

Bibliometric study of diabetic retinopathy during 2000–2010 by ISI

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Abstract

• **AIM:** To analyze the progress in diabetic retinopathy (DR) researches between 2000 and 2010 through bibliometric study.

• **METHODS:** Using ISI Web of Science database for statistical sources, we retrieved DR literatures during 2000-2010, analyzed "the number of published articles per year, authors, source publications, subject category, document type, document language, institution and country/region" by bibliometric statistical methods.

• **RESULTS:** The total number of published articles that were retrieved for the years during 2000-2010 was 8590. DR researches changed as a linear upward trend, the main researches focused on ophthalmology, endocrine and metabolic diseases. Article was the main document type. Harvard University was the major research institution.

• **CONCLUSION:** There has achieved a significant increase in the number of ISI publications and collaborations in DR literatures from 2000 to 2010. With the rising of the number of diabetes in the world, diabetic retinopathy has become a focus of scientific researches.

• **KEYWORDS:** bibliometric study; diabetic retinopathy; ISI web of science database

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INTRODUCTON

With the rapid change of lifestyle in China, there is a concern that diabetes may become epidemic. The

burden of diabetes and diabetic retinopathy (DR) are the main attention to the world public health. With the dramatic increase in the prevalence of diabetes^[1], DR as a common microvascular complication in diabetes was considered to be the final common pathway leading to blindness among working-aged people in the United States^[2], and was the second leading cause of visual impairment in Japan^[3]. The priority for ophthalmologists was to study DR, determine the pathophysiological and explore new potential therapeutic strategies for preventing blindness.

To our knowledge, this is a first study that using bibliometric method to analysis of the most frequently cited articles, which may reveal the effect of the works of colleagues and predecessors, and provide a historical perspective for the scientific progress of DR research.

MATERIALS AND METHODS

We used the Science Citation Index Expanded provided by the ISI Web of Science (Institute for Scientific Information, Thomson Scientific, Philadelphia, Pennsylvania)^[4] to search the topic named "Diabetic Retinopathy". The period of analysis was limited to the publication years from Jan. 2000 to Dec. 2010, data renewing time on Apr. 1, 2011. The data were classified according to the number of published articles per year, authors, source publications, subject category, document type, document language, institution and country/region.

Statistical Analysis We used statistics provided by ISI Web of Science database and analysis software SPSS 15.0 (SPSS, Tokyo, Japan) to analyze data. $P < 0.05$ was considered statistically significant. The basic laws of bibliometrics were as the basic method for statistical analysis.

RESULTS

The total number of published articles that were retrieved for the years during 2000 to 2010 was 8590. During 11 years, the annual output of research articles has nearly quadrupled, from 553 in 2000 to 1022 in 2010. The relationship between the number of published literatures (Y) and year (X) ($Y = 49.091X - 97646.364$, $R = 0.973$, $F = 159.224$, $P < 0.001$) was shown in Table 1. DR literatures changed as a linear upward trend year by year during 11 years (Figure 1).

Table 1 The relationship between the number of articles and year

| Number | Publication year | Record count | Percentage | Total time cited ¹ | Average citations per item ² | H-index ³ |
|--------|------------------|--------------|------------|-------------------------------|---|----------------------|
| 1 | 2010 | 1022 | 11.89 | 888 | 0.87 | 8 |
| 2 | 2009 | 1012 | 11.78 | 3328 | 3.29 | 19 |
| 3 | 2008 | 956 | 11.13 | 6296 | 6.59 | 29 |
| 4 | 2007 | 865 | 10.07 | 8872 | 10.26 | 40 |
| 5 | 2006 | 729 | 8.48 | 10636 | 14.59 | 48 |
| 6 | 2005 | 793 | 9.23 | 12054 | 15.2 | 48 |
| 7 | 2004 | 767 | 8.93 | 15754 | 20.54 | 57 |
| 8 | 2003 | 703 | 8.18 | 16407 | 23.34 | 58 |
| 9 | 2002 | 613 | 7.13 | 16535 | 26.97 | 64 |
| 10 | 2001 | 577 | 6.71 | 15169 | 26.29 | 60 |
| 11 | 2000 | 553 | 6.43 | 15665 | 28.33 | 58 |

¹ Total time cited: the total number of citations to any of the items in the set of search results.

² Average citations per item: a simple formula that calculates the average number of citing articles for all items in a set. It is the sum of the Times Cited divided by the number of results found.

³ H-index: the H-index is based on a list of publications ranked in descending order by the Times Cited.

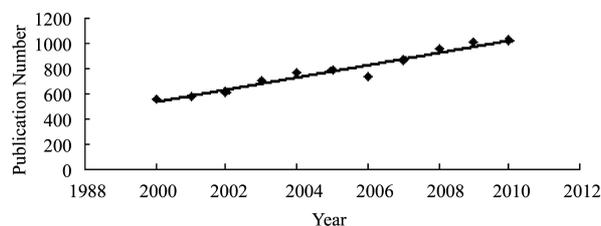
Table 2 The main authors of DR research articles

| Number | Author | Record count | Total times cited | Average citations per item | H-index | Percentage |
|--------|-------------|--------------|-------------------|----------------------------|---------|------------|
| 1 | Klein R | 145 | 3164 | 21.82 | 30 | 1.69 |
| 2 | Wong TY | 109 | 1603 | 14.71 | 23 | 1.26 |
| 3 | Aiello LP | 78 | 2310 | 29.62 | 28 | 0.9 |
| 4 | Wang JJ | 73 | 828 | 11.34 | 16 | 0.84 |
| 5 | Kern TS | 67 | 1816 | 27.1 | 24 | 0.77 |
| 6 | Klein BEK | 67 | 1248 | 18.63 | 18 | 0.77 |
| 7 | Massin P | 66 | 1265 | 19.17 | 17 | 0.76 |
| 8 | Mitchell P | 55 | 712 | 12.95 | 14 | 0.64 |
| 9 | Simo R | 55 | 438 | 7.96 | 13 | 0.64 |
| 10 | Hernandez C | 53 | 424 | 8 | 13 | 0.61 |

The main authors of diabetic retinopathy research by ISI Web of Science database were shown in Table 2. We found that professor Klein R had published 145 (1.69%) records, who was the highest in sum of the times cited and H-index but professor Aiello LP was the highest in average citations per item. This indicated that these two professors might be the leaders in DR research.

The total of 8590 articles were published in 1049 source publications, of which the top ten of them were shown in Table 3. The main source publications were Investigative Ophthalmology & Visual Science ($n=844$), Diabetes ($n=366$), Diabetologia ($n=280$) and Ophthalmology ($n=268$) which was the highest in average citations per item. The top ten articles in total times cited aspect were shown in Table 4, of which 4 articles were talking about VEGF.

We identified a classification of research areas of DR by ISI Subject Areas. DR involved 122 research subjects, main of them were in ophthalmology ($n=3983$), endocrinology & metabolism ($n=1840$), biochemistry & molecular biology ($n=428$) and cell biology ($n=423$). Ophthalmology was the one with the highest H-index and total times cited, but cell biology was the first one in average citations per item (Table 5).

**Figure 1** Trends in DR literatures in Web of Science

All of 8590 citation classics originated from 95 countries: United States ($n=2684$), Japan ($n=954$), England ($n=704$) and Germany ($n=595$) etc (Table 6). China had 343 (3.99%) publications and was the No.7. The types of literatures were Article ($n=6068$, 70.64%), Meeting Abstract ($n=929$, 10.81%), Review ($n=629$, 7.32%), Proceeding Paper ($n=601$, 6.99%), Letter ($n=215$, 2.50%), Editorial Material ($n=170$, 1.97%), and also involved Correction, News Item and Reprint. The languages of documents included English ($n=8313$), German ($n=137$), French ($n=107$), Spanish ($n=31$), Portuguese ($n=30$), Russian ($n=8$), Polish ($n=5$), Chinese ($n=3$), Turkish ($n=3$), Hungarian ($n=2$) and so on.

The leading ten institutions were listed in Table 6, led by Harvard University in Boston ($n=242$), followed by the University of Melbourne in Melbourne ($n=204$), the

Table 3 Source of publications

| Number | Source titles | Record count | Total times cited | Average citations per item | H-index | Percentage |
|--------|---|--------------|-------------------|----------------------------|---------|------------|
| 1 | Investigative Ophthalmology & Visual Science | 844 | 9139 | 10.83 | 47 | 9.83 |
| 2 | Diabetes | 366 | 5632 | 15.39 | 42 | 4.26 |
| 3 | Diabetologia | 280 | 4194 | 14.98 | 35 | 3.25 |
| 4 | Ophthalmology | 268 | 7118 | 26.56 | 45 | 3.11 |
| 5 | Retina-the Journal of Retinal and Vitreous Diseases | 257 | 3019 | 11.75 | 28 | 2.99 |
| 6 | American Journal of Ophthalmology | 246 | 4590 | 18.66 | 39 | 2.86 |
| 7 | British Journal of Ophthalmology | 241 | 3171 | 13.16 | 30 | 2.80 |
| 8 | Diabetes Care | 238 | 6016 | 25.28 | 42 | 2.77 |
| 9 | Diabetic Medicine | 192 | 2315 | 12.06 | 27 | 2.23 |
| 10 | Eye | 184 | 1373 | 7.46 | 18 | 2.14 |

Table 4 Top ten of total times cited publications

| Number | Title | First author | Source | Published year | Total times cited | Average citations per item |
|--------|--|----------------|---|----------------|-------------------|----------------------------|
| 1 | The biology of VEGF and its receptors | Ferrara N | Nature Medicine | 2003 | 2470 | 274.44 |
| 2 | Vascular-specific growth factors and blood vessel formation | Yancopoulos GD | Nature | 2000 | 1726 | 143.83 |
| 3 | Vascular endothelial growth factor: Basic science and clinical progress | Ferrara N | Endocrine Reviews | 2004 | 940 | 117.5 |
| 4 | Pegaptanib for neovascular age-related macular degeneration | Gragoudas ES | New England Journal of Medicine | 2004 | 864 | 123.43 |
| 5 | Global data on visual impairment in the year 2002 | Resnikoff S | Bulletin of the World Health Organization | 2004 | 725 | 90.62 |
| 6 | Angiopoietin-1 protects the adult vasculature against plasma leakage | Thurston G | Nature Medicine | 2000 | 545 | 45.42 |
| 7 | Human endothelial progenitor exhibit impaired proliferation, cells from type II diabetics adhesion, and incorporation into vascular structures | Tepper OM | Circulation | 2002 | 524 | 52.4 |
| 8 | Advanced glycation end-products: a review | Singh R | Diabetologia | 2001 | 513 | 46.64 |
| 9 | VEGF and the quest for tumour angiogenesis factors | Ferrara N | Nature Reviews Cancer | 2002 | 464 | 51.56 |
| 10 | Intravitreal triamcinolone for refractory diabetic macular edema | Martidis A | Ophthalmology | 2002 | 454 | 45.4 |

Table 5 Research areas of DR study

| Number | Subject areas | Record count | Total times cited | Average citations per item | H-index | Percentage |
|--------|-----------------------------------|--------------|-------------------|----------------------------|---------|------------|
| 1 | Ophthalmology | 3983 | 45313 | 11.38 | 78 | 46.36 |
| 2 | Endocrinology & Metabolism | 1840 | 27461 | 14.92 | 68 | 21.42 |
| 3 | Biochemistry & Molecular Biology | 428 | 12871 | 30.07 | 56 | 4.98 |
| 4 | Medicine, General & Internal | 423 | 5663 | 13.39 | 34 | 4.92 |
| 5 | Pharmacology & Pharmacy | 406 | 5088 | 12.53 | 32 | 4.72 |
| 6 | Medicine, Research & Experimental | 330 | 8145 | 24.68 | 36 | 3.84 |
| 7 | Cell Biology | 253 | 10083 | 39.85 | 43 | 2.95 |
| 8 | Peripheral Vascular Disease | 203 | 3343 | 16.47 | 27 | 2.36 |
| 9 | Surgery | 183 | 1358 | 7.42 | 18 | 2.13 |
| 10 | Neurosciences | 155 | 2177 | 14.05 | 22 | 1.80 |

University of Wisconsin in Madison ($n=191$) and The Johns Hopkins University in Baltimore ($n=181$) *etc*. Funding agencies involved National Institutes of Health (NIH), National Eye Institute (NEI), Juvenile Diabetes Research Foundation (JDRF), Research to Prevent Blindness (RPB) from United States, National Natural Science Foundation of China and so on.

DISCUSSION

As far as we know, this is the first study about looking at research productivity of DR using bibliometric method

through ISI Web of Science database. The ISI Web of Science database enables users to search current and retrospective literature from approximately 8,500 of the most prestigious, high-impact research journals in the world. It also provides a unique search method and cited reference searching. With it, users can navigate forward, backward, and through the literature, searching all disciplines and time spans to uncover information relevant to their researches^[5].

We found 8590 articles through ISI Web of Science during 2000-2010. The researches on DR increased sharply both in

Table 6 The main institutions, country/region and funding agencies

| Number | Institutions | Record count | Countries/territories | Record count | Funding agencies | Record count |
|--------|---------------------------|--------------|-----------------------|--------------|--|--------------|
| 1 | Harvard Univ | 242 | USA | 2684 | National Institutes of Health | 103 |
| 2 | Univ Melbourne | 204 | Japan | 954 | National Eye Institute | 68 |
| 3 | Univ Wisconsin | 191 | England | 704 | Juvenile Diabetes Research Foundation | 66 |
| 4 | Johns Hopkins Univ | 181 | Germany | 596 | Research to Prevent Blindness | 46 |
| 5 | Univ Sydney | 117 | Australia | 412 | National Natural Science Foundation of China | 28 |
| 6 | Natl Univ Singapore | 107 | Italy | 352 | American Diabetes Association | 19 |
| 7 | Wayne State Univ | 106 | China | 343 | Biomedical Research Council | 14 |
| 8 | Univ So Calif | 94 | France | 284 | National Medical Research Council | 13 |
| 9 | Univ Heidelberg | 92 | Canada | 258 | Thomas Foundation | 13 |
| 10 | Case Western Reserve Univ | 88 | Spain | 237 | | |

China [6] and the world. By linear equation, we know that average annual growth article was 49. There would be 1075, 1124 and 1173 publications in 2011, 2012 and 2013, respectively.

The H-index was based on a list of publications ranked in descending order by the times cited. The value of H was equal to the number of papers (N) in the list that have N or more citations. This metric is useful because it discounts the disproportionate weight of highly cited papers or papers that have not yet been cited[7].

Bibliometric study emphasized the combined use of mathematical models and statistical methods to analyze all knowledge carrier quantitatively which was experience in several statistical laws as the core. According to Price law, the "core author" should be completed half of the sum publications, issued a document to the core by a minimum number of m -values: $m = 0.749 \times \sqrt{n_{\max}}$, which issued a document up to n_{\max} refer to the author of papers published, in this study it was 145, calculated m was 9, indicating the first author of papers more than 9 in DR research was the core author during 2000-2010 [8]. Professor Klein R and Aiello LP were the top two in publications and H-index, so they were both the leaders in DR research.

This bibliometric study of publications in the research of DR based on ISI Web of Science database showed that research productivity, as measured in both the number of publications had increased during 2000-2010. The results of this study were an indicator of the productivity of DR researchers. This analysis will be helpful to find out the obstacles of research productivity, which would help to develop research capacity and lead to more publications. Results provide initial benchmarks on DR publication in journals in ISI that may be useful to follow research trends.

There were many institutions engaged in DR research during 2000-2010, including Harvard University, University of Melbourne and University of Wisconsin *et al* however, there was no significant difference in the number of publications.

This study showed that the concentration of DR research was not very strong, but we could see that DR research focused on the United States, where publications were much more than other countries. Although 343 publications had been done by China occupied the No.7. The focus of funding agencies was National Institutes of Health, we found 28 DR research achieved funding assistance by National Nature Science Foundation of China at No.5. But compared with the international health research fundings, there still was a disparity. We hope the national authorities will increase investment in DR research to reduce the gap between China and the international research areas in the future.

Reviewing the literatures using ISI Web of Science database, we found DR research focused on the pathogenesis, pathology, clinical and epidemiological study between 2000 and 2010. The main research direction of ophthalmologist interests included effect of VEGF (vascular endothelial growth factor) on retinal neovascularization and anti-VEGF therapy.

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