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Bibliometric Analysis of Stem Cell Publications in Iran

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ABSTRACT

Objective: The purpose of this study is to examine qualitative and quantitative states of stem cell research in Iran in order to extract information production patterns. *Methods:* The data were extracted by searching through the Science Citation Index (SCI) Expanded database related to January 2013. The number of published articles and frequency of their citation were used as indices of the quality and quantity of information production. *Results:* Total number of Iranian stem cell articles and proceedings indexed in Web of Science until 2012 was 709. The highest frequency belonged to the multiple institution category (45-50% of the articles during 2005-2012). The highest CPP rate (29.7) belonged to the international articles written by the authors from other countries with Iranian coauthors. *Conclusion*: Although cooperation between more authors from different institutions and countries can increase the quality of scientific articles, results of this research showed that international research must be distinguished in terms of author sequence.
Key words: Stem cells, Citation, Bibliometric analysis, Iran.

1. INTRODUCTION

Research on stem cells is an emerging field that has attracted great attention of medical researchers and practitioners due to its potential for medical treatment (1). By definition, stem cells are undifferentiated cells in human body with the ability to divide in order to replenish dying cells. Stem cell therapy offers a promising approach for regeneration of damaged vascular and cardiac tissues after myocardial infarction. They can be used in the treatment of damaged spinal cord, Parkinson's disease, Alzheimer's disease, and diabetes by replacing damaged cells (2). Due to the capacities of stem cells, a huge body of research has been dedicated to this field.

The output of research activities by individuals or institutions are published in journals, thus being used and evaluated by other researchers. This process creates a collaborative network among researchers (3). These articles have unique capacity to discover knowledge patterns in the world (4). Different approaches have been used to discover knowledge patterns in articles, one of which is bibliometrics where different scientific areas are mapped using their outputs as reflected in different databases. Studies have shown that mapped articles can provide a comprehensive representation of a scientific field (5).

Bibliometric analysis is a method for analyzing scientific production (6, 7) and is a tool for evaluating the quality of scientific production (8). Scientific outputs of countries, institutions, or journals in different medical areas such as diabetes (8), AIDS (9), bacteriology (10), and emergency medicine (11) have been evaluated using bibliometric methods.

Bibliometric analysis includes both quantitative description of research outputs and qualitative analysis using citation analysis (12, 13). Citation analysis examines the frequency of citations made to an article in different sources. The number of citations indicates the scientific impact of an article and quality of that article using citation indices (14). Nonetheless, little research has been conducted to evaluate the trends and quality of global stem cell research (15) and the majority of these studies have been carried out in more developed countries (16, 17). Therefore, it is imperative to have a clear understanding of the trends of information production in the field of stem cells in Iran so that researchers could have better collaborations with their peers.

The purpose of this study is to examine qualitative and quantitative states of stem cell research in Iran in order to extract its information production patterns.

2. METHODS

With a bibliometric approach, the present research comparatively analyzed stem cell research in Iran. The data related to research publications and frequency of citations were extracted by searching through the Science Citation Index (SCI) Expanded database of Thomson Reuters related to January 2013. SCI is a multidisciplinary database that provides bibliographic and citation information. The reason for using Web of Science database was its search-related

Year	International type 1		Multiple institution		International type 2		Multiple department		Single department		Total	
	NP	NP%	NP	NP%	NP	NP%	NP	NP%	NP	NP%	NP	NP%
1996	-	-	-	-	1	100	-	-	-	-	1	100
1998	-	-	1	100	-	-	-	-	-	-	1	0.1
1999	-	-	1	50	-	-	-	-	1	50	2	0.3
2003	-	-	-	-	2	100	-	-	-	-	2	0.3
2004	1	11	1	11.1	2	22.2	1	11	4	44.4	9	1.3
2005	-	-	5	45.5	2	18.2	3	27	1	9.1	22	2.6
2006	-	-	12	46.2	1	3.8	6	23	7	26.9	26	3.7
2007	3	7.1	19	45.2	9	21.4	4	9.5	7	16.7	42	5.9
2008	5	7.8	31	48.4	5	7.8	15	23	8	12.5	64	9
2009	7	8.1	46	53.5	9	10.5	15	17	9	10.5	86	12.1
2010	13	10	62	49.2	12	9.5	24	19	15	11.9	126	17.8
2011	20	13	81	50.9	18	11.3	29	18	11	6.9	159	22.4
2012	27	15	100	55.6	12	6.7	30	17	11	6.1	180	25.4
Total	76	11	359	50.6	73	10.3	127	18	74	10.4	709	100

Table 1. *Frequency of Iranian research on stem cells by collaboration*

capabilities and application of citation frequency as a quality measure of articles. To search for stem cell, its synonyms, and their variations, the terms were searched as follows:

TS=(stem cell* OR mother cell* OR progenitor cell* OR colony forming unit*) AND CU=(Iran)

The search was limited to articles and proceeding papers and other formats such as abstracts and reviews were excluded. Citations per publication (CPP) index was used to calculate the mean number of citations to each article. Number of high-quality papers (NHQ) was calculated using the mean citations to each article and the articles whose number of citations was twice of mean citations to each article were considered high-quality papers. Moreover, relative quality index (RQI) was calculated as ratio of high quality papers to total number of papers.

To examine effect of collaboration, the articles were categorized into five groups based on the country of origin, institutions, and departments of the institutions. For this categorization, type of collaboration was identified using address of the author(s) (C1 field):

- Single department: The addresses were all from a single department in an Iranian institute.
- Multiple departments: The addresses were from two or more departments in an Iranian institute.
- Multiple institutions: The addresses were from different Iranian institutions.
- International type 1 (first author from Iran): The addresses were related to an Iranian first author and coauthors from other countries.
- International type 2 (first author from other countries): The addresses were related to an Iranian coauthor and authors from other countries.

Microsoft Excel was used to prepare the data and calculate different indices and Pivot Table in Excel was used for drawing the required tables.

3. FINDINGS

Total number of Iranian stem cell articles and proceedings indexed in Web of Science until 2012 was 709. Table 1 shows the publication trend by Iranian authors in collaboration with researchers from other countries. The first article was related to research activities in the field of stem cells carried out in 1996 and, until 2003, total number of articles on this subject was 6. The beginning of serious research activities was in 2004 when 9 articles were published, which was 1.5 times of total number of articles which had been published until then. Later, the highest growth in research happened in 2006 with 26 articles, twice of total number of articles published in 2005. Despite the relative decline in 2009, research growth continued in 2010 and had an upward trend since then.

To further study the research pattern on stem cells in Iran, the collaboration between authors was examined. According to Table 1, the first article was written by an author from other countries and an Iranian coauthor and the second article published in 1998 was the product of collaboration between Iranian institutions. Therefore, the first article with an Iranian first author was published in 1998. The highest frequency belonged to the multiple institution category (45-50% of the articles during 2005-2012). The second ranking belonged to the multiple department category, where 127 articles were published as a result of collaboration between departments of a single institution. Frequency of the articles written by a single institution constituted 10% of the total number of articles, which was 27% in 2006, but followed a downward trend later.

International articles with an Iranian first author ranked fourth in frequency. These articles followed a moderately upward trend from 2007 to 2012. Last on this table were the articles written by first author from other countries and Iranian coauthors. With 73 articles (10.3 percent of total number of articles), this category had an irregular trend up to 2012. The first article on stem cells in the present study was of this type, which was published in 1996. The highest frequency in this category occurred in 2011 with 18 articles, which later decreased to 12 in 2012.

Collaboration	TNP	TNP%	TNC	CPP	IMF		NHQ	NHQ/TNC%	RQI
					All papers	HQ papers			
International type 1	29	7.837838	252	8.7	2.12	2.46	3 (5.9%)	10.3	0.75
Multiple institution	178	48.10811	1748	9.8	2.02	3.5	21 (41.2%)	11.8	0.86
International type 2	43	11.62162	1278	29.7	5.78	9.86	16 (31.4%)	37.2	2.70
Multiple department	68	18.37838	624	9.2	1.6	2.28	7 (13.7%)	10.3	0.75
Single department	52	14.05405	337	6.5	1.43	2.60	4 (7.8%)	7.7	0.56
Total	370	100	4239	11.4	-	-	51 (100%)	13.8	1

Table 2. *Frequency of citations to the articles and high-quality articles in the field of stem cells*

In addition, the articles published up to 2010 (370 articles) and their citations up to 2012 (4239 citations) were examined. One measure of article quality is citations per publication (CPP). The highest CPP rate (29.7) belonged to the international articles written by authors from other countries and Iranian coauthors. Second on the rank were articles published by authors from different institutes (CPP=9.8). The lowest CPP (6.5) belonged to the articles written by a single department.

Based on the equation provided in the methods section, 51 high-quality papers were identified that constituted 13.8 percent of total number of articles. The highest frequency of high-quality papers (21 articles) belonged to the multiple institution category, while the least number of high-quality papers (3 articles) belonged to international collaboration with an Iranian first author. In terms of the ratio of high-quality papers to total number of papers, more than one third of international articles with Iranian coauthors were high-quality (37.2%). The second rank belonged to the multiple institution category where 11.8% of the articles were high-quality. International articles with an Iranian first author and multiple department articles had the same ratio (10.3%).

The highest RQI belonged to international articles with Iranian coauthors and the lowest RQI belonged to the articles written by a single department. Mean impact factor (MIF) of the international articles with Iranian coauthors (5.78) was significantly higher than the MIF of other categories. Moreover, the IMF of the journals related to high-quality papers from this category was even higher (9.86).

4. DISCUSSION

Iran has recently experienced a dramatic increase in the number of articles in the field of stem cells. Although the advent of stem cell research in Iran goes back to 1996, only few articles were published up to 2004 (6 articles). From 2004 on, however, the number of articles gradually increased, marking this year as the beginning of serious research activities in the field of stem cells. The majority of the published articles were the result of collaborations between institutions and the number of individual articles decreased over time. Other studies have also suggested that collaboration between researchers has recently gained more importance and has been regarded as an important factor in the development of subject areas and dissemination of research results (18). In addition, increased collaboration is not restricted to a specific field (19, 20). Growth in the volume of stem cell research that is a result of collaboration between institutions and universities suggests that researchers attempt to use facilities and capacities of different institutes to further their research. The current trend of collaborative publications can increase author efficiency (21). Thus, one reason for the increasing research in the field of stem cells is the shift to collaboration between different institutes.

The number of citations to an article is a measure of its quality and importance (19). Citation index showed interesting trends in different article categories. The articles written by international authors and Iranian coauthors were significantly different from other categories. Although the highest number of citations was made to this category of articles (CPP=29.7),mean citation index was similar for different categories (ranging between 8.7 and 9.8). Past studies have demonstrated that international papers are likely to receive more citations than single-author papers (20). Therefore, the average numbers of citations to the articles in two international article categories (with Iranian first author and Iranian coauthors) were expected to be close, while a significant difference was observed between these groups (29.7 against 8.7). Since article quality depends on financial status, workforce, and research facilities of institutions (19), the significantly high number of citations to international articles with Iranian coauthors and their overall higher quality can be attributed to their access to advanced facilities and capabilities, which highlights the importance of author sequence and developing guidelines for this purpose (22-24). The present findings also supported the importance of author sequence in articles by showing weight of the first author in article quality. However, in many bibliometric studies, quality of publications in different countries has been examined without accounting for author sequence (19, 25-27).

5. CONCLUSION

The increasing trend of collaboration between researchers from different institutes and decrease in single-author publications suggest the proclivity of authors toward using capacities of different institutes. In addition, it appears that development in the field of stem cells requires collaboration between a

broad range of scientists from different fields. These two factors have led to a shift from single-author research to multi-disciplinary and multiple institutional studies. Although cooperation between more authors from different institutions and countries can increase quality of scientific articles, results of this research showed that international research must be distinguished in terms of author sequence. For instance, the number of citations to an article which is a measure of its quality was significantly different in the articles written by an Iranian author from the ones written by Iranian coauthors.

To sum up, the reasons for differences in the quality of international articles with Iranian coauthors should be investigated. Moreover, the condition of stem cell research in Iran can be compared with other Middle Eastern or Eastern Mediterranean countries, which can provide a more realistic and detailed picture of the research conducted in these countries.

CONFLICT OF INTEREST: NONE DECLARED.

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