

## A scientometric investigation of the publication trends of Iranian medical informatics articles based on ISI Citation Databases

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### ABSTRACT

This study analyzed the qualitative and quantitative developments of medical informatics articles in Iran from 1987 to 2009, based on ISI Citation databases. The first phase of the analysis included date of publication, type of document, language of the article, source of publication, subject areas, and the countries involved in developing the articles. Citation indicators formed the second phase of investigation in this study. In the third phase, the citing articles were analyzed in terms of their date of publication, type of document, language, subject area, citation sources and the country where the citation had taken place. The publications, with some fluctuations, followed a rising trend until 2007, but after this date there was some decline in publishing such articles. Among 62 documented articles investigated, 58 were published in journals, and the remaining four were presented in conferences. The language of all 62 articles was English. Britain had the greatest contribution, i.e. 13 (21%) documents, in publishing such articles. Regarding their subject area, most of the articles, i.e. 28 (45%) documents, dealt with "health care sciences and health services". As for their source of publication, 7 (11.29%) articles had been published in the *Medical and Biological Engineering and Computing Journal*. The greatest number of citations belonged to 2005 while the greatest number of H-Index and citation average per year belonged to 2007. There were a total of 196 citations to 62 articles, out of 186 articles. 20% of all citing articles embarked upon self-citation. The overall average for referencing to each article was 3.16 and the H-Index of all Iranian medical informatics articles was 7. Most of the citing articles belonged to more recent years. The language of most citing articles was English. Most of the references to the articles first belonged to scholars from the United States, i.e. 41 (22%) times, and then to those from Iran, i.e. 40 (21.5%) times. The greatest number of citing articles (12 articles or 6.45%) were published in the *Journal of Medical and Biological Engineering and Computing*. Generally speaking, the year 2007 seemed to mark a turning point in publishing the greatest number of medical informatics articles from Iran. The articles published this year showed some improvement in quality as well.

**Keywords:** Medical Informatics; Scientometrics; ISI Citation Databases; Iran

### INTRODUCTION

Informatics, as a significant form of knowledge, is rooted in the science, technology and engineering of computer hardware, software, and communication [1]. The *ASIS Thesaurus of Information Science and Librarianship* defines informatics as the area of activity that represents the conjunction of information science and information technology [2]. According to Collen, medical informatics is a new knowledge domain of computer and information science, engineering and technology in all fields of health and medicine, including research, education and practice [3]. As Guenther has indicated, medical informatics refers to

information technologies that concern patient care and the medical decision-making process [4]. *Medical Subject Headings (MeSH)*, defines medical informatics as the field of information science concerned with the analysis and dissemination of medical data through the application of computers to various aspects of health care and medicine [5]. Informatics was born in early 1940, when computer was limited to a job title only. The term computer, at this time, was practically tantamount to giving a calculator and a set of formulae to a person to perform a set of computations [1]. Then, after nearly a decade, a new field known as medical informatics was introduced while, at the same time, medicine

also learned how to exploit the extraordinary capabilities of the electronic digital computers which, in turn, helped medical researchers to fulfill their complex information needs more effectively [3]. PubMed search also indicates that the first article on medical informatics was published in this decade, i.e. 1956 [6]. According to Collen, the first groups of articles on this subject appeared in the 1950s, followed by a rapid increase in the number of publications in the 1960s. In 1970s, medical informatics was introduced as a new field of specialty [3] although, according to Guenther, the term 'medical informatics' was used since the mid 1970 [4]. However, it was in 1987 when the term 'medical informatics' was first introduced in the *Medical Subject Headings (Mesh)* in the United States [5]. Now given that field specific thesaurus contains the terms and idioms which are commonly used in that particular field and that a term cannot enter the hierarchical structure of the thesaurus unless it secures its place in the scientific language of the field, we can consider 1987 as real birthplace of medical informatics in different fields of science. As such, it sounds logical to view 1987 as a starting point for the commencement of scientometrics studies in this field.

Scientometrics is the quantitative study of the disciplines of science based on published literature and communications. It intends to identify the emerging areas of scientific research, examine the development of research over time, and explore the geographic and organizational distribution of research [7]. Citation Reports of ISI citation databases (web of science) and Scopus are two important tools for the scientometrics. Nonetheless, since Scopus has started its citation reports after 1996 [8], publications prior to this date are accessible only thorough the reports of ISI citation databases.

Bearing in mind the significant position of medical informatics in developing health sciences on the one hand, and the rapid development of graduate education in medical informatics in Iran on the other, the current study is to investigate the publication and citation status of Iranian research articles in medical informatics, based on the citation reports of ISI. According to our investigation, no research had already been carried out on this issue in Iran. Results of such research could provide a better insight on the scientific status of Iranian researches in terms of the type and number of research articles they have

recorded in medical informatics. Also the results can help the relevant authorities to develop better policies with active participation in the growth and development of medical informatics in both national and international arenas.

Many of the studies carried out thus far have a lot in common with the current study in terms of methodology, subject area or databases they have employed. Bearing in mind this point, this study will exclusively focus on the studies that are more comparable to the current work in terms of subject area and methodology. DeShazo and colleagues in the year 2009 used MeSH to study the publication trends in the medical informatics literature. The purpose of their study was to identify publication output, and research areas. They also intended to identify the publication trend of the field of medical informatics descriptively and quantitatively over a period of 20 years (1987–2006) [9]. Mendis tried to obtain an overview of Australian health informatics (HI) research through a bibliometric analysis, using PubMed in 2007. In this study, Australian Health Informatics publications from 1970 to 2005 were studied [10]. LaVallie and colleagues surveyed the "evolution" of the field of medical informatics by describing trends in quantity of medical informatics-indexed publications, identifying major journals being published, with their area of focus, and presenting trends in impact factor scores from 1994 to 2003. The changes they have indicated, in terms of total impact-scores, suggest an increasing trend in the publication of high impact journals [11]. Synnestvedt and colleagues in the year 2005 have embarked upon a study, entitled "Visual Exploration of Landmarks and Trends in the medical informatics Literature". The study presents preliminary results from a visual study of a new dataset, with forty years of data citation record (i.e., 1964 - 2004), from twelve journals on medical informatics. The study resorts to a progressive (knowledge-domain) approach in order to visually map different issues such as the pivotal documents, with high citations in medical informatics, and the emerging research topics. It continues to detect and visualize the trends and patterns in scientific literature of the field [12].

Scientometrics studies in Iran started in 2005 [13]. Based on our investigations, there is no particular research on scientometrics of medical informatics yet, although researches have relied on scientometric methodology to

explain publication trends of scientific fields, or to show geographic and organizational distributions of scientific publications. Shahbodaghi and colleagues follow a comprehensive study of the articles published by faculty members of Shahid Beheshti University of Medical Sciences and their citation status, as reported by the Institute for Scientific Information (ISI), from 1998 to 2007 [14]. Amirjalali in the year 2008 compared the scientific output of medical science universities of Iran on pediatrics medicine, using the Pubmed database. According to the results, Tehran University of Medical Sciences had participated in 25 percent of the publications dealing with pediatric science [15]. Rezaie Ghale's study assessed the productivity of research on diabetes. It also evaluated the gap between research on diabetes and those carrying the burden, in both developed and developing countries. The study performed an extensive search in PubMed database for diabetes publications, using diabetes as the MeSH term. The aim was to identify the proportion of diabetes publications from countries of different regional and economic classifications in 1992, 1997 and 2002 [16].

## MATERIALS AND METHODS

This research belongs to Scientometric studies. The population under study is composed of Iranian medical informatics articles that have been published during 1987 to 2009 and then reported in the ISI citation databases. Web of Science, the powerful tool of ISI, has been used to collect the research findings. To collect the data, two search activities were performed. In the first search, the subject headings of the Medical Subject Headings (MeSH), known as medical informatics, together with all its subsets and their entry terms were identified and then searched in the topic field of advance search of Web of Science for a time span of 1987 to 2009. In the next step, the collected data (results) were subjected to content analysis to identify those dealing with medical informatics. According to this analysis a total of 7796 articles dealt with medical informatics. The last step involved the analysis of articles in relation to the countries of their origin, according to which only 17 articles belonged to Iran. To make sure of the accuracy of the results, the researcher compared the search results against the total number of scientific publications of the

country. Accordingly, the second series of search were performed, using the country's label for a period of 1987 to 2009. According to the results, in this period, a total of 71043 articles carried Iran's name in the ISI Citation databases. Content analysis of the articles indicated that the subject area of 62 articles dealt with medical informatics. So the results of the first search were not approved. Then, further analysis of the results of the 62 articles of the second search was carried out. It is necessary to mention that all the search and retrieval functions were performed on 24 and 25 of July.

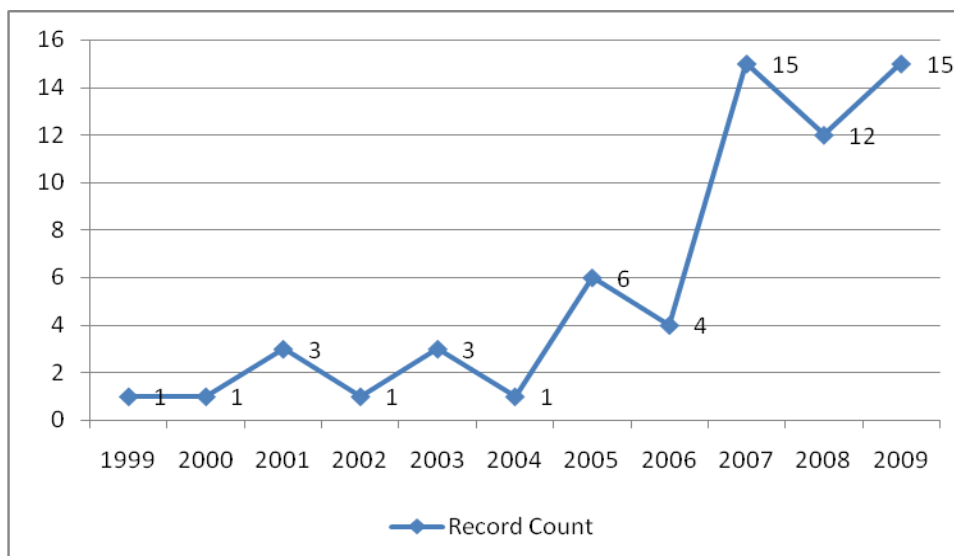
In terms of publication date, document types, type of language, publishing countries, subject area and publication source, all the 62 articles were analyzed. Then, the citation status of the articles, in terms of sum of the times cited, citation average per article, H-Index, citation average per year since the publication date and self citation was investigated. In the end, the citing articles were further analyzed for issues like their date of publication, type of document, language, citing countries, subject area and publishing sources.

## RESULTS

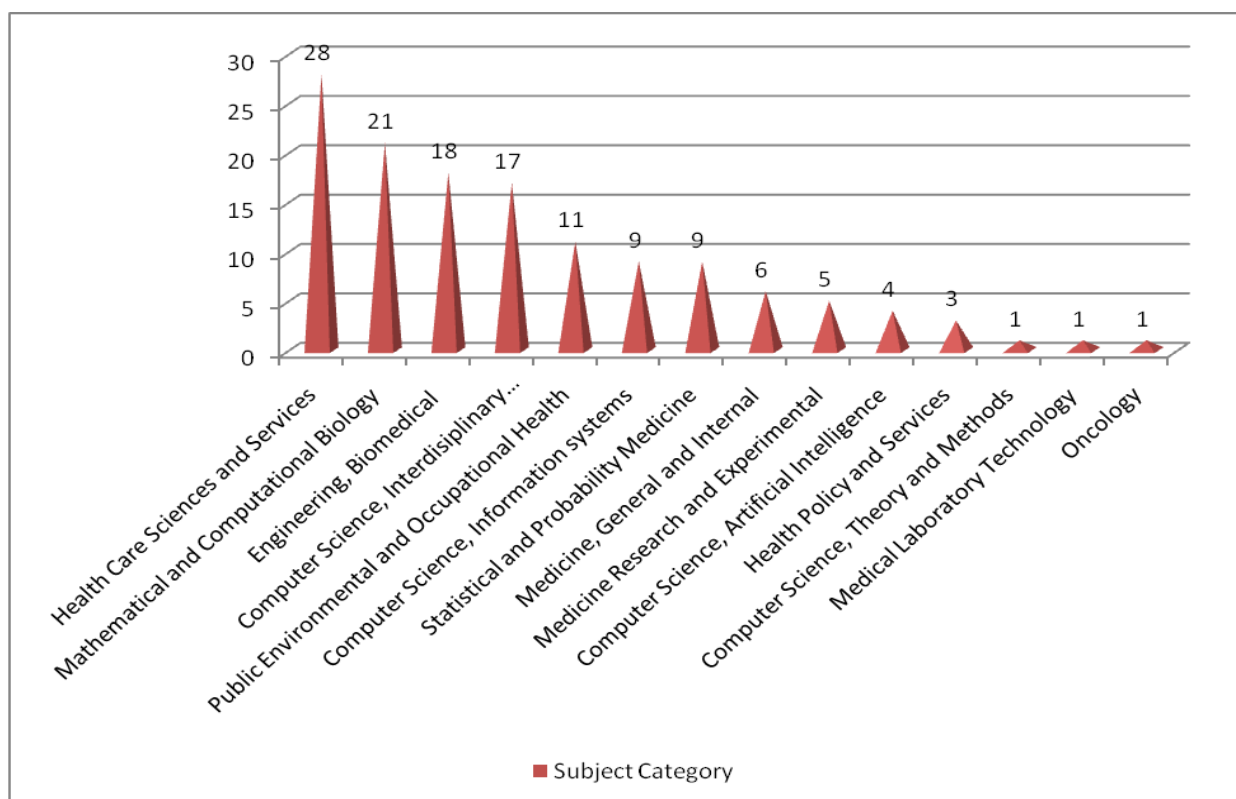
According to the results, Iranian scholars did not have any articles on medical informatics in the ISI citation databases from 1987 to 1999, but in 1999 they had their first article appear in this database. As Figure 1 shows, Iranian articles on medical informatics follow a rising trend, with some fluctuations of course, until 2007 although in 2008 the trend slows down a little. In 2009, also, there is no significant progress, compared to the rising trend in 2007.

The analysis of data based on document type indicated that, of the 62 documents, 58 articles (94%) appeared in journals while four articles were presented in conferences. The language of all 62 articles was English. Regarding the countries publishing the articles, Britain with 13 (21%) articles, Sweden with 10 (16%), the USA with 8 (13%), Australia 3 (5%), Canada 3 (5%), Whales 2 (302%), and other countries like Finland, Japan, Holland, Scotland, Spain, Switzerland, Taiwan, and Turkey, each with 1 (1.6%) article, were involved in this process. The language of all 62 articles was English.

As Figure 2 indicates, the greatest number of publications (i.e. 28 articles) dealt with, "health care sciences and services".



**Figure 1:** Distribution of Iranian medical informatics articles, based on their date of publication

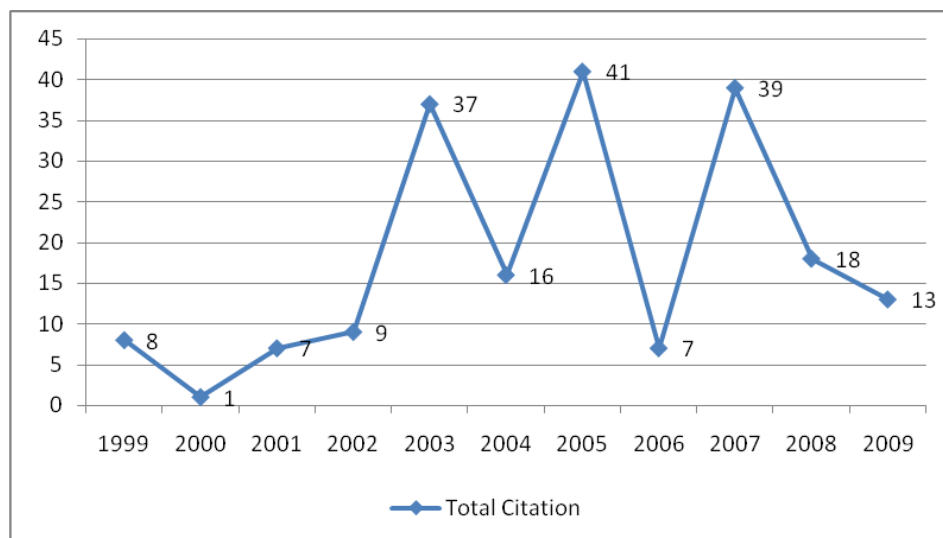


**Figure 2:** Distribution of subject categories of Iranian medical informatics articles

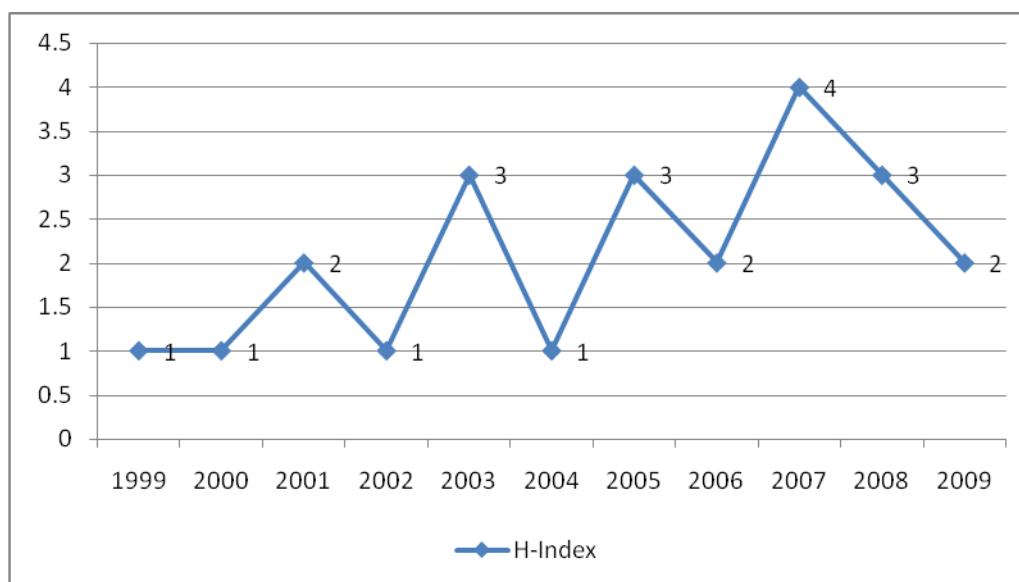
Regarding their source of publication, the *Medical and Biological Engineering and Computing Journal* (with Impact factor=1.757 in the year 2009) [17], published 7 articles (11.29%), while two other journals, i.e. *International Journal of Technology Assessment in Health Care* (with Impact factor=1.794 in the year 2009)[18] and *Journal of Evaluating Clinical Practice* (with Impact factor=1.487 in the year 2009)[19], each published 6 articles (9.68%).

Here, in an attempt to identify the trend

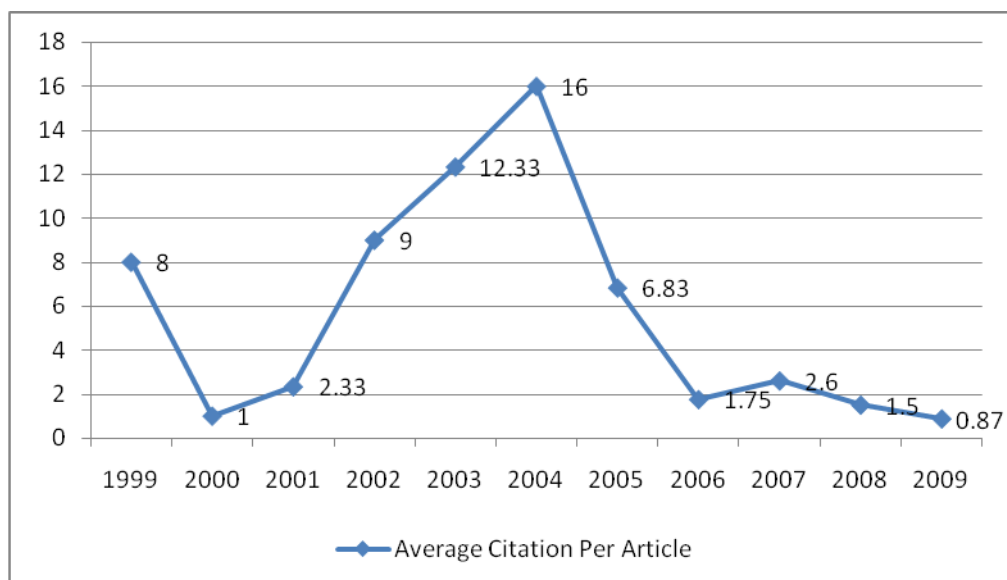
related to the quality of medical informatics articles, the necessary data were obtained based on their publication date and then the relevant Figures were presented. As Figure 3 indicates, articles published in 2005 achieved the greatest number of citation. Also according to Figures 4 and 6, in terms of H-index and the average citations for each article per year, the greatest number of articles was published in 2007. The average for greatest citation per article belonged to 2002.



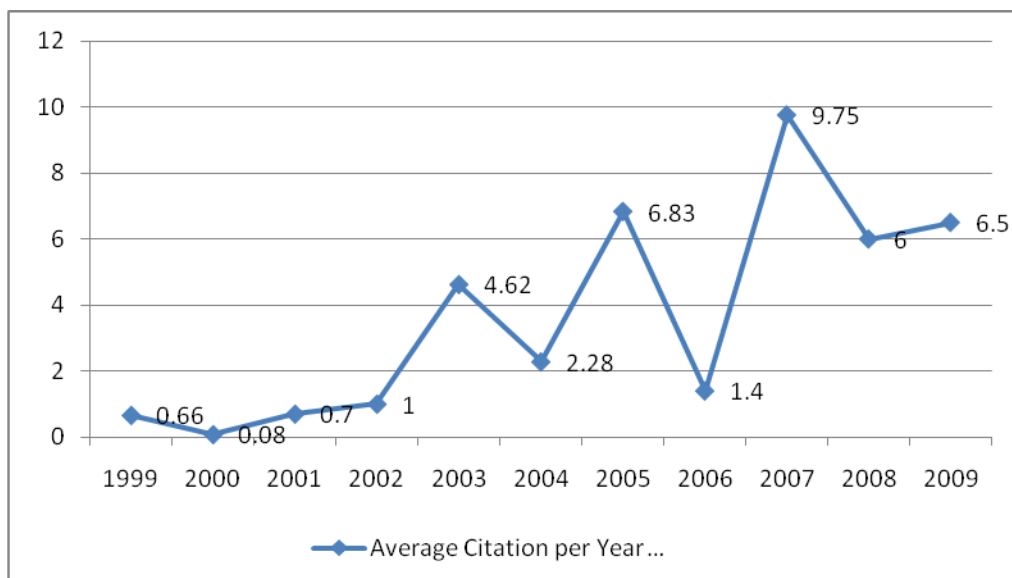
**Figure 3:** Distribution for citation rates according to their publication year



**Figure 4:** Annual H-index of the articles



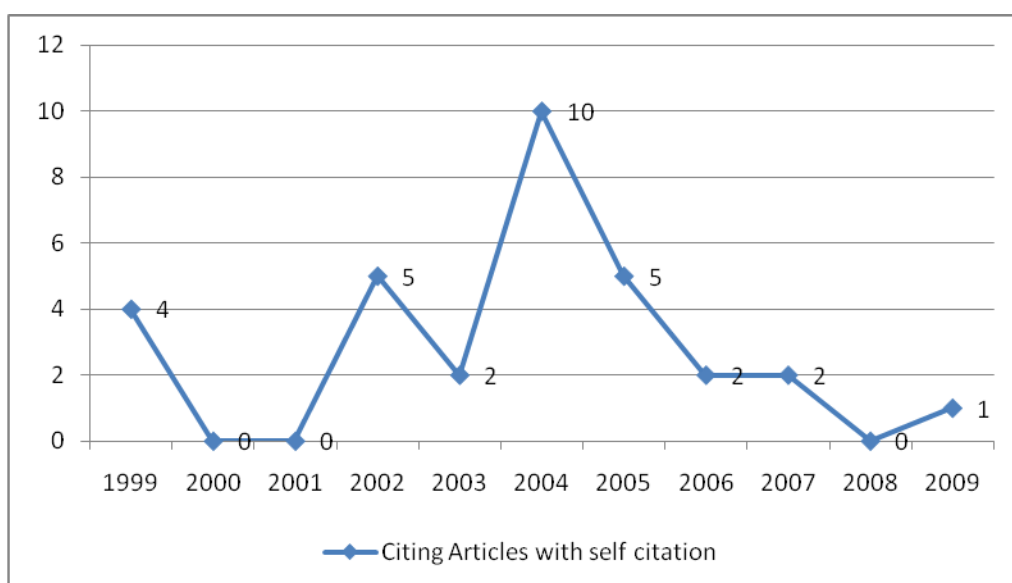
**Figure 5:** Citation average per article, according to their publication year



**Figure 6:** Citation average per year, since the publication date of the articles

Regarding the number of self-citations, the citing articles were first identified. Then the self-cited articles were spotted. According to our search, there were a total of 196 citations to 62 articles, out of 186 articles, belonging to

Iran's medical informatics. Further investigation revealed self-citations in 39 articles (forming 20.1% of all citing articles). Figure 7 shows the self-citation trend in articles under study.

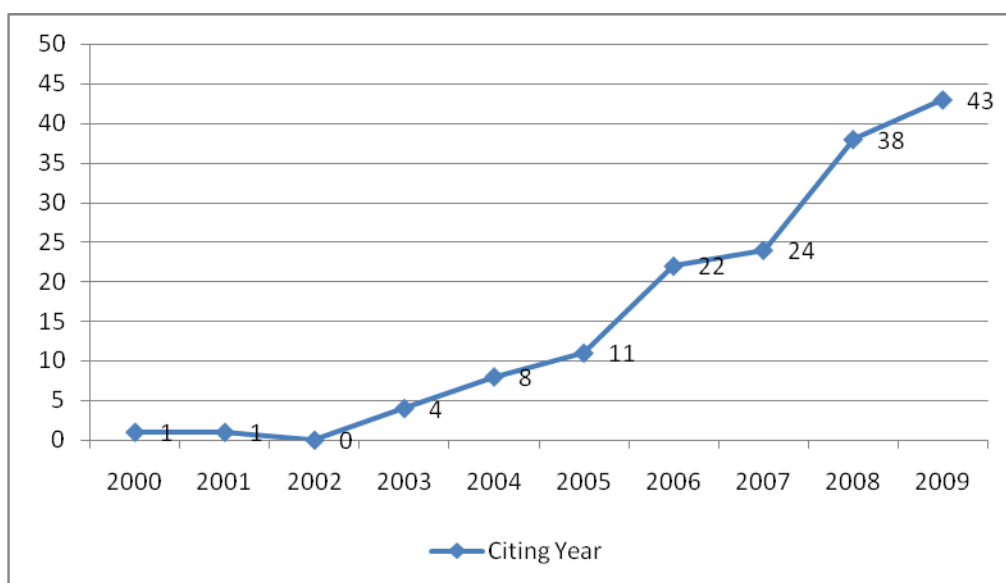


**Figure 7:** Self-citation distribution of Iranian medical informatics articles

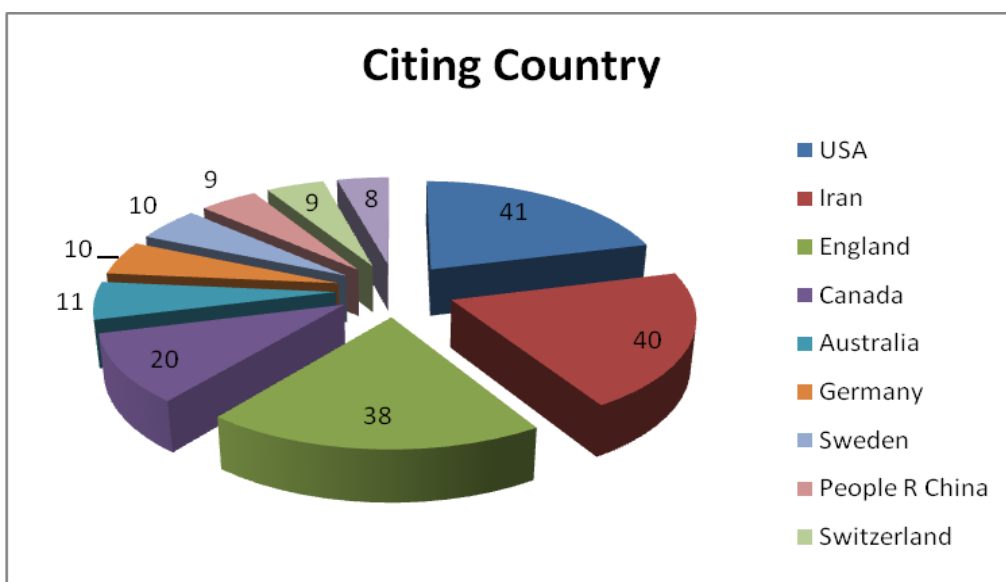
According to the analysis, the overall citation average per article was 3.16 and the H-index for all medical informatics articles from Iran was 7. Further investigation of the citing articles showed that the 62 articles from Iran's medical informatics had been cited 151 times in journals and 35 times in conferences. Regarding the publication year of the citing articles, most of the citing articles have been published in recent years, as Figure 8 shows, and the citation frequency shows a steady rise

over time as we get closer to more recent years.

Further studies show that 183 citing articles (i.e. 98.4% of them) were written in English while just three of them were in French, Polish and Turkish languages. Regarding their country of origin, as Figure 8 above indicates, the greatest number of citations first belonged to researchers from the U.S. (i.e. 41 citations, 22%) and then to those from our country, Iran (i.e. 41 citations, 22%).



**Figure 8:** Distribution of citing articles, based on their publication year



**Figure 9:** Distribution of countries citing Iranian medical informatics articles

In terms of source of publication, the greatest number of citing articles (i.e. 13 articles, 6.45%) appeared in *Medical & Biological Engineering & Computing* (impact factor = 1.757 in 2009) [17], the next greatest number (i.e. 8 articles, 3.4%) in statistics in medicine (impact factor = 1.99 in 2009) and the fewest number (i.e. 6 articles, 3.22%) in *Journal of Evaluation in Clinical Practice* (impact factor=1.487 in 2009)[19] respectively.

## DISCUSSION

According to the results of the current study, from 1987, when the term “medical informatics” developed and its subtitles entered in the American *Medical Subject*

*Heading* [5], to 1999 there were no publications from Iranian scholars on this subject area. So given that the citation reports of the ISI databases indicate the international position of sciences, the year 1999 was the beginning of the entrance of Iranian scholars into the field of medical informatics. As Figure 1 indicates, 2007 is the year when our scientists published the greatest number of articles on medical informatics. Before 2007, there were fluctuations in the number of articles published by our scholars although the overall trend indicated a rising pattern. In 2008, there was a slight set back in the number of publications and in 2009, compared with 2007; there was no significant rise in the number of publications. It is difficult to

specifically refer to factors accounting for the decline because, on the one hand, medical informatics has received more attention in Iran recently as evidenced by a sharp rise in its postgraduate education and, on the other hand, the 2009 articles are still being entered into the databases following a long delay awaiting for citation. Nonetheless, the trend indicating the publication curve seem to be alarming for those involved in medical informatics in Iran, Particularly those involved in research on this subject area.

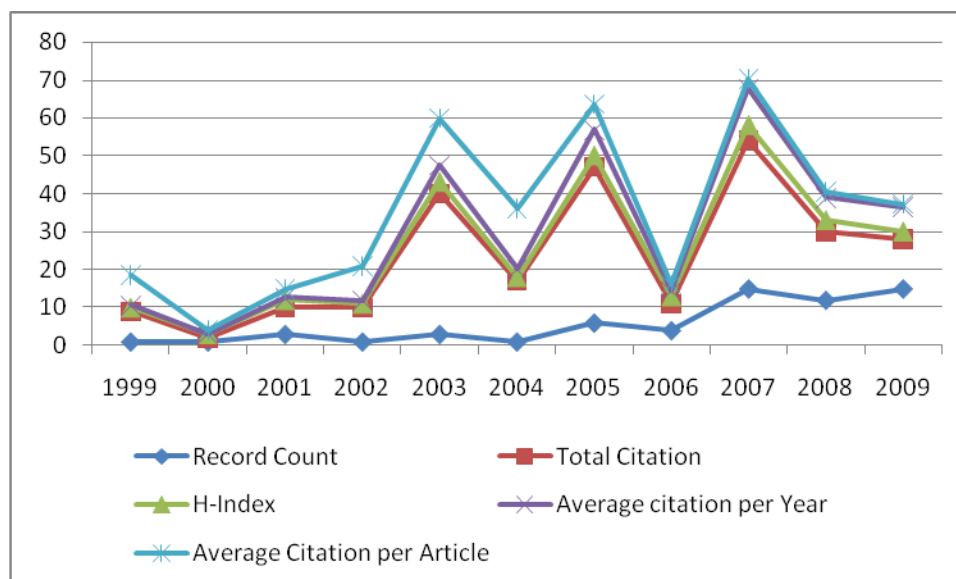
The results indicated that 58 (94%) articles, out of 62 Iranian informatics articles, were published in journals while just four articles were presented in conferences. Considering that presenting in international conferences can enhance the country's research record both qualitatively and quantitatively, a poor record in international conferences has to be dealt with properly.

All the 62 articles were written in English. This may indicate that the dominant language of ISI citation databases is English and that the articles written in Farsi lose the chance of being published in the ISI databases. This can also indicate that English is the international language of science. Anyway, it is essential to have an ongoing program to enhance the capabilities of our researchers in medical

informatics to publish more articles in English; likewise it seems logical to publish more journals in English, which meet international standards on medical informatics.

According to Figure 2, the articles dealing with subject areas of Health Care Sciences and Services included the greatest number of articles (28 articles or 45%). In this regard, content analysis of the articles based on the tree diagram of medical informatics of the Medical Subject Headings (MeSH) of American National Library of Medicine is recommended. This could help to identify the subject orientation of our country's medical informatics articles.

The results show that most citations happened in 2005. Also the highest rate of H-Index and average citation per year belonged to 2007. The average citation per article was also the highest in 2002. Among different measures used to identify the quality of Iranian articles on medical informatics, the greatest rates of H-Index and average citation per year belonged to 2007 articles. Therefore, it can be concluded that the year 2007 marked a rising trend both qualitatively and quantitatively for Iranian articles on medical informatics. This is clearly indicated in Figure 10, below.



**Figure 10:** A rising trend in the quality and quantity of Iranian articles on medical informatics

The results indicated a rising distribution based on the publication years for the citing articles. That is, the number of Iranian medical informatics articles increased over time. This may indicate the growing influence of our country's articles on the medical informatics

science worldwide. In other words, Figure 8 may duly indicate the development of a rising trend in the quality of articles on medical informatics published in Iran.

Further investigations showed that the language of citing articles were mostly (183



articles, 98.4%) English and that, among different countries, the biggest citations belonged to the United States, with 41 citations (22%), followed by our own country with 40 citations (21.5%). The results once again show the importance of persuading our researchers to publish articles in an international language. Language is certainly the most significant medium of establishing communication to impart knowledge. According to a Shannon Weaver Model of Communication, one of the conditions for proper exchange of message is the existence of a common language between the sender of the message and its receiver. It is obvious that even the best research published in Farsi will have little chance of being subjected to international audiences. Nonetheless, removing language obstacles and presenting research findings in international arenas can help to enhance references made to articles, thereby exerting greater impact on the relevant science.

As for the publication of citing articles and Iranian medical informatics articles, journals of *Medical and Biomedical Engineering and Computing* (impact factor = 1.757 in the year 2009)[17] and *Journal of Evaluation of Clinical Practice* (impact factor = 1.487 in the year 2009)[19] occupy the first three ranks. Whether this position is due to self citation or other factors has to be investigated in future studies.

In the end, further qualitative and quantitative scientometric studies have to be carried out both nationally and internationally, in line with planning and policy making strategies, in order to map up our national scientific work on medical informatics. Such studies, along with research plans on our domestic needs, can be used to identify our research priorities in the world of science. There is no doubt that in a knowledge based society, research is the most important source in all areas of decision making at micro- and macro-levels. Identifying research priorities in medical informatics and encouraging scientists to follow such priorities could provide the necessary data for formulating micro and macro policies and making proper decisions for all the theoretical and practical issues in medical informatics.

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