Medical Informatics: A Scientometric Study Based On Scopus Database

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Abstract

This study presents the Scientometric analysis on Medical Informatics literature research outputs. The study covers a period of 10 years from 2007 to 2016. The data for the study was downloaded from the Scopus Database. The study found that there are 14366 publications contributed to the Medical Informatics literature across the globe. It reveals that more number of published literatures in the first half of the study period got more citations than the one in the second half. Collaborated research work dominates the area of study. United States of America has produced more number of research outputs and Article is the most preferable form among the bibliographical forms of publications. English is the most preferable language of communication. "Studies in Health Technology and Informatics", book series is the most preferable source of communication for the researchers in this area to publish their works. Harvard Medical School is the highest contributor among the Institutions.

Keywords

Scientometrics, Medical Informatics, Authorship Pattern, Citation Analysis, Scopus Database, Relative Citation Index and Relative Uncitedness Index.

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INTRODUCTION

Medical Informatics is found at the intersection of healthcare and technology. It is where skills in both medical and computer sciences come together in an effort to improve healthcare and patient outcomes. Professionals in this hybrid field draw on expertise from both disciplines to put technology to its best use in patient care, clinical and research settings.

METHODOLOGY

The study aims to analyze the global contributions to the Medical Informatics research outputs. The data for the study was downloaded from the Scopus database. The study covered a period of 10 years from 2007 to 2016. Bibliometric/Scientometric Indicators on Authorship Pattern, Citation studies were analyzed in the study. The following search string has been used for the study to download the data and for the analysis and preparation of tables SPSS and Excel software has been used.

(TITLE-ABS-KEY ("Medical Informatics") AND PUBYEAR > 2006 AND PUBYEAR < 2017)

REVIEW OF LITERATURE

Bhardwaj (2014) studied the India's contribution to the dengue fever research for a period of 40 years from 1973-2012 based on the SCOPUS database and found that the Indian scientists frequently collaborated with Americans, the British, Swiss and Canadians. Bansal et al. (2016) analyzed the Indian output on Hepatitis C for a period of ten years from 2005 to 2014 with the following parameters: publication growth, global rank, citation impact, share of international collaborative papers and medium of communication. Ho, Siu and Chuang (2016) made a bibliometric analysis on dengue-related publications from 1991 to 2014 and found that the average number authors per article increased from 4.0 to 6.7 during the period. Sweileh, et al (2017) analyzed the world-wide scientific literature in mobile health during the period 2006 – 2016 and found that most of the publications were by article type. Yang, et al (2017) carried out a bibliometric study to identify publication trends in the field of telemedicine within the past two decades. Zhang, et al (2016) performed a bibliometric analysis focusing on studies involving male infertility worldwide during the period 1995-2014 and found that the USA and its institutions play a dominant role. Koo (2017) studied the profile of research articles on aromatherapy published in the past two decades

(1995–2014) and found that half of the total publications were from non-English speaking countries.

OBJECTIVES OF THE STUDY

- To study the global publications trend on Medical Informatics research outputs published during the study period 2007-2016
- To study the Authorship pattern on publications
- To identify the most prolific authors in this area of research
- To study the Citation Analysis on publications
- To study the uncited publications
- To find out the highly cited publications
- To identify the most preferred bibliographic form of documents for publishing the research outputs
- To examine the geographical contributions to the research output
- To find out the top ten authors who contributed to the literature
- To study the prolific Institutions contributed to the literature
- To study the language wise distribution of published literature

LIMITATIONS OF THE STUDY

This study is limited to publications indexed in Scopus database only. The duration of the study confines to ten years (2007-2016) only.

DATA ANALYSIS & RESULTS

Table 1 represents the yearly distributions of publications and its citation analysis. Citation is an important factor for any research output, which is being used to measure its quality. The Citation per Paper (CPP) is the ratio between total numbers of citations received/ total number of publications in a specific period of time. Relative Citation Index (RCI) (Kumari, 2009), is an indicator of influence and visibility of research in global perspective, is defined as the proportion of an entity's share of world citations to that entity's share of world publications (RCI = C%/P%). An entity's citation rate is equal to the world's citation rate if, RCI value is equal to one. If, RCI >1 indicates that an entity's citation rate is higher than the world's citation rate and RCI<1 indicates that that entity's citation rate is less than the world's citation rate. In this study, we have applied the same on yearly distribution of publications.

Table 1: Citation Analysis on Yearly Distribution of Publications

S. N.	Year	TP	TP (%)	CP	CP (%)	TC	Citations (%)	CPP	RCI
1	2007	1144	7.96	839	8.63	18487	14.11	16.16	1.77
2	2008	1096	7.63	776	7.99	15935	12.17	14.54	1.60
3	2009	1338	9.31	971	9.99	20795	15.88	15.54	1.71
4	2010	1338	9.31	895	9.21	16128	12.31	12.05	1.32
5	2011	1444	10.05	1038	10.68	15726	12.01	10.89	1.20
6	2012	1624	11.31	1152	11.86	13112	10.01	8.07	0.89
7	2013	1689	11.76	1156	11.90	13688	10.45	8.10	0.89
8	2014	1937	13.49	1330	13.69	10287	7.85	5.31	0.58
9	2015	1770	12.32	1091	11.23	5446	4.16	3.08	0.34
10	2016	986	6.86	468	4.82	1371	1.05	1.39	0.15
	Total	**14366**	**100.00**	**9716**	**100.00**	**130975**	**100.00**	**9.18**	

(TP – Total Publications; CP – Cited Publications, TC- Total Citations, CPP – Citations per paper, RCI- Relative Citation Index)

The above table represents the yearly distribution of publications on Medical Informatics during the study period from the year 2007 to 2016. During the period, 14366 publications were produced the highest number of publications were reported in the year 2014 with 1937 publications followed by 1770 in 2015 and 1689 in 2013 publications respectively. In the overall productivity of 14366 publications, 9716 (67.63%) publications were cited and received 130975 citations. The average citation per paper (CPP) was 9.18. The Relative Citation Index varies between 0.15 and 1.77 during the study period. The RCI shows that more number of publications in the first half were received more number of citations when compares to the publications in the second half of the study period.

Uncited Publications

The Relative Uncitedness Index (RUI) (Carg K C & Kumar S 2014) which is going to be used in this study to measure the uncitedness of yearly distribution of publications. RUI is the ratio of the share of uncited articles to the share of total articles. The value of RUI can be zero or more. Higher RUI value indicates less citation impact and zero RUI value indicates that there is no uncited article for the calculating unit.

Table 2: Uncitedness of Index on Yearly Distribution of Publications

Year	TP	TP (%)	UCP	UCP (%)	RUI
2007	1144	7.96	305	6.56	0.82
2008	1096	7.63	320	6.88	0.90
2009	1338	9.31	367	7.89	0.85
2010	1338	9.31	443	9.53	1.02
2011	1444	10.05	406	8.73	0.87
2012	1624	11.31	472	10.15	0.90
2013	1689	11.76	533	11.46	0.97
2014	1937	13.49	607	13.05	0.97
2015	1770	12.32	679	14.60	1.18
2016	986	6.86	518	11.14	1.62
Total	**14366**	**100.00**	**4650**	**100.00**	

(TP – Total Publications; UCP – Uncited Publications, RUI- Relative Uncitedness Index)

The above table shows that 4650 (32.37%) publications out of the total productivity have not received any citations yet. The Relative Uncitedness Index varies between 0.82 and 1.62 during the study period. It further reveals that more number of published works in the second half of the study period were went uncited when compared to the published works in its first half.

Table 3 represents the authorship pattern of the Medical Informatics results outputs. The publications during the study period were categorized as single authored and multi authored publications viz., two authors, three authors, four authors and five and above authors (publications which contributed by five and more than five authors are categorized as a single entity). In this study, average number of authors per article was calculated by total number of authors/total number of publications and average number of articles per author was calculated by total number of publications/total number of authors and the same has been tabulated. Further, the authorship collaboration in publications during a specific time period can be calculated using the Degree of Collaboration (DC) indicator (Subramaniyam, 1983). The Degree of Collaboration (DC) among authors is the ratio of the number of collaborative publications versus the total number of publications published in a discipline during certain period of time and the same can be calculated using the formula DC = $N_m/(N_m+N_s)$; where, N_m = Number of multiple authors publications during a specific period in a discipline and N_s= Number of single authored publications in the discipline during the given period of time.

Table 3: Authorship Pattern

S. No.	Number of Authors	Public cations	(%)	Total Authors
1	Single Author	4054	28.22	4054
2	Two Authors	2435	16.95	4870
3	Three Authors	2201	15.32	6603
4	Four Authors	1679	11.69	6716
5	Five ≤ Authors	3997	27.82	19985
	Total	**14366**	**100.00**	**42228**
Average Number of Authors per article = 2.94				
Average Number of Article per Author = 0.34				
Degree of Collaboration = 0.72				

The above table shows that there are 4054 (28.22%) publications were contributed by single authors and the remaining (71.78%) were from collaborated works. In the collaborated research works category five and above authors contributed 27.82% of the total productivity followed by two authored contributions with 16.95% and three authored contribution with 15.32% of the total publications respectively. Approximately there are 42228 authors contributed to the literature. Average number of authors per article is 2.94 and average number of article per author is 0.34. The Degree of collaboration in publication stood at 0.72 during the study period.

Table 4: Prolific Authors

S. No.	Name of the Author	No. of Publications	(%)
1	Hagland, M.	67	0.47
2	Haux, R.	67	0.47
3	Conn, J.	63	0.44
4	Ammenwerth, E.	55	0.38
5	Bates, D.W.	50	0.35
6	Ohno-Machado, L.	44	0.31
7	Borycki, E.M.	43	0.30
8	Lovis, C.	42	0.29
9	Sittig, D.F.	41	0.29

10	Kushniruk, A.W.	40	0.28
11	Other Authors	13854	96.44
	Total	**14366**	

The above table represents that the authors Hagland, M. and Haux, R has published 67 papers each and ranked top in terms of publications during the study period followed by author Conn, J who has published 63 papers.

Table 5: Distribution of Publications

S. No.	Country	Pub.	Share (%)	Bibliographic Form	Pub.	Share (%)	Language	Pub.	Share (%)
1	USA	5080	35.36	Article	8227	57.27	English	13771	95.86
2	United Kingdom	1108	7.71	Conference Paper	2460	17.12	French	120	0.84
3	Germany	731	5.09	Review	1406	9.79	Spanish	109	0.76
4	Canada	629	4.38	Editorial	891	6.20	German	106	0.74
5	Australia	522	3.63	Note	591	4.11	Chinese	94	0.65
6	France	465	3.24	Short Survey	362	2.52	Japanese	50	0.35
7	Netherlands	353	2.46	Letter	277	1.93	OtherLanguages	116	0.81
8	Spain	343	2.39	Others forms	152	1.06			
9	South Korea	333	2.32						
10	Italy	324	2.26						
11	Other Nations	4478	31.17						
	Total	**14366**		**Total**	**14366**		**Total**	**14366**	

The above table represents that United States of America has contributed 35.36% of the total productivity and ranked top among the countries which is followed by United Kingdom with 7.71% and Germany with 5.09% of the total productivity respectively. The researchers in this area of study has preferred Articles as their most preferable form of communication to publish their research works and it occupies more than half (57.27%) of the total productivity which is followed by Conference paper with 17.12% and Reviews with 9.79% respectively on total productivity. A lion's share of 95.86% of the publications was published in English language.

Table 6: Highly Cited Publications

Year	NOA	Authors	Title	Source	NoC
2009	6	Harris, P.A., et al.,	Research electronic data capture (REDCap)-A metadata-driven methodology and workflow process for providing translational research informatics support	Journal of Biomedical Informatics	3828
2013	90	Mancia, G., et al.,	2013 ESH/ESC guidelines for the management of arterial hypertension: The Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC)	European Heart Journal	1678
2010	10	Wolfe, F., et al,	The American College of Rheumatology preliminary diagnostic criteria for fibromyalgia and measurement of symptom severity	Arthritis Care and Research	1155
2007	20	Rosenfeld, R.M., et al.,	Clinical practice guideline: Adult sinusitis	Otolaryngology - Head and Neck Surgery	577
2012	15	Fedorov, A., et. al.,	3D Slicer as an image computing platform for the Quantitative Imaging Network	Magnetic Resonance Imaging	532
2011	10	Black, A.D., et al.,	The impact of ehealth on the quality and safety of health care: A systematic overview	PLoS Medicine	478

2007	4	Canalis, E., Mazziotti, G., Giustina, A., Bilezikian, J.P.	Glucocorticoid-induced osteoporosis: Pathophysiology and therapy	Osteoporosis International	465
2008	3	Häyrinen, K., Saranto, K., Nykänen, P.	Definition, structure, content, use and impacts of electronic health records: A review of the research literature	International Journal of Medical Informatics	463
2010	2	Aronson, A.R., Lang, F.-M.	An overview of MetaMap: Historical perspective and recent advances	Journal of the American Medical Informatics Association	453
2009	3	Park, N., Kee, K.F., Valenzuela, S.	Being immersed in social networking environment: Facebook groups, uses and gratifications, and social outcomes	Cyberpsychology and Behavior	442
2011	4	Buntin, M.B., Burke, M.F., Hoaglin, M.C., Blumenthal,D.	The benefits of health information technology: A review of the recent literature shows predominantly positive results	Health Affairs	428
2008	6	Berghöfer, A., et al.,	Obesity prevalence from a European perspective: A systematic review	BMC Public Health	423
2010	2	Holden, R.J., Karsh, B.-T.	The Technology Acceptance Model: Its past and its future in health care	Journal of Biomedical Informatics	419
2009	1	Blumenthal, D.	Stimulating the adoption of health information technology	New England Journal of Medicine	415
2007	4	Siegel, J.D., Rhinehart, E., Jackson, M., Chiarello, L.	Management of multidrug-resistant organisms in health care settings, 2006	American Journal of Infection Control	399

(NoA – Number of Authors; NoC: Number of Citations)

The eight year old article on "Research electronic data capture (REDCap)-A metadata-driven methodology and workflow process for providing translational research informatics support" by Harris, P.A., et al., published in Journal of Biomedical Informatics has been cited by a maximum of 3828 times.

Table 7: Prolific Sources for Publications

S. No.	Name of the Source	No. of Publications	Percentage (%)
1	Studies in Health Technology and Informatics	1900	13.23
2	Journal of the American Medical Informatics Association	479	3.33
3	Journal of Biomedical Informatics	396	2.76
4	International Journal of Medical Informatics	355	2.47
5	Healthcare Informatics Research	254	1.77
6	Healthcare Informatics the Business Magazine for Information and Communication Systems	252	1.75
7	Methods of Information in Medicine	231	1.61
8	Yearbook of Medical Informatics	208	1.45
9	AMIA Annual Symposium Proceedings AMIA Symposium AMIA Symposium	186	1.29
10	Modern Healthcare	166	1.16

11	BMC Medical Informatics and Decision Making	146	1.02
12	Journal of Medical Systems	140	0.97
13	Journal of Medical Internet Research	118	0.82
14	Journal of the American Health Information Management Association	109	0.76
15	Journal of AHIMA American Health Information Management Association	105	0.73
16	Other Publications	9321	64.88
	Total	**14366**	

From the above table it is observed that Studies in Health Technology and Informatics has published the highest number of papers in this area of research with 1900 (13.23%) publications and ranked top among the sources of publications which is followed by Journal of the American Medical Informatics with 479 (3.33%) and Journal of Biomedical Informatics with 396 (2.76%) publications respectively.

Table 8: Prolific Institutions

S. No.	Name of the Institution	No. of Publications	(%)
1	Harvard Medical School	322	2.24
2	VA Medical Center	250	1.74
3	Brigham and Women's Hospital	214	1.49
4	Columbia University in the City of New York	184	1.28
5	Inserm	174	1.21
6	University of Washington, Seattle	169	1.18
7	Vanderbilt University	127	0.88
8	National Institutes of Health, Bethesda	125	0.87
9	University of Victoria	124	0.86
10	University of Utah	121	0.84
11	University of California, San Francisco	118	0.82
12	University of Toronto	115	0.80
13	Massachusetts General Hospital	113	0.79
14	University of Pittsburgh	111	0.77
15	Mayo Clinic	106	0.74
16	Other Institutions	11993	83.48
	Total	**14366**	

Harvard Medical School ranked top among the Institutions in publications with 322 (2.24%) contributions followed by VA Medical Center with 250 (1.74%) and Brigham and Women's Hospital with 214 (1.49%) publications respectively.

FINDINGS

- There are 14366 publications were reported to the during the study period 2007-2016.
- In the overall productivity, 67.63% of the publications were cited and yielded 130975 citations with an average value of 9.18 citations per paper.
- Relative Citation Index (RCI) indicates that more number of publications received more number of citations in the first half of the study period.
- Relative Uncitedness Index (RUI) indicates that there is a raise in uncited publications during the second half of the study period.
- Multi-authored publications outnumbered single authored publications during the study period shows that the researchers in this field prefer collaborated research works rather than an individual one.
- Authors, Hagland, M. and Haux, R published a maximum of 67 papers each during the study period.
- United States of America has contributed maximum number of publications during the study period.
- "Article" is the most preferable form of communication among the researchers.
- "English" is the most preferable languages for communication among the researchers.
- An article by Harris, P.A., published in the Journal of Biomedical Informatics in the year 2009 yielded a maximum of 3888 citations.

- "Studies in Health Technology and Informatics", book series is the most preferable source of communication for the researchers in this area to publish their research works.
- Harvard Medical School is the highest contributor among the Institutions.

CONCLUSION

The quantum of research outputs shows a positive trend during most part of the study period whereas it shows decreasing trend in recent years. More than two third of the total productivity got cited and the study found that there are more number of uncited publications in the second half of the study period. It may be due to less age of the research outputs and there are chances for these publications to get citations in future. This area of research is not an exception to its contemporaries in collaborative research works, most productive countries, most preferable form of publications and most preferable language of communications.

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