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Visualization of collaboration in psychology: a case study of Iran

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Using bibliographic data extracted from the *Web of Science* (WoS) and social network analysis techniques, a network of co-authorship for psychology papers published by Iranian authors have been analyzed. The study covered the period from 1970 (the year WoS first included Iranian-authored papers) through the end of 2016. For this period, a total of 2,204 records were retrieved from WoS. Of this, 18.11% were single-authored papers, and 81.88% were multi-authored. The collaboration network has a density of 63%, which is above the average and shows that the network is relatively interconnected, with researchers collaborating on joint publications. Centrality closeness was 16.63%, and the co-authorship network betweenness centrality was 6.64%. The clustering coefficient was 0.82, and the centrality degree of network was 16.5%. Ghorbani, Zarrindast, and Moradi were the most productive and effective authors in the network.

Keywords: Co-authorship networks; Scientific collaboration; Psychology; Iran

Introduction

The last several decades have witnessed developments in information and communication technology that have led to major changes not only in the flow of scientific information but also in the entire landscape of research activities. In an attempt to respond to the changing scientific environment, scientists have improved research activities by increasing their collaboration on research projects and publications.

The social process of scientific collaboration is indeed complex. It is more than the simple interaction between individual scientists and their networks. Governments and governmental institutions are also part of the process. These institutions are potentially driven by different agendas for promoting international collaboration[1].

International collaboration has increased and expanded rapidly. According to a report prepared by the (British) Royal Society, international scientific collaboration has expanded on a global scale. The USA leads the world in research, producing 20% of the world's authorship of research papers, dominating world university league tables, and investing nearly US$400 billion per year in public and private research and development. The United Kingdom, Japan, Germany, and France each also command strong positions in the global league tables, producing high quality publications and attracting researchers to their world-class universities and research institutes. These five countries alone are responsible for 59% of all spending on science globally[2].

Collaboration brings significant benefits for researchers. It occurs for many reasons among researchers all over of the world, as publications' authorship statements often demonstrate. Studying research output as reflected in co-authorship networks provides insight into collaboration networks. One of the techniques for analysis of a co-authorship network is social network analysis (SNA), which is being increasingly applied to many studies in different fields.

Social network systems consist of two elements: nodes and edges between nodes. For the purposes of analysis, nodes can be individuals, companies, countries, etc., while edges refer to the interactions or relationships between the nodes. SNA uses graph theory based on statistical techniques to examine the structure of a network and to analyze the relations between the nodes within that network[3].

In addition, SNA analyzes the relationships between actors, here authors, show their location

within the network and the overall structure of the network. SNA generally applies some indicators at macro-level (density, clustering coefficient, network diameter, average geodesic distance) and micro-level (centrality closeness, betweenness, and degree) for each network. The degree centrality quantifies a network member's number of connections or in directed graphs the number of incoming ties (indegree) and outgoing ties (outdegree). Beyond the individual level, network members appear together in clusters with stronger in-group than out-group connections and consequently form the next mode: the group level. This latent social structure can be identified exclusively by means of SNA, which, comparable with a cluster analysis, determines the strongest connections within the social network. 'Density' reflects the overall connectedness within a network by relating the number of existing ties to the number of theoretically possible ties between all network members. Reciprocity specifies the number of mutual relationships by measuring the extent of bidirectional connections. 'Centralization' indicates the variance of centrality within a social network by determining the difference in the network members' number of connections (i.e., the degree centrality)[4].

SNA techniques are applied in many different research areas, especially in sociology and the social and behavioral sciences. Many researchers have collaborated on SNA studies to analyze interactions between the academics whose publications are found in the *Web of Science* (WoS)[5,6,7].

The present study likewise focuses on collaborative efforts; in this case, those of Iranian researchers in psychology whose publications are listed in WoS.

Review of literature

The co-authorship network has been studied from different aspects by many researchers. We review some recent studies on co-authorship networks and collaborations with a focus on studies using SNA techniques.

A Pakistan-based research study examined the association of co-authorship network centrality (degree, closeness, and betweenness) and the academic research performance of chemistry researchers in Pakistan. A non-temporal analysis using node-level regression showed a positive impact of degree and closeness and a negative impact of betweenness centrality on research performance. Temporal analysis using node-level regression (time 1: 2002–2005; time 2: 2006–2009) confirmed the direction of causality and demonstrated the positive association of degree and closeness centrality on research performance. Findings indicated a moderate role of gender on the relationship of both degree and closeness centrality with research performance for Pakistani female authors[5].

The assessment of authors' productivity in the *Journal of Research in Medical Sciences* showed that the highest rankings belonged to just five authors. Furthermore, analysis of co-authorship in the network demonstrated that in the betweenness centrality index, three authors had a good position in the network. Based on the shortest paths, they could be considered the network leaders, able to control the flow of information in the network compared with the other members. On the other hand, the key roles in the network according to the productivity and centrality indexes belonged to Iran, Malaysia, and United States. The co-authorship network of the journal had the characteristics of a small world network. In addition, the theory of six degrees of separation proved valid in the network[8].

Another Iranian-based study, this by Daneshmand, Forouzandeh, Azadi & Cheraghzadeh-Dezfuli (2015), reported on the quantitative and qualitative evaluation of hematological research output in the five Islamic countries with the highest number of publications from 1996 to 2013: Iran, Turkey, Malaysia, Saudi Arabia, and Egypt. The bibliometric study was carried out during September 2014 in the Blood Transfusion Research Center in Shiraz, Iran, and evaluated the quantity and quality of hematological research publications based on SCImago Journal Ranking, for the years 1996-2013. The authors used *hematology* as a keyword but placed no restriction on language or document type. The ranking and analyzing indicators included 'number of documents,' 'citable documents,' 'citation,' 'self-citation,' 'cites per document,' 'H-index,' 'cited documents,' and 'international collaboration.' The results showed that the five Islamic countries had published a total of 6914 documents in the field of hematology for the period in question. This number represented 0.248 % of the total documents on hematology produced globally. The number of publications and citable documents for the five countries had grown during the period and

that of the five, Turkey, Iran, and Egypt had the highest number of publications and citable documents. Furthermore, Turkey and Iran led in qualitative indicators such as the H-index and citations. The authors recommended that despite the considerable improvement in recent years, the five countries should provide additional support to their scientific institutes to further increase the quantity and quality of hematology publications[6].

Sarwar and Hassan (2015) reported on their study that used the *Scopus* database to analyze the scientific research landscape of the Islamic world. They assessed the research productivity, scholarly impact, and international collaboration across all science and technology areas over the period 2000–2011. While Turkey clearly led among the Islamic countries, Iran ranked second in terms of publication output. All the subject areas showed an annual increase in publications by more than 10%. The highest percentage of publications in the Islamic world was in the area of veterinary medicine. The authors also found that the top collaboration in the Islamic countries occurred chiefly within the countries themselves[9].

Wood and Feroz Khan (2015) used SNA techniques to examine research in the field of international trade negotiation. They constructed, visualized, and investigated the international trade networked knowledge infrastructure by analyzing 3074 publications, 1054 journal sources, 4,047 authors, 1516 organizations, 87 countries and keywords associated with the field of research. The network and ego-level properties—such as degree centralities, density, components, structural holes, and degree distribution—suggested that the international trade co-authorship network was relatively fragmented. Results showed that in terms of degree, betweenness, and eigenvector, the United States and the United Kingdom occupied the highest positions, with France and Germany also holding places of importance. The results demonstrated the centrality or closeness of a country in the network to other institutions and its ability to control the flow of information within the network[7].

A study by Maisonobe and colleagues analyzed the evolution of the world collaboration network both at the domestic and international levels during the 2000s. Using data from the Science Citation Index Expanded, authors' addresses were geo-localized and grouped by urban areas. Data suggests that interurban collaborations within countries increased together with international linkages. In most countries, domestic collaborations increased faster than international collaborations. Even among the top collaborating cities, sometimes referred to as "world cities", the share of domestic collaborations has gained momentum. Their results suggest that, contrary to common beliefs about the globalization process, national systems of research have been strengthening during the 2000s[10].

Fung and Wong (2017) have explored the intensity of research being done in traditional medicine and have identified China, Hong Kong, Taiwan, South Korea, Malaysia and Japan as countries who are actively researching traditional medicine. The selected economies have accounted for more than 40% of the world total publication share (based on ISI data) in the past eight years, peaking at roughly 50% and has been one of the leading regions for the growth and modernization of traditional medicine. The authors identified three network models that describe the outcomes of the innovation strategies in place, a network-based extension of previous studies. Their notion of three separate network models has been demonstrated in China (PRI-centric), Hong Kong (university-centric) and Japan (firm-centric) with each showing their own characteristics in terms of resource allocation and contribution to research volume and capability. Of the various case studies highlighted, the university-led model (Hong Kong) has shown the highest exposure to international collaboration, particularly with key actors in the mainland[11].

A study on the professional network and scientific productions in six academic fields in U.S revealed that both exploration and exploitation are necessary strategies for scientific production. A strictly explorative approach, which results in both gaining and losing more ties, can simultaneously boost grant dollars and hurt publications. And while an exploitation strategy may result in short term gains in productivity, it may limit the innovativeness of future research. These results are driven by the costs and benefits associated with each strategy. Exploitation strategies take advantage of known processes, existing competencies, and established norms to lower the transaction costs associated with collaboration[12].

The literature review shows that SNA have been vastly used to investigate the co-authorship and

collaboration networks structure in many studies. More recent studies applied this technique to provide more insights into the nature and structure of collaboration networks.

Objectives of the study

- To examine psychology publications in WoS by authors affiliated with Iranian institutions (1970-2016);
- To depict the co-authorship network in psychology publications by using SNA metrics at macro-level including density indicator, the clustering coefficient, and the mapping of co-authorship network; and
- To examine the co-authorship network in psychology publications by using SNA metrics at micro-level including the centrality indicators (degree, closeness, and betweenness)

Methodology

This research examines the association of co-authorship network centrality (degree, closeness, and betweenness) and the research performance of psychology researchers affiliated with Iranian institutions. Using SNA metrics and visualization techniques, we were able to establish the structural characteristics of the Iranian co-authorship community and to identify the influential members of the co-authorship network. The study covered the period from 1970 (the year the WoS first included an Iranian-authored paper in psychology) through the end of 2016. Data were obtained by multiple searches in the *Science Citation Index*, with the use of the keyword *Iran* in the country field for the searches. Advanced searches through different fields in the database were used to find any scientific publications with affiliations to Iranian institutes or universities. The following software products were applied for data analysis and interpretation: HistCite, VOSviewer, UCINet, Excel, Bibexcel. Data were pre-processed before entry into the aforementioned software.

Analysis

A total number of 2,204 records for publications on psychology having authors affiliated with at least one Iranian institution were retrieved from the WoS. The WoS first included a publication on psychology by an Iranian author in 1970. Fig. 1 shows the rate of publications in WoS increased 11.8% yearly. This represents significant growth.

Authors per published paper

Table 1 shows the number of authors per published article. Single-authored papers accounted for 18.11% of the total publications and multi-authored papers accounted for 81.89%. Papers with 2, 3, and 4 authors represented 24.88%, 21.33%, and 16.52% of the total, respectively. A surprising finding was that 38.1% of the papers had more than 10 authors, showing the

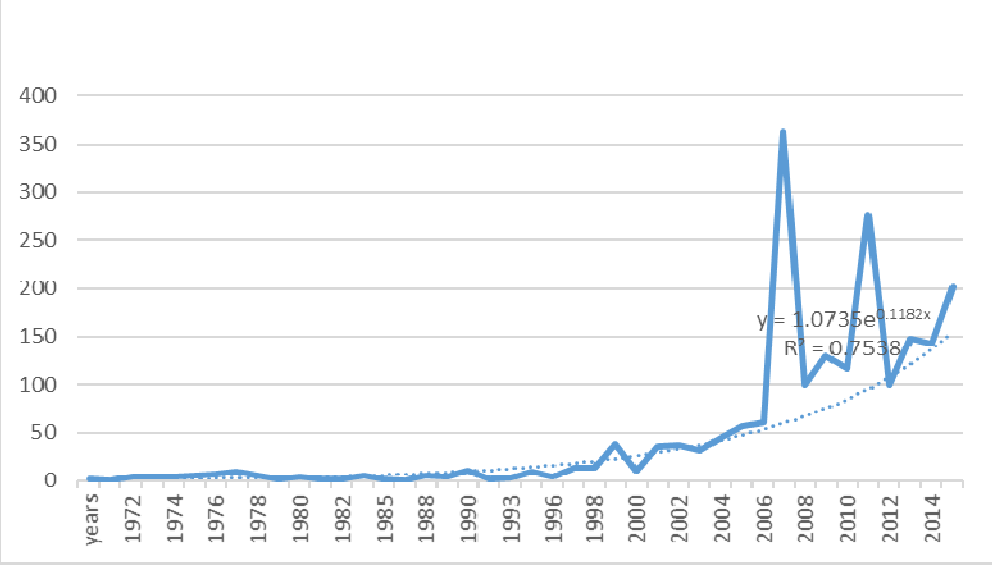

Fig. 1—Psychology publications by Iranian authors in WoS (1970-2016)

Table 1—The number of psychology papers by the number of co-authors

Number of authors	Number of papers	Percent
1	388	18.11
2	533	24.88
3	457	21.33
4	354	16.52
5	191	8.91
6	75	3.50
7	45	2.10
8	32	1.49
9	17	0.79
10	8	0.46
11+	880	38.1
Total	2204	100

Table 2—Iranian institutions producing the most psychology publications listed in WoS (1970-2016)

Sl. no.	Institutions	Total papers	Local Citation	Global Citation
1	University of Tehran	242	151	1164
2	Tehran University of Medical Sciences	215	85	1970
3	Islamic Azad University	212	36	658
4	University of Isfahan	107	3	149
5	University of Shiraz	87	8	384
6	Shiraz University of Medical Sciences	64	31	444
7	Shahid Beheshti University	63	4	129
8	Shahid Beheshti University of Medical Sciences	60	10	162

great amount of collaboration among Iranian authors in the field of psychology.

Most productive institutions

Table 2 shows the most productive Iranian institutions and their local and global citation in the field of psychology. As can be seen, University of Tehran was most productive, followed by the Tehran University of Medical Sciences, the Islamic Azad University, the University of Isfahan, University of Shiraz, the Shiraz University of Medical Sciences, the Shahid Beheshti University, and the Shahid Beheshti University of Medical Sciences. While the University of Tehran tops the list, the Tehran University of Medical Sciences has greater global citation. Table 2 also shows that both University of Shiraz, the Shiraz University of Medical Sciences have received more global citations in comparison with other top universities.

Collaborating countries

Figure 2 shows the collaborative countries with Iran for co-authorship in psychology publications in WoS. The analysis of data shows that nearly fifty percent (1085 out of 2204 papers) of the papers coauthored by Iranian researchers. The other fifty percent (1119 papers) of the papers have been authored with international researchers from 89 countries. The USA tops the list with 8.84 percent (195 papers) and England with 4.58 (101 papers) percent of total publications.

Co-authorship network

A macro-level analysis of the co-authorship network gave the density indicator, the clustering coefficient, and a mapping of co-authorship network. These are shown in Figures 3, 4, and 5, respectively.

The density indicator of the collaboration network was 63%, meaning that 63% of possible collaborations had occurred among Iranian researchers, while 37% did not. This finding indicates that probability of possible collaboration in future is 37%, while the network is relatively interconnected now because the density indicator stands above the average.

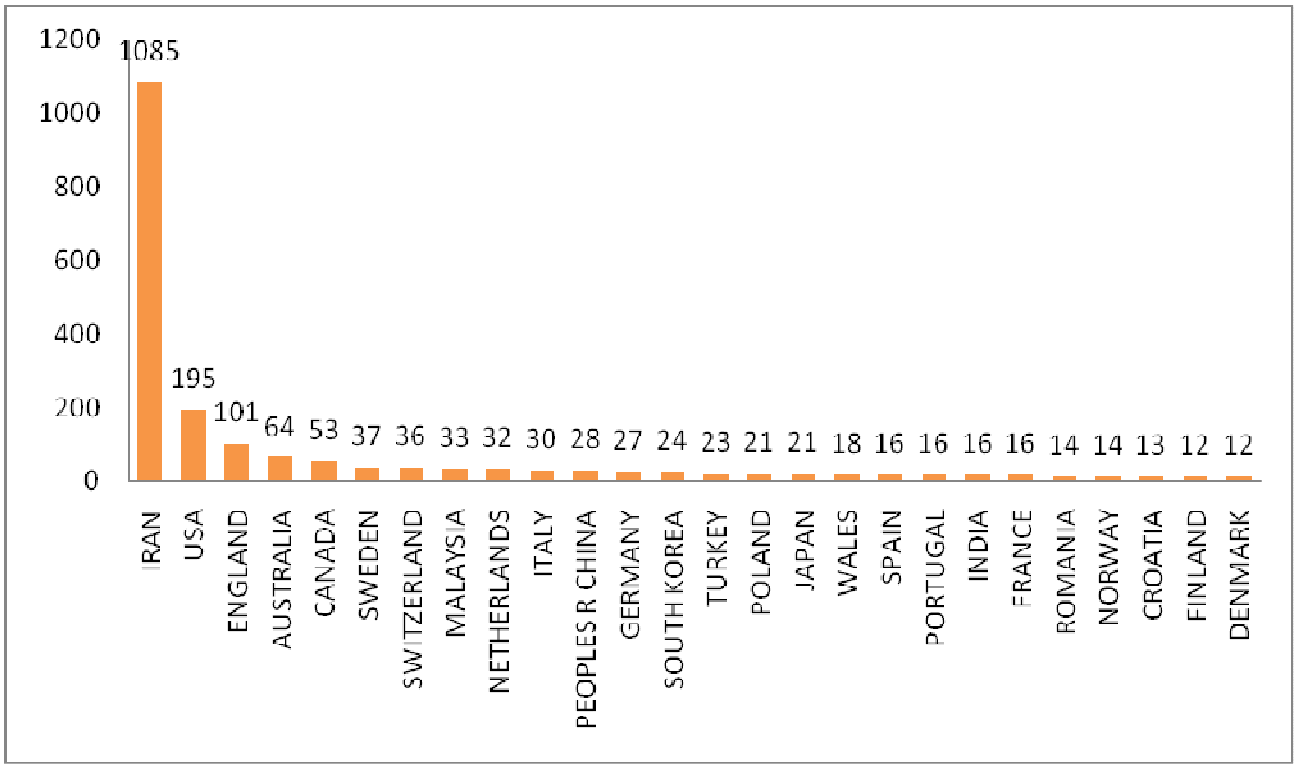

Fig. 2—Collaborative countries with Iran in psychology publications in WoS (1970-2016)

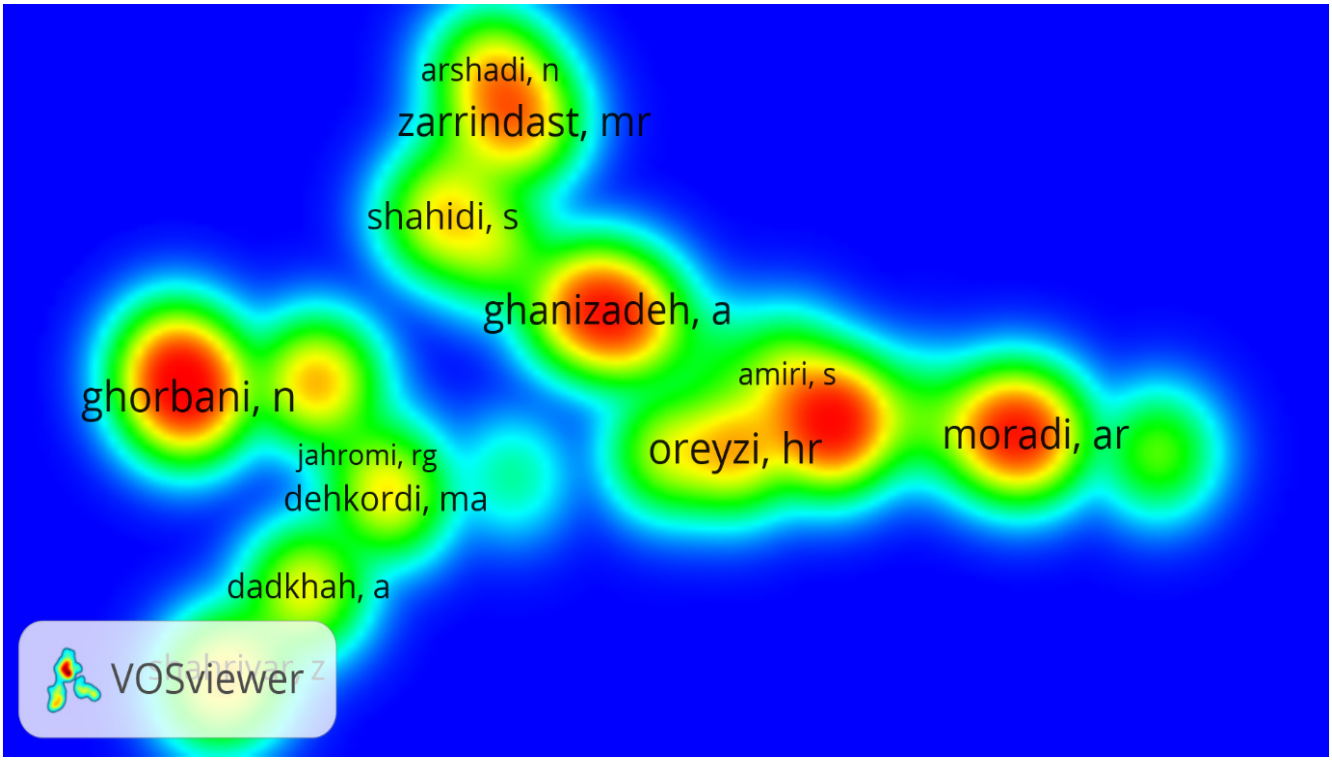

Fig. 3—Density indicator for psychology publications by Iranian authors in WoS (1970-2016)

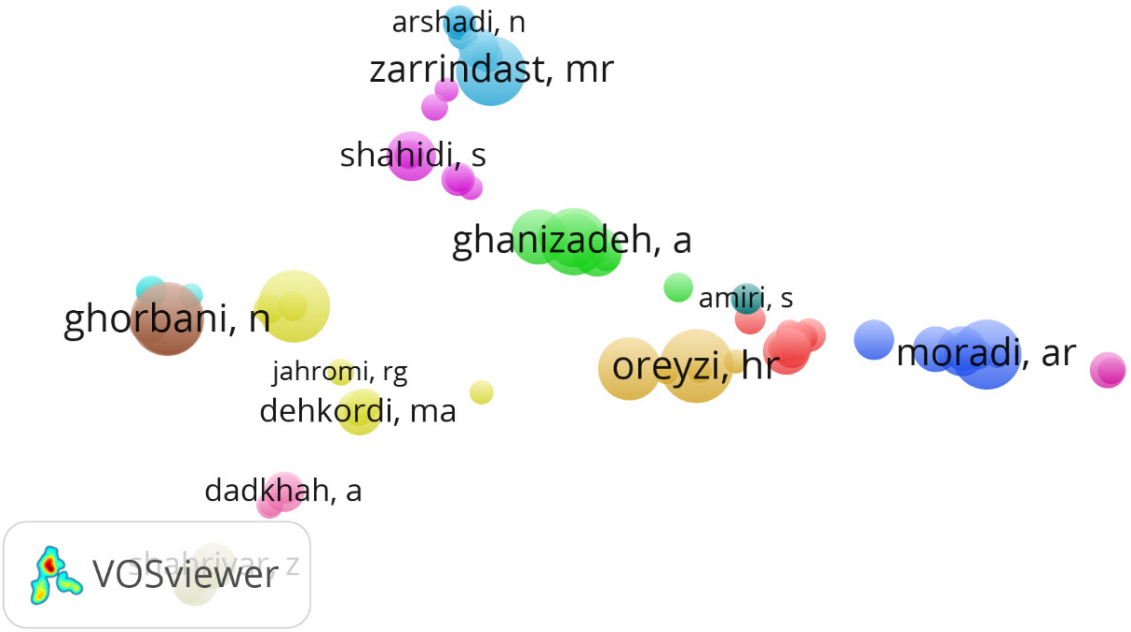

Fig. 4—The clustering coefficient of psychology publications by Iranian authors in WoS (1970-2016)

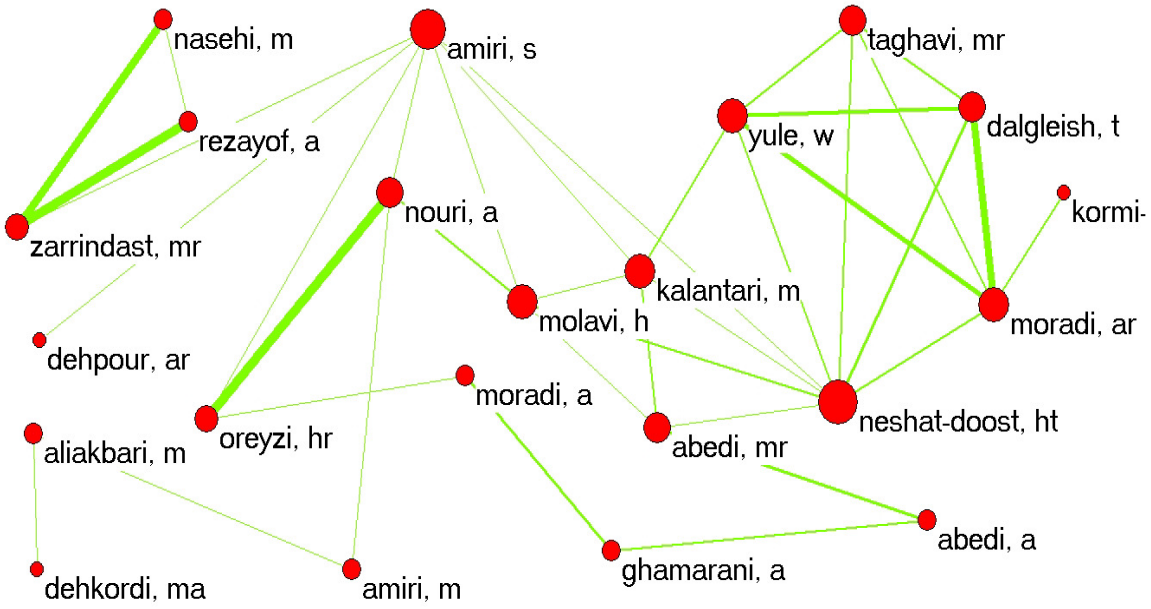

Fig. 5—Map of the co-authorship network for psychology publications by Iranian authors in WoS (1970-2016)

The clustering coefficient was 0.82, indicating a high tendency toward scientific relationships

A micro-level analysis of the co-authorship network and the centrality indicators (degree, closeness, and betweenness) yielded the results shown in Tables 2, 3, and 4.

An analysis of the co-authorship network centrality (degree, closeness, and betweenness) showed that the

Table 3—The centrality degree of psychology publications by Iranian authors in WoS (1973-2014)

Row	Authors	Out degree	In degree	Normalized out degree	Normalized in degree
1	Ghorbani	29.000	29.000	0.186	0.186
2	Zarrindast	27/.167	27.167	0.174	0.174
3	Moradi	26.000	26.000	0.167	0.167
4	Nouri	22.000	22.000	0.147	0.147
5	Mohammadi	19.000	19.000	0.141	0.141
6	Shahidi	17.000	17.000	0.123	0.123

Table 4—The centrality closeness in psychology publications by Iranian authors in WoS (1970-2016)

Row	Authors	Farness	Normalized closeness
1	Mohammadi	3685.000	24.288
2	Amiri	3818.000	23.442
3	Besharat	3828.000	23.380
4	Molavi	3951.000	22.652
5	Malek	3964.000	22.587
6	Nouri	3968.000	22.555

Table 5—The centrality betweenness in psychology publications by Iranian authors in WoS (1970-2016)

Row	Author	Betweenness	Normalized Betweenness
1	Mohammadi	15172.278	6.912
2	Besharat	15105.217	6.882
3	Nouri	14014.444	6.385
4	Sadeghi	9461.107	4.310
5	Shahidi	9455.447	4.318
6	Akhondzadeh	9038.083	4.118

centrality degree was 16.5%, with Ghorbani, Zarrindast, and Moradi being the most productive and effective authors in the network.

The co-authorship network centrality closeness was 16.63%; Mohammadi, Amiri, and Besharat were the top authors.

The co-authorship network centrality betweenness was 6.64%. Mohammadi, Besharat, and Nouri had the highest betweenness scores in the network (Table 5).

Discussion

The annual growth of publications by Iranian researchers in the field of psychology averaged 11.8% during the years studied. The number of papers peaked in the latter half of the first decade of this century but is now growing again. While the study yielded 2,142 publications with affiliations to Iranian institutions, this does not reflect the total research performance by Iranian researchers because a significant number of other psychology papers appeared in Persian which are not included in international databases. The *Web of Science*, for instance, indexes mainly English-language peer-reviewed journals. A solution to this language problem is needed. One approach is to encourage Iranian researchers to write more papers in English and to represent their research outputs to the global society by publishing in international journals indexed by the *Web of Science.*

This is a limitation of the current study because we considered only international publications by Iranian researches in psychology. We suggest to other researchers to study publications in Persian and make

a comparison with the result of the current study in this particular field.

Conclusion

The collaboration network among Iranian researchers in psychology demonstrated a relatively good interconnection among them, but this of course could always be increased. We recommend that Iranian universities establish some types of incentives to further this.

There is a need to find a solution to the language problem. Persian publications should be included in international databases in order to present to the world a complete picture of the scientific publications by Iranian researchers.

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