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Visualizing the Structure of Iranian Medical Science Publications

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Abstract

This paper presents the results of a bibliometric analysis of the Medical Sciences (MS) domains in Iran. Totally 9047 articles indexed in ISI (Thomson Reuters Database) from 1989 to 2008 in December 2008 have been extracted. HistCite™ applications are used to discover the Iranian publication status during this period. The publication count has grown at an approximate rate of 40.5% per year. We tried to introduce the most productive authors, and cited works. Moreover, distributions of output in journals identified by ISI and research output analysis of different universities were presented. The most influential cited authors and articles in this research were drawn. Finally, the process of the evolution of the medical sciences discipline, and its shift over the period of the research was traced and shown in the map. Using HistCite™ applications, retrieved articles were analyzed and visualized.

Keywords: medical sciences, information visualization, bibliometric analysis, scientific publication, scientometric indicators

Introduction

The ability to judge a nation's scientific standing is vital for the governments, businesses and trusts that must decide scientific priorities and funding, **(**King**,** 2004**)**. Medical progress depends on scientific communication of research findings. There has been a significant increase in the volume of scientific publications in recent years, (Swaminathan, Phillips-Bute ,& Grichnik, 2007). Over the last two decades, there has been considerable growth in Iranian's concern with the status of Medical Sciences, (Malekzadeh, Mokri, & Azarmina, 2001). In 1989 there were only three papers written by Iranian medical authors indexed in SCI database. But in 2008 this database contained 1944 Iranian medical articles. Iranian publications increase began right after Iraq-Iran war in 1989. Osareh and McCain (2008) attribute this rise in productivity and visibility to a combination of factors including not only the improvements in the economic, educational, and political situation, but also an increase in the number of

internationally educated Iranian students, the increase in the collaboration between Iranian and international researchers, and in the publications in international journals.

Iran has witnessed a remarkable growth in various fields of sciences in the last two decades. Among them, Iranian Medical Science (MS) as a strategic scientific field has an important position in the structure and context of science as one of the most important discipline. In this article we decided to map the structure of Medical Science output throughout history in a period of 20 (1989-2008) years and specific scientific impressions are analyzed. The structure of (MS) fields which helps to key out the influential scholars, publications, institutions and countries in (MS) domain during the studied period is identified. Results of this article also can show some strength and weaknesses of Iranian Medical Science output during 1989-2008. For example, the publication count of Iranian Medical Science output has grown at an approximate rate of 40.5% per year, from a low of 3 articles in 1989 to 1944 articles published in 2008. While, Iranian research studies in medical sciences tend to be published in journals with lower impact factors (IF) than the world average (this includes the 31 major journals indexed in JCR) and the mean (IF) of 31 top journals was only 1/5. The results of this study also can help Iranian Medical Researchers to overcome to some of the weaknesses of Iranian Medical Science scientific products.

Literature Review

In this section, we review some development in Medical Sciences research. Few studies have investigated Iranian Medical Sciences publications. Moin, Mahmoudi, and Rezaei (2005), considered Iranian scientific output at the threshold of the 21st century and confirmed an increasing growth after the Iraq-Iran war, which marks the period of stability and development. Nedjat et al. (2008), in a paper revealed that in the past two decades, scientific publications in Iran have increased their medical science content, and the number of articles published in ISI journals has doubled between 1997 and 2001. A similar trend shows itself when this growth in Medical Sciences publications was compared with that of overseas countries. Hassanzadeh Esfanjani et al. (2010) in a study on investigating the 30-year medical products of Iran indexed in the SCI, confirmed that from 1983 till 2007, a growing trend could be observed in the scientific medical products of Iran. Malekahmadi et al. (2011) in a study confirmed that the contribution of Iran in production of pediatrics science increased after 2002, this pattern is in parallel with other research fields.

The following papers take us through some of related literature that used HistCite™[1]. Hamidi, Asnafi, and Osareh (2008), the pioneers of applying HistCite™ in Iran, investigated scientific publications in the fields of Bibliometrics, Scientometrics, Informetrics and Webometrics in WOS during 1990-2005. Baradar, Tajdaran, Musavi, and Abedi (2009) in a study traced the map of Iranian ISI papers on Nanoscience and Nanotechnology. The relationships among N&N and other disciplines appear mutually. The convergence of Basic Sciences (Physics and Chemistry) and Engineering (Materials Engineering and Metallurgy) have the highest impacts on their fundamental and applied aspects, respectively. Osareh and Bajji (2009) in a study, using the HistCite™ software, drawn the social sciences map and identified the effective papers and authors. The study indicated that the scientific production of Iranian authors in the field of social sciences in the period 1990-2006 in SSCI follows an ascending trend, with some fluctuations in the years 2004 to 2006. Osareh and Keshvari (2010), used scientometric techniques and HistCite™ software to visualize the structure of

Iranian scientific output in Science Citation Index. In this study 8 clusters have been formed on the two levels (GCS & LCS). The subject area of whole clusters was Chemistry. Balasubramani and Murugan (2011), in a survey examined the research field of Sago in terms of publication output as per science citation index database between 1978 and 2010. The data shows increase in the basic research activity in this research field. Ashrafi et al. (2012) studied Iranians' contribution to world literature on Neuroscience. Findings showed progress of Neuroscience in Iran is mostly seen in the Neuropharmacology and the Neurology subfields.

A review of the literature of MS confirms an increasing number of papers published in Iran in the past two decades and HistCite™ is applicable software which is used and valid in different fields to visualize the results of literature searches in Web of Science.

Research Objectives

The present study aims to discover and generate the scientific map of medical sciences in Iran during 1989 and 2008. Considering the importance of these fields for the development of communities, and in order to demonstrate research activities in these fields, we are interested in identifying the structure and dynamics of MS fields to identify the influential scholars, publications, institutions, countries and words (most used words in document titles) in the medical sciences domains. In particular, our goal is to objectively identify major research experts, papers, institutions, etc., in the domains of interest. Meanwhile, we would like to identify the degree of co-authorship among authors of medical sciences during studied period.

Methodology

Citation data can be used to identify the structure of different research disciplines, fields and even sciences as a whole, (Garfield & Welljams-Dorof, 1992). We retrieved 9047 articles indexed in the Web of Sciences, 1989-2008, (20 years) that dealt with the intersection of Medical Sciences. The search query was conducted in Web of Sciences subject areas. Using HistCite™ applications, retrieved articles were analyzed and visualized. To show main clusters and subject relevance of each cluster, keywords in titles of each paper in MeSH (http://www.nlm.nih.gov/mesh/) were searched. For each cluster we trace the leaves to get one to three general subjects for each cluster. The Impact Factors (IF) for journals were obtained from Journal Citation Report 2008.

Data Collection

The population for this study was the Medical Sciences articles written by authors affiliated to the Iranian Universities. Research results in the domains of (MS) were retrieved by subject areas (Ophthalmology, Allergy, Parasitology, Pathology, Pediatrics, Gastroenterology and Hepatology, Peripheral Vascular Disease, Biochemistry and Molecular Biology, Genetics and Heredity, Pharmacology and Pharmacy, Biotechnology and Applied Microbiology, Cardiac and Cardiovascular Systems, Hematology, Cell Biology, Immunology, ... and Nephrology) from ISI's web of science online interface (http://www.isiknowledge.com) in December 2008. The data were captured in plain text. For analyzing, the data in 500 batches were entered into the HistCite™ software. HistCite™ saves information on the title, author, journal, cited references, times cited, year of publication, document type, language, institution and country for each article. For the study, 9047 papers indexed by

SCI for 20 years (1989-2008) were considered, and the graph of MS in the studied period was mapped.

Results

Table 1 shows the most productive authors within our set. Zarrindast with 208 articles (2.3%), Dehpour with 192 articles (2.1%), Azizi with 136 articles (1.5%), Shafiee with 94 articles (1%) are the most productive authors within our set.

Table 1
Top 10 most productive authors

#	Author	Recs	TLCS	TGCS
1	Zarrindast MR	208	657	1739
2	Dehpour AR	192	555	1096
3	Azizi F	136	427	908
4	Abdollahi M	115	303	796
5	Shafiee A	94	148	448
6	Larijani B	93	59	248
7	Moosavi-Movahedi AA	93	147	493
8	Malekzadeh R	86	207	620
9	Amini M	77	79	196
10	Saboury AA	65	109	385

Number of authors per article. A total of 73 articles were produced by single authors and 8986 (99.1%) were written by at least two authors (co-authored). As can be seen in Table 2, most papers involved collaboration between three to six authors.

Table 2
Number of co-authors per article

Number of Docs	Frequency of Co-authors	Percent
1	73	.8
2	314	3.2
3	1295	13.4
4	2366	24.4
5	1784	18.4
6	1257	13.0
7	666	6.9
8	460	4.8
10	294	3.0
11	194	2.0
12	73	.8
13	32	.3
14	26	.3
15	25	.3
16	17	.2
17	9	.1
18	14	.1
19	6	.1
20	6	.1
21	2	0
22	3	0

Number of Docs	Frequency of Co-authors	Percent
23	7	.1
24	3	0
25	1	0
26	5	1
27	2	0
28	2	0
31	2	0
38	2	0
Total	9059	100

Table 3 shows the two top cited papers that are cited at least 100 times based on Global Citation Scale (GCS). The GCS depends on how often each article is cited in the entire SCI. The paper by Singh , Niaz , Sharma, Kumar , Rastogi , and Moshiri (1997) is the most cited (230 times). Another major publication that is highly cited across disciplinary boundaries is by Reilly , Armstrong , Dorosty , Emmett , Ness , Rogers, Steer, and Sherriff (2005) cited 163 times.

Table 3
Paper Citation Networks

#	Date/ Author/ Journal	LCS	GCS
1	517 Singh RB, Niaz MA, Sharma JP, Kumar R, Rastogi V, Moshiri M. Randomized, double- blind, placebo-controlled trial of fish oil and mustard oil in patients with suspected acute myocardial infraction: The Indian experiment of infarct survival, 4. CARDIOVASCULAR DRUGS AND THERAPY, 1999 JUL: 11(3): 485-491	0	230
2	3376 Reilly JJ, Armstrong J, Dorosty AR, Emmett PM, Ness A, Rogers I, Steer C, Sherriff A. Early life risk factors for obesity in childhood: cohort study BRITISH MEDICAL JOUNRAL , 2005 JUN 11, 330 (7504): 1357-1359	0	163

Table 4 shows the articles that are cited at least 20 times based on LCS. The LCS is based on the citation frequency within the retrieved collection. The article by Azizi, Salehi, Etemadi, and Zahedi Asl (2003) is the most cited (34 times). Another major publication that is highly cited across disciplinary boundaries is by Azizi et al (2002) cited (29 times).

Table 4
Papers Cited at Last 20 Times Based on LCS

#	Date/Author/ Journal	LCS	GCS
1	2053 Azizi F, Salehi P, Etemadi A, Zahedi-Asl S Prevalence of metabolic syndrome in an urban population: Tehran Liquid and Glucose Study Diabetes Research and Clinical Practice, 2003 JUL, 61(1): 29-37	34	80
2	1531 Azizi F, Shekholeslam R, Hedayati M, Mirmiran P, Malekafzali H, et al. Sustainable control of iodine deficiency in Iran: Beneficial results of the implementation of the mandatory law on salt iodization Journal of Endocrinological Investigation, 2002 MAY: 25 (5): 409-413	29	38

A total of 9047 article were published in 1475 different scientific journals. Table 5 gives a rank order listing of the top 10 journals in which 69 to 162 Iranian publications were appeared. Five journals, such as *Iranian Journal of Public Health, Saudi Medical Journal,*

Archives of Iranian Medicine, Pakistan Journal of Medical Sciences and European Journal of Pharmacology published more than 100 articles each. *The European Journal of Pharmacology* received 302 local citations with 105 records and *Iranian Journal of Public Health* gathers 11 local citations with 162 records.

Table 5
Journal Distribution

#	Journal	Recs	TLCS	TGCS
1	Iranian Journal of Public Health	162	11	35
2	Saudi Medical Journal	161	26	103
3	Archives of Iranian Medicine	154	6	40
4	Pakistan Journal of Medical Sciences	143	2	5
5	European Journal of Pharmacology	105	302	791
6	African Journal of Biotechnology	83	3	34
7	Journal of Ethnopharmacology	72	131	549
8	Daru-Journal of Faculty of Pharmacy	71	40	46
9	International Journal of Dermatology	71	53	294
10	Brain Research	69	171	535

The ranked word lists of HistCite™ sort the vocabulary taken from the document titles (Garfield, Paris,_& Stock, 2006). As can be seen in the Table 6, the term "Iran" is the top scorer of the title terms. Ranked second we see "*Patents*", coming third is "*Effect*" followed by "*Effects*". HistCite™ does not yet recognize phrases and does not make use of conflation algorithms, so "*Effect*" and "*Effects*", "*Iran*" and "*Iranian*" are two separate entries in the list.

Table 6
Terms by Count of Publications

#	Word	Recs	Percent	TLCS	TGCS
1	IRAN	956	10.6	1082	3605
2	PATIENTS	754	8.3	404	2801
3	EFFECT	643	7.1	478	2194
4	EFFECTS	513	5.7	632	2492
5	IRANIAN	512	5.7	531	2111
6	TREATMENT	355	3.9	182	1543
7	USING	322	3.6	173	1000
8	RATS	318	3.5	525	1545
9	HUMAN	309	3.4	199	1706
10	ACTIVITY	303	3.3	249	1481

Table 7 shows the language of documents. The (Medical Sciences) literature is mainly written in English (99.9 %). The English documents gather more than 99% of all local citations. Not all documents in other languages are cited locally or globally (Table 7).

Table 7
The Language of Documents

#	Language	Recs	Percent	TLCS	TGCS
1	English	9046	99.9	6904	36228
2	French	8	0.1	7	22
3	German	2	0.0	0	0

4	Danish	1	0.0	0	0
5	Italian	1	0.0	0	1
6	Turkish	1	0.0	0	0

Total numbers of Institutions that produce these documents are 6023. Table 8 presents the most productive institutions in this research. Papers have been published with different variation: *Tehran Medical Sciences University, University Tehran Medical Sciences and University Tehran Medical Science & Health Services* are three names used for one institution, so these three names assumed as one name. *Tehran Medical Science University* is the most productive institution. Following that, *University Tehran, Shaheed Beheshti Medical University*, *Shiraz Medical School*, and *Tarbiat Modaress University* come out with high rankings. Although some of the studied authors have positions in hospitals and research institutions, they opt to identify themselves with a university due to the fact that association with universities are culturally and socially deemed as the more prestigious universities.

Table 8
Top 10 Cited Institutions

#	Institution	Recs	Percent
1	Tehran Med Sci Univ, Univ Tehran Mad Sci, Univ Tehran Med Sci & Hlth Serv	1572	17.3
2	Univ Tehran	881	9.7
3	Shaheed Beheshti Med Univ, Shahid Beheshti Med Univ, Shaheed Beheshti Univ Med Sci, Shahid Beheshti Univ Med Sci, Shahid Beheshti Univ Med Sci & Hlth Serv	800	8.9
4	Shiraz Med sch, Shiraz Univ Med Sci	565	6.2
5	Tarbiat Modaress Univ, Univ Tarbiat Modarres, Tarbiat Modarres Univ, Tarbiat Modares Univ	477	5.2
6	Pasteur Inst Iran, Inst Pasteur, Inst Pasteur Iran	276	3.1
7	Esfahan Univ Med Sci, Isfahan Univ Med Sci, Isfahan Univ Med Sci & Hlth Serv	271	3
8	Tabriz Med Sci Univ, Tabriz Med Univ, Tabriz Univ Med Sci	269	2.9
9	Iran Univ Med Sci, Iran Univ Med Sci & Hlth Serv	268	3
10	Mashad Univ Med Sci, Mashhad Univ Med Sci	198	2.2

Table 9 shows a rather high international cooperation level with native English-speaking countries. The results of this study showed that the authors of 101 countries collaborated with Iranian authors in producing scientific documents. USA ranked the first with 609 records in this research. UK and Canada ranked second and third. Other countries less than 200 research papers collaborated with Iran.

Table 9
International Collaboration

#	Country	Recs	Percent	TLCS	TGCS
1	Iran	8993	99.3	6854	35748
2	USA	609	6.7	522	4555
3	UK	455	5.0	339	3746
4	Canada	253	2.8	110	1197
5	Australia	159	1.8	125	910
6	France	148	1.6	110	1016
7	Japan	137	1.5	73	1138

8	Germany	129	1.4	71	893
9	Sweden	129	1.4	71	717
10	Italy	98	1.1	76	951

Using *HistCite*™, highly cited papers that are not part of our database were identified. These are Lowry (1951) with 120 citations, Miller (1988) with 88, Bradford (1976) with 87 citation, Paxinos (1986) with 77 citations, Laemmli (1970) with 73 citation, Friedewald (1972) with 68 citation, and *Azizi* (2000) with 59 citation. The reason that they are not included is that, some of them are not in the ISI web of Knowledge and were not used as seeds.

Table 10
Highly Cited Documents in Web of Science

#	Author / Year / Journal		Recs	Percent
1	LOWRY OH, 1951, J BIOL CHEM, V193, P265	WoS	120	1.3
2	MILLER SA, 1988, NUCLEIC ACIDS RES, V16, P1215	WoS	88	1.0
3	BRADFORD MM, 1976, ANAL BIOCHEM, V72, P248	WoS	87	1.0
4	PAXINOS G, 1986, RAT BRAIN STEREOTAXI	WoS	77	0.8
5	LAEMMLI UK, 1970, NATURE, V227, P680	WoS	73	0.8
6	FRIEDEWALD WT, 1972, CLIN CHEM, V18, P499	WoS	68	0.8
7	AZIZI F, 2000, CVD PREVENTION, V3, P242	WoS	59	0.7
8	SAMBROOK J, 1989, MOL CLONING LAB MANU	WoS	51	0.6
9	*AM PSYCH ASS, 1994, DIAGN STAT MAN MENT	WoS	44	0.5
10	DUBUISSON D, 1977, PAIN, V4, P161	WoS	44	0.5

The numbers of articles on MS published each year are shown in Figure 1. Publications remarkably increased from 1989 to 2007 and a peak appears in 2007. A slightly decrease appears in 2008. The top cited year within GCS is 2005 and within LCS is 2004.

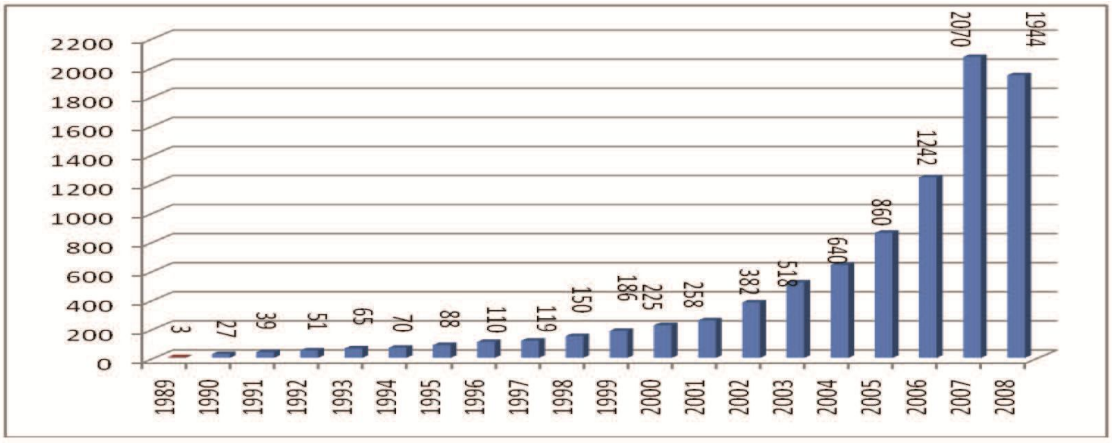


Figure 1. Distribution of records based on publication year.

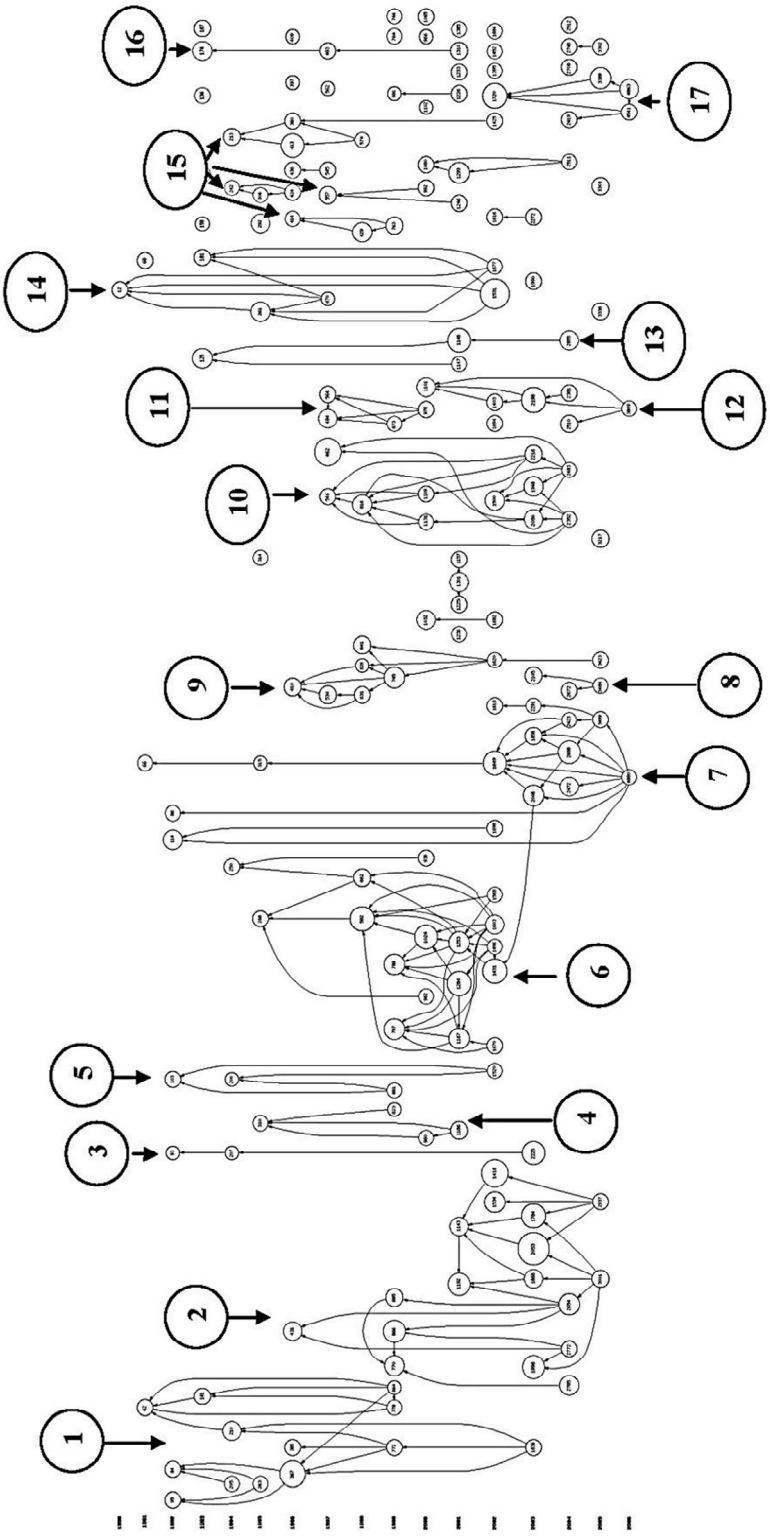


Figure 2. HistCite™ historiograph of the most highly cited papers within the Medical Sciences (MS) domain (threshold 181 citations, 2 percent of the whole dataset).

By looking at cluster maps generated on an annual schedule, the literature epidemiologist could see how an outbreak of research actually spreads over time, through what channels, and to whom, (Garfield, 1980). Figure 2 shows a historiograph of the 181 most cited papers, 2 percent of the whole dataset. The graph fall into 17 clusters and 206 links observed. It means there are few interlinkages among main clusters. Figure 2 Also shows a year-by-year map of 181 most cited papers. In 2002 there are 24 highly cited papers, in 2001 there are 18 and in 2004 there are 17 highly cited papers. The least cited paper goes back with one paper in 1990.

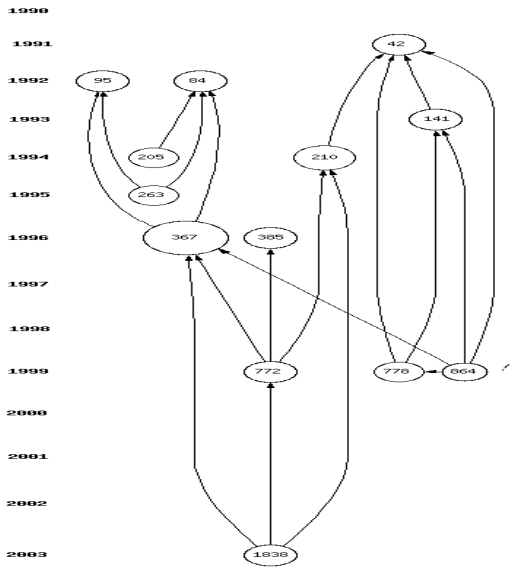
The study of the clusters shows some medical categories are more influential than others. The most influential ones are *Alkaloids & Organic chemicals*, B*ody weight & Cardiovascular system - Metabolic diseases, Physiological effects of drugs & Digestive system disease & Alkaloids & RNA viruses* and *Salivary glands & organophosphorus compounds.*

The 17 main clusters are as follows:

1. *Alkaloids & Organic chemicals*
2. *Body weight & Cardiovascular system - Metabolic diseases*
3. Skin manifestation
4. gastrointestinal disease
5. Parasitic disease
6. *Physiological effects of drugs & Digestive system disease & Alkaloids & RNA viruses*
7. *Chemical & drugs & Heterocyclic compounds*
8. Body weight
9. Chemical action and uses & Solubility
10. *Salivary glands & organophosphorus compounds*
11. Central nerves system
12. Gastrointestinal neoplasms
13. Thalassenia
14. Iodine deficiency
15. Parasitic disease & leishmania
16. Hepatitis-B
17. Immunodeficiency & consanguinity

Out of 17 mentioned clusters, 5 (including clusters 1, 2, 6, 7 and 10) are more noticeable which will be described as follows:

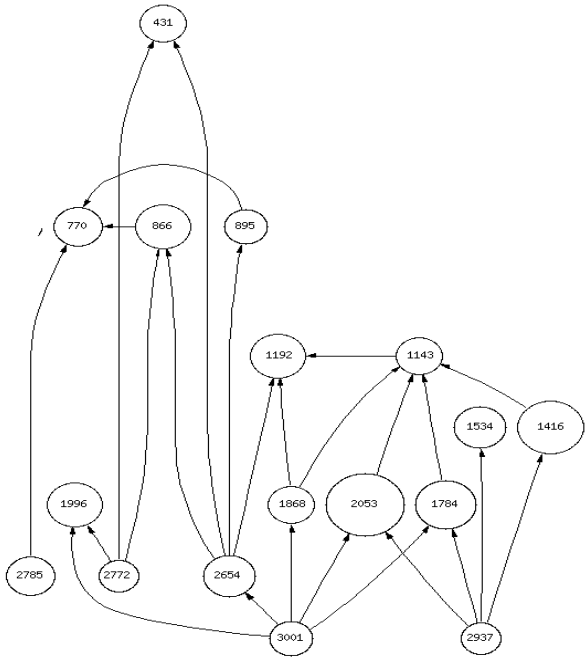
1. Cluster 1 which is about *"Alkaloids & Organic Chemicals"* consists of 13 links, began from 1991 up to 2003. The most productive author in this cluster is *Zarrindast* with 10 papers; other authors are *Sabetkasai* with two papers and *Rezayat* with one paper. Most of the papers of this cluster are published in 2 journals (EUROPEAN JOURNAL OF PHARMACOLOGY and PSYCHOPHARMACOLOGY). *Zarrindast* also cooperated in publishing the papers number 141, 210 and 778 with *Sabetkasai* and *Rezayat*. The paper of *Zarrindast* (paper number 367) with LCS 24, GCS 40 is the most influential paper.



42 Zarrindast MR, 1991, LCS 10, GCS 15
84 Zarrindast MR, 1992, LCS 9, GCS 18
95 Zarrindast MR, 1992, LCS 9, GCS 29
141 Sabetkasai M, 1993, LCS 10, GCS 13
205 Zarrindast MR, 1994, LCS 8, GCS 9
210 Rezayat M, 1994, LCS 13, GCS 28
263 Zarrindast MR, 1995, LCS 8, GCS 11
367 Zarrindast MR, 1996, LCS 24, GCS 40
385 Zarrindast MR, 1996, LCS 10, GCS 18
772 Zarrindast MR, 1999, LCS 9, GCS 27
778 Sabetkasai M, 1999, LCS 8, GCS 18
864 Zarrindast MR, 1999, LCS 7, GCS 24
1838 Zarrindast MR, 2003, LCS 9, GCS 24

Cluster 1. Alkaloids & organic chemicals.

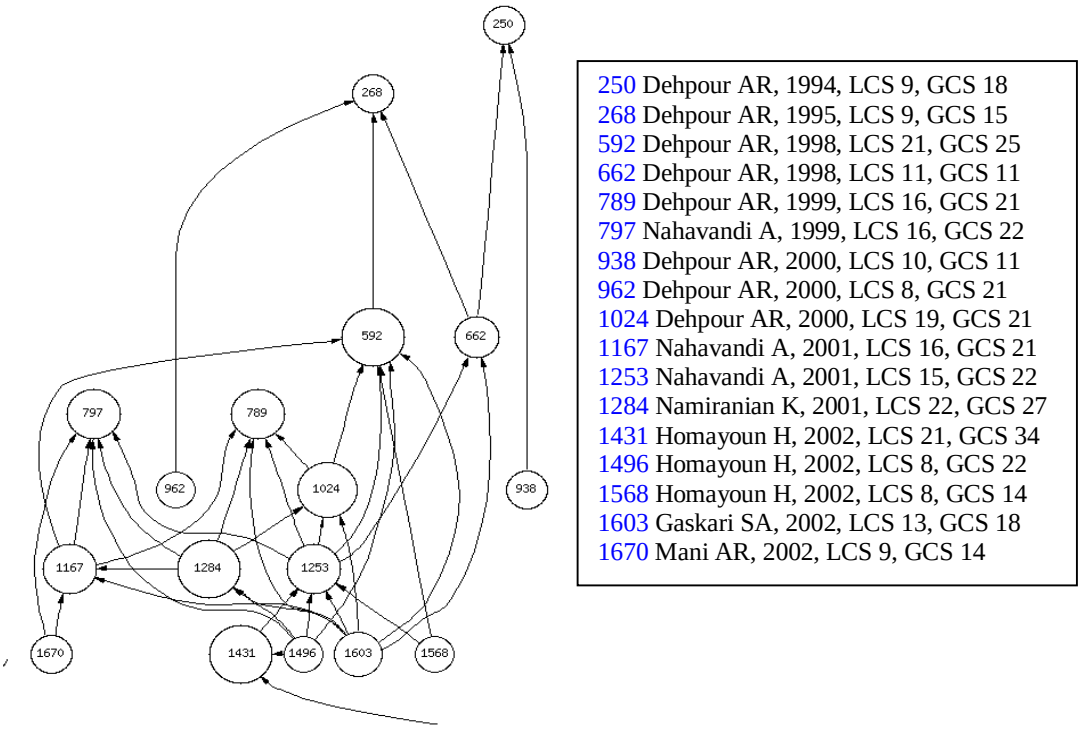
2. Cluster 2 refers to *"Body Weight & Cardiovascular System - Metabolic Diseases"*, with 17 links. The most productive author is *Azizi* with 8 papers, following him *Sarraf-Zadegan* with 3, *Mirmiran* and *Esmaillzadeh* each with 2 papers and *Kelishadi* and *Pishdad* each with 1 paper. Most of the papers of this cluster are published in 3 journals (ACTA CARDIOLOGICA, EUROPEAN JOURNAL OF EPIDEMIOLOGY and INTERNATIONAL JOURNAL FOR VITAMIN AND NUTRITION RESEARCH). The paper of *Azizi* (paper number 2053) with LCS 34, GCS 80 is the most influential paper.



431 Pishdad GR, 1996, LCS 13, GCS 22
770 Sarraf-Zadegan N, 1999, LCS 14, GCS 19
866 Sarraf-Zadegan N, 1999, LCS 18, GCS 29
895 Sarraf-Zadegan N, 1999, LCS 11, GCS 18
1143 Azizi F, 2001, LCS 12, GCS 19
1192 Azizi F, 2001, LCS 17, GCS 21
1416 Azizi F, 2002, LCS 26, GCS 34
1534 Azizi F, 2002, LCS 16, GCS 16
1784 Azizi F, 2003, LCS 22, GCS 23
1868 Azizi F, 2003, LCS 13, GCS 18
1996 Mirmiran P, 2003, LCS 18, GCS 18
2053 Azizi F, 2003, LCS 34, GCS 80
2654 Mirmiran P, 2004, LCS 15, GCS 24
2772 Esmaillzadeh A, 2004, LCS 10, GCS 24
2785 Kelishadi R, 2004, LCS 14, GCS 20
2937 Azizi F, 2005, LCS 10, GCS 13
3001 Esmaillzadeh A, 2005, LCS 11, GCS 17

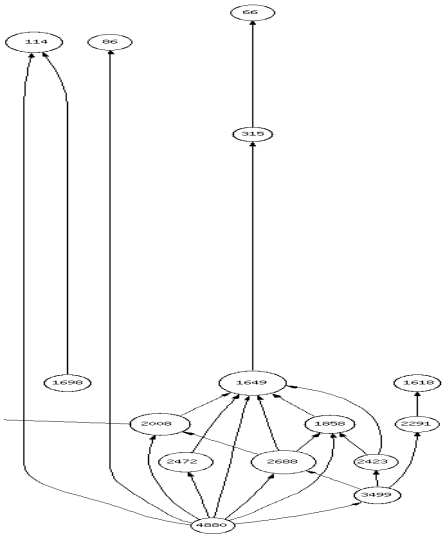
Cluster 2. Body weight & cardiovascular system - Metabolic diseases.

3. Cluster 6 is about *"Physiological Effects of Drugs & Digestive System Disease & Alkaloids & RNA Viruses"* with 17 links. The most productive author is *Dehpour* with 8 papers followed by *Nahavandi* and *Homayoun* each with 3 papers, and *Gaskari*, *Mani* and *Namiranian* each with one paper. Most of the papers of this cluster are published in 3 journals (CLINICAL AND EXPERIMENTAL PHARMACOLOGY AND PHYSIOLOGY, EPILEPSY RESEARCH and EUROPEAN JOURNAL OF PHARMACOLOGY). The paper of *Homayoun* (paper number 1431) with LCS 21, GCS 34 is the most influential paper. Clusters 6 and 7 has linked through the citation of Khavandgar's paper (Document number 2008) to Homayoun's paper in 2002 (Document number 1431).



Cluster 6. Physiological effects of drugs & digestive system disease & alkaloids & RNA viruses.

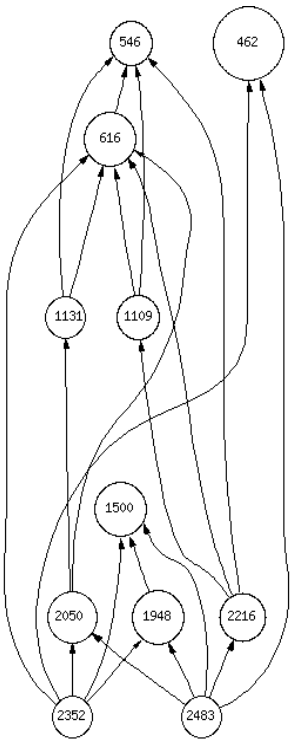
4. Cluster 7 is about *"Chemical & Drugs & Heterocyclic Compounds"* with 15 links. The most productive author is *zarindast* with 11 papers, *Khavandgar* with 2 papers, *Gholami* and *Homayoun* each with 1 paper. Most of the papers of this cluster are published in 2 journals (BEHAVIOURAL BRAIN RESEARCH and EUROPEAN JOURNAL OF PHARMACOLOGY). The paper of *Khavandgar* (paper number 1649) with LCS 20, GCS 32 is the most influential paper.



66 Zarrindast MR, 1991, LCS 8, GCS 9
86 Zarrindast MR, 1992, LCS 8, GCS 16
114 Zarrindast MR, 1992, LCS 14, GCS 29
315 Zarrindast MR, 1995, LCS 7, GCS 10
1618 Gholami A, 2002, LCS 9, GCS 21
1649 Khavandgar S, 2002, LCS 20, GCS 32
1698 Zarrindast MR, 2002, LCS 10, GCS 20
1858 Homayoun H, 2003, LCS 11, GCS 19
2008 Khavandgar S, 2003, LCS 15, GCS 24
2291 Zarrindast MR, 2003, LCS 8, GCS 19
2423 Zarrindast MR, 2004, LCS 8, GCS 12
2472 Zarrindast MR, 2004, LCS 12, GCS 16
2688 Zarrindast MR, 2004, LCS 18, GCS 29
3499 Zarrindast MR, 2005, LCS 10, GCS 12
4880 Zarrindast MR, 2006, LCS 8, GCS 11

*Cluster 7.*Chemical & drugs & heterocyclic compounds.

5. Cluster 10 is about *"Salivary Glands & Organ Phosphorus Compounds"* with 11 links. The most productive author is *Abdollahi* with 9 papers, then *Ranjbar* and *Akhgari* each with one paper. Most of the papers of this cluster are published in 2 journals (COMPARATIVE BIOCHEMISTRY AND PHYSIOLOGY C-TOXICOLOGY & PHARMACOLOGY and HUMAN & EXPERIMENTAL TOXICOLOGY). The paper of *Abdollahi* (paper number 462) with LCS 25, GCS 47 is the most influential paper.



462 Abdollahi M, 1997, LCS 25, GCS 47
546 Abdollahi M, 1997, LCS 9, GCS 13
616 Abdollahi M, 1998, LCS 14, GCS 15
1109 Abdollahi M, 2000, LCS 9, GCS 14
1131 Abdollahi M, 2000, LCS 8, GCS 11
1500 Ranjbar A, 2002, LCS 14, GCS 44
1948 Akhgari M, 2003, LCS 14, GCS 51
2050 Abdollahi M, 2003, LCS 12, GCS 25
2216 Abdollahi M, 2003, LCS 11, GCS 25
2352 Abdollahi M, 2004, LCS 8, GCS 35
2483 Abdollahi M, 2004, LCS 8, GCS 21

Cluster 10. Salivary glands & organ phosphorus compounds.

Conclusions

This paper analyzed 9047 records written by 18026 authors independently or cooperatively, published in 1475 journals, with 196871 cited references, and 16700 unique title words. The highest

number of publications produced was 2070 in 2007. The mean for GCS was 4.00, for cited reference (CR) was 27.72, and for number of author (NA) was 4.55.

Iranian publications in Medical Sciences tend to be published in journals with lower impact factors (IF). The publication count has grown at an approximate rate of 40.5%.

Main noticeable clusters are: *"Alkaloids & Organic chemicals*", *"Body Weight & Cardiovascular System - Metabolic Diseases"*, *"Physiological Effects of Drugs & Digestive System Disease & Alkaloids & RNA Viruses*", *"Chemical & Drugs & Heterocyclic Compounds*" and, "*Salivary Glands & Organ Phosphorus Compounds"*. The most productive institution is *"Tehran Med Sci Univ"* where Zarrindast, Dehpour, Shafiee and Larijani (the most productive authors) hold teaching positions in this university. USA ranked first in collaborating with Iranian authors in publishing papers. The (MS) literature is mainly written in English. *"Iranian Journal of Public Health*" is the top journal in which most papers have been published and the most productive authors within our set are *Zarrindast*, *Dehpour* and *Azizi*.

Contribution of Iran in production of Medical Sciences is showing a sharp increase after 2007 and a slightly decrease appears in 2008.

The findings pinpoint main research institutes, authors, subjects and core journals. Being recognized as main research institutes means that these institutes are more likely to secure their needed fund from the government. Moreover, being recognized as outstanding authors entails broader scientific cooperation and added prestige for their publications. Singling out main fields depicts Iranian authors' interests in (MS) domains. Finally, finding main journals helps library and information centers locate and procure core publication in (MS) domains with greater ease and at lower cost.

The results of this research can provide inclusive information for specialists to see which subject areas in their discipline have been under research by other investigators and would let the policy makers allocate adequate budgets to subject fields with more authority. Saving the time in reading the key papers is the other result for researchers.

Endnote

1. HistCite™ version 7.11.7 was used in this study

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