and its density degree is 0.57. "Mohebali" ranked top in all of centrality measures.The most of the publications were related to 2012, "Mohebali" with about 9% of all documents was the Iranian most prolific author in Parasitology field. The Iranian researches have published mostly (266 documents) in "Iranian Journal of Parasitology", and the most of the documents belong to "Tropical Medicine" subject field. The most of Iranian researchers' scientific cooperation was performed with England and United States.

Conclusion: Bringing forth density degree (is 0.57) showed that this network has an almost medium density. Indeed, the authors have had relations in moderate level with each other in the network. The findings of this study can be identified aspects of scientific collaboration, and help policy makers of Parasitology field research.

Introduction

Nowadays collaboration is a significant aspect of the research community and the most common symbol of collaboration is co-authorship.Co-authorship among researchers makes a type of social network which is called co-author network (1).

Co-authorship networks are a main type of social networks used broadly to characterize the structure of scientific cooperation and the situation of individual researchers. Although slightly alike to the much surveyed citation network (2-4), co-authorship insinuates a much stronger social relation than a citation. Citations can happen without the authors to know each other and can cover over time. Co-authorship alludes to a collegial and temporal relation that puts it more expressly in the domain of Social Network Analysis (SNA) (3).

"Social network is a network of relationships which is made as a result of cooperation between scientists, organizations, countries, and so on in common or different majors and their interrelationships" (1, 5). SNA assumes that "people or groups are connected together by social relationships, forming a social network as a representation of relationships among them" (1, 6). A Co-authorship network is a social network wherein the authors are connected together by a devious route via taking part in one or more publication (7). Several methods and measures are applied in SNA; however, when the aim is to investigate status of an actor in the network, the centrality measures should be applied. It means the situation of an actor is shown generally by its centrality (1, 3).

"Degree centrality of a node is defined as the total number of edges that are adjacent to this node". Degree centrality displays the simplest prototyping of the concept of the centrality whereas it measures just how many linkages connect authors to their immediate neighbouring in the network (3, 8, 9). "Degree centrality is equal to the number of connec-

tions that an actor (a node) has with other actors" (10), "which is the number of links going into or coming out of a node in a network" (1, 11).

"Closeness centrality focuses on how close an actor is to all other actors. It is measured as a function of mean geodesic/shortest distances" (12). While authors may be well linked to their immediate neighbours, yet be part of a partly isolated group. Although locally well linked, overall centrality is little. Closeness centrality thus extends the description of degree centrality with a focus on that an author so close to all the other authors. To count closeness centrality of a node in the network should specify its shortest distances to all the authors and invert these values to a metric of closeness. A central author is therefore specified in the networks with many, short links to the other authors (1, 3, 8, 13).

Betweenness centrality expresses a various operationalization of centrality. It is on the bases of specifying how often a specific node is found on the shortest route between each pair of nodes in the network. Nodes that are frequently on the shortest route between other nodes are supposed highly central since they administrate the network's flow of information. Betweenness centrality can be utilized in detached networks; although, can create a large number of nodes with zero centrality, given that many nodes may not operate as a bridge in the network (1, 3, 8). This measure is on the bases of the number of shortest routes crossing through an actor. Actors with a high betweenness perform the function of linking various groups, as 'middlemen' (1, 10).

Many researchers studied Iranian co-authorship networks in various fields, including medical sciences such as emergency medicine (14), medicine (15) and psychology and psychiatry (16), but as far as we found out, none of them investigated network of researches in Parasitology. Parasitology is a sci-

entific field in which many universities have student in different degrees (17) and many researches base their researches on, so we decided to study the works of these researches in international level.

The aim of this research was to assess the Iranian Parasitology researchers' performance from 1972 through 2013 based on the web of Science databases, and analyze and visualize the scientific performance of their co-authorship network according to their scientific publications.

Methods

Data were collected from Web of Science (WOS) in July 10th, 2014. Iranian publications indexed in A&HCI, SSCI, SCI-EXPANDED, CPCI-SSH, CPCI-S, until 2013 refined by "Research Areas" and all documents in Parasitology chosen to analyse. The first document in this field belongs to 1972. As a result, the population of this study consists of all Iranian publications in the Parasitology field during 1972-2013. Totally, 1048 documents were re-

trieved in all types. The raw data were saved in Plaintext format files that each of them encompasses 500 records. The initial analysis was performed via WOS analysis section. For making the social network of Iranian Parasitology researchers' co-authorship, all the files merged into a single file, and then by using Coauthor.exe co-author matrix was constructed, using NETDRAW and UCINET softwares the co-authorship map was drawn and then was analysed based on SNA measures Including centrality (closeness, betweenness, etc.).

Results

Growth of outputs

Investigating of the publishing date of outputs showed that there isn't any publication before 1997 and the first one belongs to this year. The most outputs are in 2012 and the lowest are in 1972, 1976, 1983, 1984, 1992 and 1997 with just 1 output (Fig. 1).
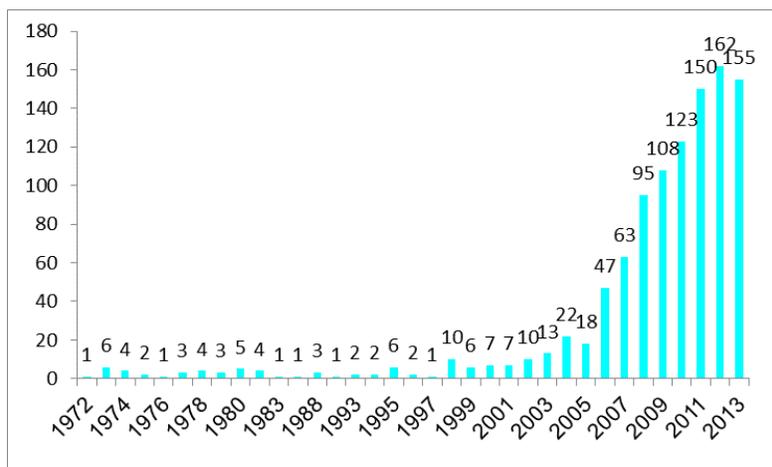

Fig. 1: Growth of Iran's authors in the parasitology outputs 1972-2013

Prolific authors

Tale 1 shows the rank list of the top ten Iran's authors in the Parasitology field based on the publication numbers. As shown,

"Mohebali M" was the most prolific author, with 85 papers. "Vatandoost H" and "Oshaghi MA" with 52 and 41 papers ranked second and third respectively.

Collaboration of countries

There were 54 countries/territories collaborated with Iran's authors in the Parasitology field during 1990-2013. Out of these 54 countries, England with 38 documents had the highest number of collaborations, followed by USA and Germany with 28 and 19 documents respectively. The top 10 countries/territories were ranked based on the total number of collaborations can be seen in Table 2.

Preferred journals

The Iranian researchers have published their papers in 44 scientific journals. Among these journals, ten top journals published 35 or more papers, which are about 80% of all papers. "Iranian Journal of Parasitology" was the top journal by publishing 266 documents, followed by "Parasitology Research" and "Iranian Journal of Arthropod Borne Diseases" with 117 and 80 documents respectively. Theses top 10 journals are shown in Table 3.

Research categories in Parasitology

Examination the sub-subject of Parasitology has been interested by Iranian researcher showed that "Tropical Medicine" is ranked in the top of the list. These rankings are displayed in Table 4.

Table1: Top 10 Prolific Iran's authors in Parasitology 1972-2013

Authors	records	% of 1048
MOHEBALI M	85	8.111
VATANDOOST H	52	4.962
OSHAGHI MA	41	3.912
KAZEMI B	39	3.721
MOBEDI I	35	3.34
KIA EB	32	3.053
KHAMESIPOUR A	32	3.053
HAGHIGHI A	31	2.958
ZAKERI S	30	2.863
RAEISI A	30	2.863
KESHAVARZ H	30	2.863

Table 2: Top 10 countries, which have the most collaboration with Iran's authors in Parasitology 1972-2013

Countries/Territories	records	% of 1048
IRAN	1048	100
ENGLAND	38	3.626
USA	28	2.672
GERMANY	19	1.813
SPAIN	13	1.24
FRANCE	13	1.24
CANADA	13	1.24
AUSTRALIA	12	1.145
SCOTLAND	11	1.05
JAPAN	11	1.05
ITALY	11	1.05

Table 3: Top 10 most preferred journals with Iran's authors in parasitology 1972-2013

Source Titles	records	% of 1048
IRANIAN JOURNAL OF PARASITOLOGY	266	25.382
PARASITOLOGY RESEARCH	117	11.164
IRANIAN JOURNAL OF ARTHROPOD BORNE DISEASES	80	7.634
EXPERIMENTAL PARASITOLOGY	69	6.584
VETERINARY PARASITOLOGY	65	6.202
ANNALS OF TROPICAL MEDICINE AND PARASITOLOGY	56	5.344
ACTA TROPICA	52	4.962
TROPICAL BIOMEDICINE	49	4.676
JOURNAL OF HELMINTHOLOGY	35	3.34
JOURNAL OF ARTHROPOD BORNE DISEASES	35	3.34

Co-authorship pattern

Collaboration is an intense kind of interaction that permits to efficient communication also the sharing of competency and other resources (18). In order to calculate Collaborative Coefficient (CC) we have used the formula below (19):

Table 4: The research categories with Iran's authors in Parasitology 1972-2013

Web of Science Categories	records	% of 1048
PARASITOLOGY	1048	100
TROPICAL MEDICINE	229	21.851
PUBLIC ENVIRONMENTAL OCCUPATIONAL HEALTH	185	17.653
VETERINARY SCIENCES	66	6.298
INFECTIOUS DISEASES	47	4.485
ZOOLOGY	45	4.294
IMMUNOLOGY	12	1.145
BIOCHEMISTRY MOLECULAR BIOLOGY	3	0.286
MICROBIOLOGY	2	0.191
VIROLOGY	1	0.095

$$CC = 1 - E\,[1/X]$$
$$= 1 - \Sigma\,(1/j)\,P(X{=}j)$$

$$1 - \frac{f_1 + (1/2)f_2 + \ldots + (1/k)f_k}{N}$$

$$= 1 - \frac{\sum_{j=1}^{k}(1/j)f_j}{N}$$

Collaborative Coefficient (CC) is a number between 0 and 1, CC 0 means that a set of document has no collaboration and a number nearest to 1 means highest collaboration.

To get CC, co-authorship pattern of Iranian researchers in the Parasitology field in Web of Science during 1972-2013 was investigated. Five or more author-pattern was the prevailing pattern (Fig. 2). Regarding this pattern and using mentioned formula, collaborative coeffi-

cient is equal 0.7, which means almost high collaboration between the authors.

Co-author Network

There were 500 authors involved in the 1048 papers in the field of Parasitology during 1990–2013 and 152 of them had at least one collaboration with others. Due to have a clear and distinct map of the co-authorship network, we use frequency thresholds and just authors with a collaboration threshold of >=20 were regarded. As a result, the co-authorship network contains 78 nodes (authors).

Figure 3 shows the co-authorship network of Iran Parasitology researchers in Web of Science during 1972-2013.
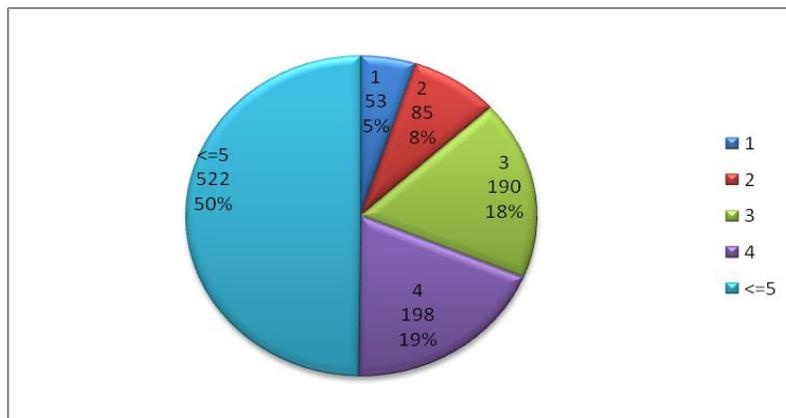

Fig. 2: Co-authorship pattern of Iran researchers in the Parasitology 1972-2013

As shown in Fig. 3; 78 authors constituted this network with 0.57density. Otte and Rousseau defined density as "an indicator for the level of connectedness of a network. It is given as the number of lines in a graph divided by the maximum number of lines (the case where every author is connected to every other one)" (10). Therefore, it is a relative measure with values between 0 and 1. The degree density of the network (0.57) shows

that 57% of total potential and possible relationships in the network were done so the network has a medium density. Indeed, the authors (nodes) in this network have had connections with one another in a moderate level. Three centrality measures (Degree centrality, Betweenness centrality and Closeness centrality) were calculated for the network under study.
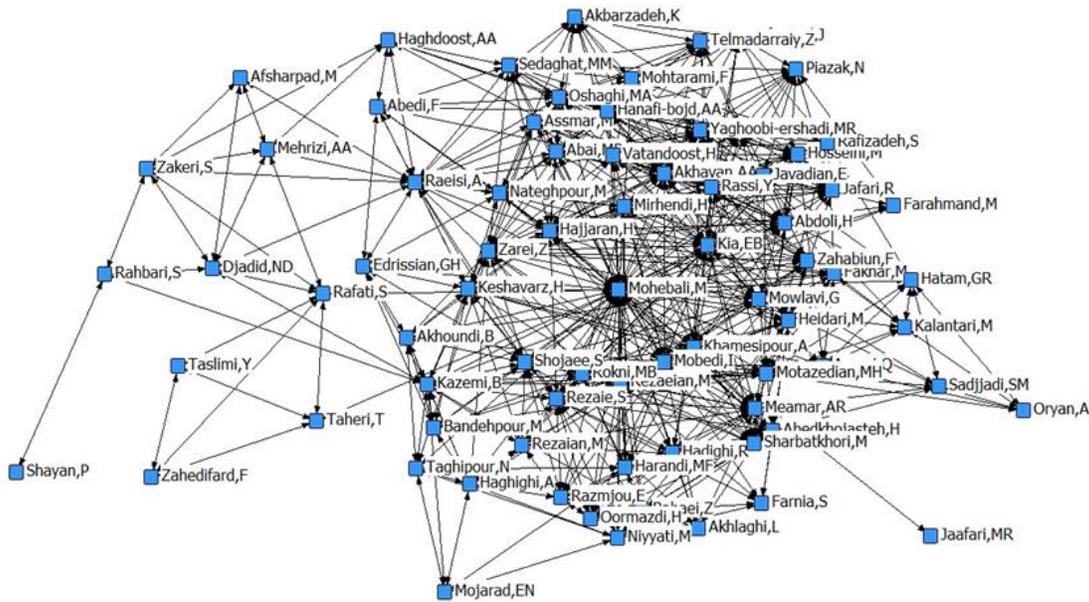

Fig. 3: Co-author network of Iran researchers in Parasitology 1972-2013

Degree centrality

Degree centrality in the co-authorship network means that the most central authors are the ones who have the most connections to other authors in the network and are therefore the most active in the sense of collaboration (20). According to degree centrality, which showed in the Table 5, "Mohebali, M" (257) have the highest co-authorship frequency with others, followed by "Vatandoost" (133) and "Oshaghi" (123).

Betweenness centrality

Betweennessis based on the number of shortest routes crossing through an actor.

Table 5: Degree Centrality of co-author map of Iran's authors in the Parasitology outputs 1972-2013

Rank	author	Degree Centrality
1	Mohebali, M	257
2	Vatandoost, H	133
3	Oshaghi, MA	123
4	Rassi,Y	113
5	Kia, EB	98
6	Raeisi, A	83
7	Akhavan, AA	83
8	Zarei, Z	78
9	Abai, MR	78
10	Rezaeian, M	76

Table 6: Betweenness Centrality of co-author map of Iran's authors in the Parasitology outputs 1972-2013

Rank	author	Betweenness Centrality
1	Mohebali,M	876.963
2	Raeisi, A	230.254
3	Kazemi, B	201.604
4	Kia, EB	118.066
5	Khamesipour, A	113.864
6	Rafati, S	106.836
7	Zarei, Z	91.883
8	Rassi, Y	84.636
9	Rezaeian, M	79.516
10	Rahbari, S	77.979

Table 7: Closeness Centrality of co-author map of Iran's authors in the Parasitology outputs 1972-2013

Rank	author	Closness Centrality
1	Mohebali, M	96
2	Kia, EB	131
3	Zarei, Z	132
4	Rezaeian, M	132
5	Vatandoost, H	132
6	Rassi,Y	132
7	Hajjaran, H	133
8	Mirhendi, H	135
9	Shojaee, S	136
10	Raeisi, A	137

High betweenness owner actors execute the task of linking various groups, as 'middlemen' (1, 10). As we can see in the Table 6, in the network under study "Mohebali, M" have the highest betweenness centrality, which means he is such a middleman in a network of Iran researchers in the research area of Parasitology in Web of Science during 1972-2013.

Closeness centrality

A high closeness of an author implies that he is linked to all other authors via a low number of routes or paths (1, 10). A central author is therefore characterized with many short relations to other authors in the networks (1, 3). Based on the Closeness centrality showed in the table 7, "Mohebali M" has the highest closeness in the whole network and "Kia EB" ranked second.

Discussion

Mapping of scientific publications is one of the fields, which belong to scientometrics that can investigate scientific publications from different aspects such as co-citations, co-words or co-authors etc. Co-authors networks show many points, from the rate of relatedness between authors in one field to forming the scientific networks.

Due to the importance of the collaboration in scientific works, many studies have investigated this issue in different levels (21) such as country level (22), university level (23), discipline level (14, 24) and journal level (25, 26). In this study, we have investigated Iranian publications in Parasitology field and the co-author map of them.

The number of publications in Parasitology field, as other scientific fields, which had investigated by scientometric studies, shows high growth rate.The three authors who ranked first to third based on the number of publications are "Mohebali M" "Vatandoost H" and "Oshaghi MA". All three authors are full professors in School of Public Health of Tehran University of Medical Science. The first author affiliates department of Parasitology and Mycology and two other one-affiliate department of medical Entomology and Vector control.

The findings of this research also showed that the most collaboration of Iranian researchers in Parasitology field was with England researchers. This result is somehow different with many studies in other fields that revealed that USA researchers collaborated with Iranian researchers more than other countries researchers did.

Investigating preferred journals shows that two Iranian journals, "Iranian Journal of Para-

sitology" and "Iranian Journal of Arthropod Borne Diseases" ranked first and third. These two international journals in this field make opportunities for Iranian researchers to publish more.

Collaborative Coefficient (CC) is a number between 0 and 1. For the papers under study, this number is .07. Hence the Iranian researchers have good collaboration in Parasitology field and half of the publications have 5 or more authors-pattern and just 5% of them have single-author pattern which is not consistent with the previous studies that showed two authors-pattern as prevailing one (16, 22).

In the Parasitology field, the co-author map of Iranian researchers includes 78 nodes with a density of 0.57, which is somehow an averaged density. According to the centrality, measures "Mohebali" ranked first in all of them. "Mohebali", "Vatandoost", and "Oshaghi" have the highest centrality degree respectively, so they are the centres of the map. Noteworthy here is that these researchers are ones with the highest number of publications too. The betweeness measures also show that "Mohebali" has the highest degree followed by "Raeisi" and "Kazemi". These researchers are the linked points of the map. In other words, they are the linkage bridge that linked the clusters of authors together. In closeness measure, "Mohebali" has the highest degree followed by "Kia". In other words, these researches have the lowest distance with others. As a conclusion, "Mohebali" is a key node in this map and play an important role in forming this co-author map.

Conclusion

Laboratory and department of Parasitology in Iran has established in 1938 in Tehran University of Medical Sciences (27), the first paper of Iranian researches in Parasitology returned to 1972 in web of science. As mentioned above, the number of publications in Parasitology field shows high growth rate. This growth can be caused by quantitative and qualitative development of universities, and reward system of universities in order to encourage the faculty member to publish, especially in English and international level.

Scientific collaboration leads to synergy that increases the quality and quantity of scientific publication in a field. The present study showed that the tendency to teamwork among Iran researchers in Parasitology exists. Some of the previous studies (25, 26) also got to conclude that among medical research scientific collaboration is almost at the high level.

The findings of this study can be identified aspects of scientific collaboration, and help policy makers of Parasitology field research.

Acknowledgement

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