Scientometric Analysis and Mapping of Scientific Articles on Diabetic Retinopathy

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ABSTRACT

Diabetic retinopathy (DR) is the major cause of blindness among the working-age population globally. No systematic research has been previously performed to analyze the research published on DR, despite the need for it. This study aimed to analyze the scientific production on DR to draw overall roadmap of future research strategic planning in this field. A bibliometric method was used to obtain a view on the scientific production about DR by the data extracted from the Institute for Scientific Information (ISI). Articles about DR published in 1993–2013 were analyzed to obtain a view of the topic’s structure, history, and to document relationships. The trends in the most influential publications and authors were analyzed. Most highly cited articles addressed epidemiologic and translational research topics in this field. During the past 3 years, there has been a trend toward biomarker discovery and more molecular translational research. Areas such as gene therapy and micro-RNAs are also among the recent hot topics. Through analyzing the characteristics of papers and the trends in scientific production, we performed the first scientometric report on DR. Most influential articles have addressed epidemiology and translational research subjects in this field, which reflects that globally, the earlier diagnosis and treatment of this devastating disease still has the highest global priority.

KEY WORDS

Diabetic Retinopathy; Bibliometrics; Historiography; Scientometry; Citation Analysis

INTRODUCTION

An estimated 382 million people had diabetes in 2013; this is expected to rise to 592 million by 2035 (1). Diabetic retinopathy (DR), age-related macular degeneration (ARMD), glaucoma, and childhood causes are the most common causes of low vision in all countries (2). Estimates of the prevalence of DR vary by study and rates range from 17.6% in a study in India to 33.2% in a large United States study (3, 4). There were 126.6 million people with DR worldwide in 2010; this is expected to increase to 191.0 million by 2030. The number of patients with vision-threatening DR will increase from 37.3 million to 56.3 million (5, 6). If a diabetic patient does not have retinopathy, studies suggest that the risk of developing new retinopathy ranges between 5% and 10% annually. Thus, there is an urgent need for prompt action.

Preventing and treating DR are major concerns in this field. If fundamental social and political changes are available, the prevention of diabetes would be the best
approach to prevent DR. Factors which lower the risk of visual morbidities and disease progression in diabetic patients include optimal blood glucose and blood pressure control beside regular ocular examinations and prompt laser treatment of macular edema as well as proliferative retinopathy. The Wisconsin Epidemiologic Study of Diabetic Retinopathy (i.e., WESDR) first identified key risk factors for DR such as longer duration of diabetes, hyperglycemia, and hypertension (7, 8). Based on the finding of this study and other studies, new screening strategies need to be developed that detect potential vision-threatening retinopathy early in clinical and nonclinical settings. Genetic risk factors for diabetes and DR should be identified, and the interactions between genes and metabolic control should be examined; these factors will help in risk stratification and in preventing vision loss (9). Therefore, implementing of novel, feasible, and sustainable strategies to control the growing current of DR is a significant challenge. Part of the challenge is the need for global level research strategic planning for preventing and treating DR.

Many clinical reviews and meta-analyses exist on DR, and scientometric studies investigating other topics in ophthalmology exist; however, quantitative description of publications specifically on DR is lacking. Recent bibliometric analysis of scientific publications has been performed for individual and institutional output analysis, and for assessing the scientific advancements and motivations of researchers and identifying current research directions in a specific field; fund assignments and subsequent research designs can be enhanced using such data because it will predict how this field will move forward (10, 11). Mapping the external and internal features of a scientific field by tracing the core production or citations, would aid in research that is more global strategic planning. Thus, we aimed to analyze the scientific productions on DR to define a general roadmap for future research strategic planning in this field.

MATERIAL AND METHODS

Data Source

A descriptive bibliometric study of scientific papers about DR was conducted. For this purpose, the ISI Web of Science database (available at http://www.isiknowledge.com) was used because it is a major source for bibliometrics, citations, and other academic impact information of scientific articles in various branches of sciences. All three resources available in the ISI web of science were used for this purpose (Science Citation Index Expanded; Social Sciences Citation Index; the Arts & Humanities Citation Index, A&HCI).

Search Strategies

For the best keywords, we created a list from the Medical Subject Headings (MeSH), which is provided by the National Library of Medicine (NLM, Bethesda, MD, USA) to index the contents of PubMed. The adopted search strategy was Title: ((Diabet* and Retinopathy) or (Diabetic Retinopathy)) as the search keyword. This yielded 3228 publications. The “*” is a wildcard that can take any value. Our search focused on articles published during 1993–2013. Our search was performed in Feb 2014. We included only research articles in the analysis and excluded meeting abstracts, case reports, review articles as well as letters.

Data Analysis

We retrieved documents related to main journals in this field, articles’ language, the publication year, first author, geographical distribution, institutional affiliations and citations of the paper by other papers from the ISI and analyzed with the analyze function provided by the ISI database. Also, we used the Journal Citation Reports (available at http://scientific.thomson.com/products/jcr) to derive journal’s impact factor. Software for statistical analysis in this study was Microsoft Excel 2003 computer spreadsheet software (Microsoft; Redmond, WA, USA). Analysis of related articles by HistCite software was performed considering the topic’s structure, history, and document relationships. We imported the bibliography derived from the web of science database to HistCite. Any articles that cited ≥ 100 were included in historiography of the DR research field from 1993 to 2013 (please refer to Appendix 1). Articles that were cited more than 100 times were evaluated by the country of affiliation of the first author and publishing journal. For identification of recent trends, the citation analysis was repeated for articles published from 2010 to 2013. For the citation analysis, two parameters were calculated: the local citation score (LCS) and the global citation score (GCS). The LCS lists all papers sorted by citation frequency within the local (i.e., the starting bibliography). By contrast, the GCS counts citations in the whole collection. For the citation burst analysis, the hundred keywords that generated the citation bursts were extracted, and then the nonspecific and general keywords were omitted.
RESULTS

Annual Publication Number During 1993–2013

There were 3,228 research articles on DR in the ISI Web of Science published during 1993–2013. These papers were drafted by 11,591 authors, 2,771 institutions, and 93 countries. The articles were published in 547 journals in 10 languages. Figure 1 demonstrates the growth rate (6.46% per year) of publications in this field.

Citation Profile of Articles

The total LCS citations were 12,830 times and the GCS citations were 62,327 times. The average citation per paper (C/P) was 19.31. Table 1 shows the articles that were cited ≥ 100. Appendix 1 shows the highly cited articles in this field. Figure 2 shows the histogram map of 20 years of research in this field. Keywords that generated citation bursts during this period were as follows: Metabolic control, Onset, Diabetes-mellitus, Glycosylated hemoglobin, Fluorescein angiography, Fluorophotometry, Neovascular glaucoma, Microangiopathy, Microalbuminuria, Glycation, Proliferative retinopathy, NIDDM, Proteinuria, Photocoagulation, Retinal blood-flow, VEGF, Maculopathy, Insulin, Nitric oxide, Screening, Telemedicine, Retinal microvascular abnormalities, Oxidative stress, Bevacizumab, Vitrectomy, and inflammation (Fig. 3).

Subject Analysis and Publisher of Documents

The most frequent topics of the top 10 highly cited papers were translational research (30%) and epidemiologic studies (70%) (Table1).

Profiles of Most Influential Authors and Journals

The highest number of articles was published by Dr. R. Klein with 133 articles (Table 2). When analyzed by the number of papers in DR, 14 of the top 20 journals were ophthalmology journals and the remaining were diabetes journals. However, when using the same calculation based on the citation number (TLCS), 6 journals were diabetes journals, 12 journals were ophthalmology journals, and 2 journals were general subject medicine journals. When analyzed by the TGCS, highly cited papers were published in ophthalmology journals, diabetes journals, general medicine journals, neurology journals and pathology journals (Table 3). Most DR articles were in English (3,058 articles) followed by German (54 articles), French (47 articles), and Spanish (21 articles). Articles were written in a total of 10 languages (English, ...
Geographical Distribution

Most of the top 10 Universities and institutions on the list are from the United States and Australia. The first two institutions are the University of Wisconsin and University of Melbourne, based on the number of documents, and the University of Wisconsin and Harvard University in based on citations (Table 4).

In general, 93 countries promoted the field of DR by publishing articles. The United States, United Kingdom, and Japan had the highest number of documents, but the United States, United Kingdom, and Australia had the highest number of citations to their research papers in the field of DR (Table 5).

Table 1. Articles With Highest Number of Citations (LCS)

| # | Author / Title / Journal | CITATION |
|---|-------------------------|----------|
| 1 | Aiello Lp, Avery Rl, Arrigg Pg, Keyt Ba, Jampel Hd, Et Al. Vascular Endothelial Growth-Factor In Ocular Fluid Of Patients With Diabetic-Retinopathy And Other Retinal Disorders New England Journal Of Medicine. 1994 Dec 1; 331 (22): 1480-1487 | 1,877 |
| 2 | Adamis Ap, Miller Jw, Bernal Mt, Damico Dj, Folkman J, Et Al. Increased Vascular Endothelial Growth-Factor Levels In The Vitreous Of Eyes With Proliferative Diabetic-Retinopathy American Journal Of Ophthalmology. 1994 Oct; 118 (4): 445-450 | 745 |
| 3 | Shannon H, Duffy H, Dahms W, Mayer L, Brillion D, Et Al. Retinopathy And Nephropathy In Patients With Type 1 Diabetes Four Years After A Trial Of Intensive Therapy. New England Journal Of Medicine. 2000 Feb 10; 342 (6): 381-389 | 622 |
| 4 | Dyck Pj, Kratz Km, Karnes Jl, Litchy Wj, Klein R, Et Al. The Prevalence By Staged Severity Of Various Types Of Diabetic Neuropathy, Retinopathy, And Nephropathy In A Population-Based Cohort - The Rochester Diabetic Neuropathy Study Neurology. 1993 Apr; 43 (4): 817-824 | 518 |
| 5 | Chaturvedi N, Sjolie Ak, Stephenson Jm, Abrahamian H, Keipes M, Et Al. Effect Of Lisinopril On Progression Of Retinopathy In Normotensive People With Type 1 Diabetes Lancet. 1998 Jan 3; 351 (9095): 28-31 | 393 |
| 6 | Wilkinson Cp, Ferris Fl, Klein Re, Lee Pp, Agardh Cd, Et Al. Proposed International Clinical Diabetic Retinopathy And Diabetic Macular Edema Disease Severity Scales Ophthalmology. 2003 Sep; 110 (9): 1677-1682 | 372 |
| 7 | Schrier Rw, Estacio Ro, Esler A, Mehler P Effects Of Aggressive Blood Pressure Control In Normotensive Type 2 Diabetic Patients On Albuminuria, Retinopathy And Strokes Kidney International. 2002 Mar; 61 (3): 1086-1097 | 367 |
| 8 | Joussen Am, Poulaki V, Le Ml, Koizumi K, Esser C, Et Al. A Central Role For Inflammation In The Pathogenesis Of Diabetic Retinopathy Faseb Journal. 2004 Jul; 18 (10): 1450-+ | 358 |
| 9 | Hammes Hp, Du Xi, Edelstein D, Taguchi T, Matsumura T, Et Al. Benfotiamine Blocks Three Major Pathways Of Hyperglycemic Damage And Prevents Experimental Diabetic Retinopathy Nature Medicine. 2003 Mar; 9 (3): 294-299 | 343 |
DISCUSSION

We analyzed the subject of highly cited papers, divided them into broad categories of clinical/translational versus basic science research (Appendix 1). Most highly cited papers are epidemiologic or translational science reports. Despite the enormous impact of DR on the quality of life and emotional status of patients, few articles among these highly cited papers addressed this subject. Highly cited reports were also addressing the following topics more frequently: laser photocoagulation and angiogenesis. As Appendix 2 shows, there is a recent trend toward more translational research such as biomarker discovery. Areas such as gene therapy and micro-RNA are among the recent hot topics. Citation burst analysis showed that certain topics are very popular such as the role of inflammation or oxidative stress in the pathogenesis of DR. In general, in the field of ophthalmology, there was an increase in the proportion of articles related to medical retina, compared to other subspecialties, between 2005 and 2009. In an analytical study of the ophthalmology research papers, case-control or cohort studies comprised most study designs (40.1%), followed by nonanalytic studies (28.7%), basic science (24.6%), randomized controlled trials (RCTs) (3.3%), review articles (2.6%), and meta-analyses (0.3%) (12). However, this was not the trend in diabetes retinopathy research. The term “citation analysis” covers concepts such as journal impact factor (JIF), the immediacy index, and cited and citing half-lives. The results of citation analysis should be interpreted concurrently with the results of the JIF because ranking of research groups on the basis of JIF has little correlation to a ranking of the same groups on the basis of citation frequency.
Table 2. The Most Active Authors in the Field of DR Research

| #  | Author      | Recs | TLCS  | TGCS  |
|----|-------------|------|-------|-------|
| 1  | Klein R     | 133  | 1653  | 6084  |
| 2  | Wong Ty     | 76   | 595   | 1868  |
| 3  | Klein Bek   | 69   | 861   | 2933  |
| 4  | Wang Jj     | 50   | 455   | 1504  |
| 5  | Moss Se     | 44   | 717   | 2642  |
| 6  | Sharma T    | 37   | 163   | 352   |
| 7  | Aiello Lp   | 35   | 506   | 3350  |
| 8  | Hammes Hp   | 35   | 164   | 1616  |
| 9  | Kowluru Ra  | 34   | 276   | 1063  |
| 10 | Raman R     | 33   | 121   | 230   |

Thus, authors who are frequently cited but choose to publish in an appropriate but lower JIF-ranked journal would not receive the best evaluation from the institutional Journal Citation Report-based assessment of an author. Overall, in our study, there was no significant correlation between the JIFs and the citation frequency of articles. This can result from several factors; for example, journals with advance online publication had higher impact factors than journals without advance online publication. Thus, factors other than the quality of papers may affect the citation frequency of a paper (13).

In a survey of 46 ophthalmology journals to identify the most frequently cited articles using the Science Citation Index Expanded (1975–2006), the 100 most cited articles were published in 13 journals, the utmost articles were in the Archives of Ophthalmology (n = 30), followed by Ophthalmology (n = 27). American Journal of Ophthalmology (n = 11) was in third place. The published articles originated from 10 countries, led by the United States (n = 86) (14). Laser photocoagulation to treat DR was one of the major topics among the 100 most cited articles. In addition, we found that the h-index of DR was 98, which indicates the appreciation of the context of DR within vision research. Publications of Dr. Klein, who is the most active scientist in the field of DR research, are also among the top 100 most cited articles in the field of ophthalmology, which shows the importance of this field. Our results for the field of citation analysis showed that most citation clusters were generated by few countries and few journals, mostly from the United States and Australian institutions. This fact may be because of the overwhelming influence of the United States on research. However, it may also be because of a tendency for American authors to cite local papers and for authors in other parts of the world to publish in and cite American journals (15).
**Fig. 2. Histogram map of 20 years of research in DR**

| Keywords                      | Strength | Begin | End | 1992 - 2014               |
|-------------------------------|----------|-------|-----|---------------------------|
| Metabolic control             | 8.0699   | 1992  | 2001|                          |
| Onset                         | 7.8749   | 1992  | 2001|                          |
| Diabetes-mellitus             | 7.158    | 1992  | 1994|                          |
| Glycosylated hemoglobin       | 5.8617   | 1992  | 1997|                          |
| Fluorescein angiography       | 5.6114   | 1992  | 1998|                          |
| Fluorophotometry              | 5.0165   | 1992  | 1998|                          |
| Neovascular glaucoma          | 4.5041   | 1992  | 2000|                          |
| Microangiopathy               | 4.4163   | 1992  | 2000|                          |
| Microalbuminuria              | 13.4556  | 1994  | 2000|                          |
| Glycation                     | 3.4028   | 1994  | 1995|                          |
| Proliferative retinopathy     | 5.2867   | 1995  | 2001|                          |
| NIDDM                         | 12.6527  | 1996  | 2001|                          |
| Proteinuria                   | 5.6377   | 1996  | 2001|                          |
| Photocoagulation              | 3.8159   | 1996  | 1996|                          |
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| Keyword                                           | Citation | Year1 | Year2 |
|---------------------------------------------------|----------|-------|-------|
| Retinal blood-flow                                | 3.4049   | 1996  | 1997  |
| VEGF                                             | 4.3345   | 1997  | 2003  |
| Maculopathy                                       | 3.5225   | 1997  | 2001  |
| Insulin                                           | 6.8506   | 1998  | 2002  |
| Nitric oxide                                      | 5.5548   | 2001  | 2003  |
| Screening                                         | 6.3987   | 2002  | 2004  |
| Telemedicine                                      | 4.4617   | 2002  | 2005  |
| Retinal microvascular abnormalities               | 3.4268   | 2006  | 2007  |
| Oxidative stress                                  | 10.1662  | 2009  | 2014  |
| Bevacizumab                                       | 6.496    | 2009  | 2010  |
| Vitrectomy                                        | 4.0998   | 2010  | 2010  |
| Inflammation                                      | 11.8843  | 2011  | 2014  |

Figure 3. Keywords with the largest citation burst and the corresponding years

Table 3. Journals with Highest Number of Papers in This Field

| #  | Journal                                      | Records | Citation | 2 year IF | 5 year IF |
|----|----------------------------------------------|---------|----------|-----------|-----------|
| 1  | Investigative Ophthalmology & Visual Science | 167     | 4378     | 3.441     | 3.730     |
| 2  | Diabetes Care                                | 162     | 4463     | 7.735     | 7.555     |
| 3  | Diabetic Medicine                            | 124     | 2380     | 3.241     | 3.303     |
| 4  | British Journal Of Ophthalmology            | 115     | 2845     | 2.725     | 3.023     |
| 5  | Ophthalmology                                | 103     | 4349     | 5.563     | 5.777     |
| 6  | Retina-The Journal Of Retinal And Vitreous Diseases | 98     | 1482     | 2.825     | 2.761     |
| 7  | Diabetes Research And Clinical Practice      | 97      | 898      | 2.741     | 2.618     |
| 8  | American Journal Of Ophthalmology           | 89      | 3275     | 3.631     | 4.292     |
| 9  | Diabetologia                                 | 87      | 2968     | 6.487     | 6.772     |
| 10 | Eye                                          | 83      | 1124     | 1.818     | 1.883     |
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| #  | Institution                                      | Records | TLCS  | TGCS  |
|----|--------------------------------------------------|---------|-------|-------|
| 1  | University Wisconsin                            | 168     | 2020  | 7248  |
| 2  | University Melbourne                            | 106     | 884   | 2721  |
| 3  | Harvard University                               | 80      | 938   | 6029  |
| 4  | University Sydney                                | 75      | 631   | 2205  |
| 5  | Natl University Singapore                       | 64      | 501   | 1433  |
| 6  | Wayne State University                           | 53      | 331   | 1584  |
| 7  | Johns Hopkins University                         | 43      | 320   | 1160  |
| 8  | Northeastern Illinois University                 | 39      | 522   | 1921  |
| 9  | Case Western Reserve University                  | 36      | 328   | 2064  |
| 10 | Aarhus University Hospital                       | 31      | 240   | 976   |
| 11 | The University of Tokyo                          | 31      | 63    | 312   |
| 12 | Singapore National Eye Center                    | 30      | 149   | 345   |
| 13 | Joslin Diabetes Center                           | 29      | 413   | 2911  |

Table 4. Institutions with highest number of papers
Factors that influence the number of citations that can be obtained by a scientific paper include (1) the merit of journal of publication and (2) the number of references that citing papers use, which is substantially affected by the differences between fields. Also, (3) the number of scientists active in the same field or subfield is important when there are relatively few colleagues working on the same topic. Thus, if for example, more scientists are working on the laser treatment of DR, then there would be heterogeneity between subfields. This may account for the difference in the number of citations between the various types of research papers in DR. For example, scientists active in more basic fields can obtain different numbers of citations than more clinically oriented scientists (15). Among the top 100 cited articles, we could determine that scientists active in the field of translational research and those who were authors on epidemiological studies and RCTs could receive significantly more citations. Much of the burden of visual disorders could be alleviated through at least the three routes: prevention and diagnostic screening, medical treatment of diagnosed conditions, and rehabilitation and support services for those with visual impairment.

Each year, tens of thousands of articles in these areas are published that discuss the medical, policy, and economic aspects of visual problems. Despite this excellent and growing body of work, several areas of research remain virtually nonexistent such as comparing the population benefits of investments in medical treatments for people with vision-threatening disease, compared to rehabilitation and adaptive services for people who have previously acquired impairment. To provide better guidelines for vision research, five major priorities for research were determined by four authorities in A Vision
for Horizon 2020. These priorities included neuron–glia interaction, gene therapy in retinal diseases, microincision cataract surgery, and femtosecond laser surgery. Improving care and care delivery in the Third World countries has also been mentioned as a research priority. The experts felt that these priority settings may be biased since they are significantly different from topics set by other authorities (16). The results of our and similar studies would help to more accurately determine research priorities in the field of DR. In conclusion, this report is the first scientometric analysis of the field of DR and can be a roadmap for future research policy in this important field.

In conclusion, this report as the first scientometric analysis of the field of DR, can be regarded as roadmap for future research policy making in this important field.

DISCLOSURE

The authors have no financial or propriety interest in any material or method mentioned in this article.

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Appendix-1: Top most cited articles in the past 20 years.

| #  | Author / Title/ Journal                                              | Citation |
|----|--------------------------------------------------------------------|----------|
| 1  | Aiello LP, Avery RJ, Arrigg PG, Keyt BA, Jampel HD, et al.         | 1877     |
|    | Vascular Endothelial Growth-Factor In Ocular Fluid Of Patients With Diabetic-Retinopathy And Other Retinal Disorders |         |
|    | New England Journal Of Medicine. 1994 Dec 1; 331 (22): 1480-1487   |          |
| 2  | Adams AP, Miller JW, Bernal MT, Damico DJ, Folkman J, et al.       | 745      |
|    | Increased Vascular Endothelial Growth-Factor Levels In The Vitreous Of Eyes With Proliferative Diabetic-Retinopathy |         |
|    | American Journal Of Ophthalmology. 1994 OCT; 118 (4): 445-450     |          |
| 3  | Shannon H, Duffy H, Dahms W, Mayer L, Brillion D, et al.           | 622      |
|    | Retinopathy and nephropathy in patients with type 1 diabetes four years after a trial of intensive therapy. |         |
|    | NEW ENGLAND JOURNAL OF MEDICINE. 2000 FEB 10; 342 (6): 381-389    |          |
| 4  | Dyck PJ, Kratz Km, Karnes JI, Litchy WJ, Klein R, et al.           | 518      |
|    | The Prevalence By Staged Severity Of Various Types Of Diabetic Neuropathy, Retinopathy, And Nephropathy In A Population-Based Cohort - The Rochester Diabetic Neuropathy Study |         |
|    | NEUROLOGY. 1993 APR; 43 (4): 817-824                               |          |
| 5  | Chatapurdi N, Spalde AK, Stephenson JM, Abrahamian H, Keiges M, et al. | 393      |
|    | Effect of lisinopril on progression of retinopathy in normotensive people with type 1 diabetes |         |
|    | LANCET. 1998 JAN 3; 351 (9095): 28-31                              |          |
| 6  | Wilkinson CP, Ferris FL, Klein RE, Lee PP, Agardh CD, et al.       | 372      |
|    | Proposed International clinical diabetic retinopathy and diabetic macular edema disease severity scales |         |
|    | Ophthalmology. 2003 SEP; 110 (9): 1677-1682                        |          |
| 7  | Schrier RW, Estacio RO, Esler A, Mehler P                           | 367      |
|    | Effects of aggressive blood pressure control in normotensive type 2 diabetic patients on albuminuria, retinopathy and strokes |         |
|    | KIDNEY INTERNATIONAL. 2002 MAR; 61 (3): 1086-1097                  |          |
| 8  | Joussen AM, Poulaki V, Le ML, Koizumi K, Esser C, et al.           | 358      |
|    | A central role for inflammation in the pathogenesis of diabetic retinopathy |         |
|    | FASEB JOURNAL. 2004 JUL; 18 (10): 1450+                            |          |
| 9  | Hammes HP, Du XL, Edelstein D, Taguchi T, Matsumura T, et al.      | 343      |
|    | Benfotiamine blocks three major pathways of hyperglycemic damage and prevents experimental diabetic retinopathy |         |
|    | Nature Medicine. 2003 MAR; 9 (3): 294-299                          |          |
| 10 | Miyamoto K, Khosrof S, Bursell SE, Rohan R, Murata T, et al.       | 329      |
|    | Prevention of leukostasis and vascular leakage in streptozotocin-induced diabetic retinopathy via intercellular adhesion molecule-1 inhibition |         |
|    | Proceedings Of The National Academy Of Sciences Of The United States Of America. 1999 SEP 14; 96 (19): 10836-10841 |         |
| 11 | Mizutani M, Kern TS, Lorenzi M                                     | 322      |
|    | Accelerated death of retinal microvascular cells in human and experimental diabetic retinopathy |         |
|    | Journal Of Clinical Investigation. 1996 JUN 15; 97 (12): 2883-2890 |          |
| 12 | Kemphen JH, O’Colmam BJ, Leske C, Haffner SM, Klein R, et al.      | 322      |
|    | The prevalence of diabetic retinopathy among adults in the United States |         |
|    | ARCHIVES OF OPHTHALMOLOGY. 2004 APR; 122 (4): 552-563              |          |
| 13 | Antonetti DA, Barber AJ, Hollinger LA, Wolpert EB, Gardner TW      | 290      |
|    | Vascular endothelial growth factor induces rapid phosphorylation of tight junction proteins occludin and zona occluden 1 - A potential mechanism for vascular permeability in diabetic retinopathy and tumors |         |
|    | JOURNAL OF BIOLOGICAL CHEMISTRY. 1999 AUG 13; 274 (33): 23463-23467 |          |
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| Page | Title                                                                 | Journal                                             | Year | PMID   |
|------|----------------------------------------------------------------------|-----------------------------------------------------|------|--------|
| 30   | The AGE inhibitor pyridoxamine inhibits development of retinopathy in experimental diabetes | Diabetes                                             | 2002 | 196    |
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The numbers before the article indicate the location of the article on the histogram map.
## Appendix 2. Top Most Cited Articles (past 3 years)

| Date / Author / Journal | GCS |
|-------------------------|-----|
| 1 206 Tang J, Kern TS   | 58  |
| Inflammation in diabetic retinopathy | |
| PROGRESS IN RETINAL AND EYE RESEARCH. 2011 SEP; 30 (5): 343-358 | |
| 2 328 Yau JWY, Rogers SL, Kawasaki R, Lamoureux EL, Kowalski JW, et al. | 56  |
| Global Prevalence and Major Risk Factors of Diabetic Retinopathy | |
| DIABETES CARE. 2012 MAR; 35 (3): 556-564 | |
| 3 49 Barber AJ, Gardner TW, Abcouwer SF | 50  |
| The Significance of Vascular and Neural Apoptosis to the Pathology of Diabetic Retinopathy | |
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| Glycemic Thresholds for Diabetes-Specific Retinopathy Implications for diagnostic criteria for diabetes | |
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| MicroRNA-200b Regulates Vascular Endothelial Growth Factor-Mediated Alterations in Diabetic Retinopathy | |
| DIABETES. 2011 APR; 60 (4): 1314-1323 | |
| 6 80 Zhong Q, Kowluru RA | 31  |
| Epigenetic Changes in Mitochondrial Superoxide Dismutase in the Retina and the Development of Diabetic Retinopathy | |
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