·Bibliometric Research·

A bibliometric analysis of academic publication on diabetic retinopathy disease trends during 1980-2014: a global and medical view

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Abstract

• AIM: To investigate diabetic retinopathy (DR) literature using the Institute for Scientific Information (ISI) Web of Science (WoS) database and to analyse the correlation results between socio-economic development datas and number of DR publications.

• METHODS: The statistical analysis of the documents published during 1980-2014 was analysed. The data of this study were based on the database of WoS. "Diabetic retinopathy" was used as the keywords to search the WoS database.

• RESULTS: The United States ranked first in the DR research with 1840 publications and 24.38% of the world production followed by England and Japan. Besides, the most productive country was Iceland. A high correlation was found between number of publications and 2014 gross domestic product (GDP) values of 81 countries (r=0.800, P<0.001). We found a significant correlation between number of publications and Human Development Index (HDI) (r=0.645, P=0.001). There is a moderate correlation between people with diabetes and number of DR publications for 81 countries (r=0.514, P< 0.01). It could be analysed that estimated publication number with DR title will be 445 according to the regression curve constituted with cubic model in 2015 (R^2=1.000).

• CONCLUSION: More DR studies have been published in developed countries, DR and other complications of diabetes have gradually increased in developing countries over recent decades. It can be expected that the number of DR studies will gradually increase in developing countries.

• **KEYWORDS:** bibliometrics; correlation analysis; developing countries; diabetic retinopathy; socio-economic development
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INTRODUCTION

Retinopathy is the most common complication of diabetes and one of the major causes of preventable blindness [1]. Recently, diabetic retinopathy (DR) incidence has increased as the leading cause of visual impairment in working-age persons in the world. The incidence of DR is related to the prevalence, type, and duration of diabetes; therefore, the increasing global population, increasing aging population, and predicted rise in the proportion of person with diabetes will inevitably be accompanied by an increase in the frequency of DR [2]. Over the last few decades, the prevalence of diabetes mellitus has increased throughout the world due primarily to the increase in type 2 diabetes, which is due to increasing obesity, emotional stress, changing dietary habits and reduced physical activity. Therefore, particularly over the last years, multiple clinical trials have defined the natural history and current treatments of retinopathy related to diabetes.

Bibliometrics, the application of mathematical and statistical techniques to the study of publishing and professional communication, is a helpful science to master in many fields[3]. It is the statistical analysis of written publications, such as books or articles. Bibliometric methods are frequently used in the field of information and library sciences, including scientometrics. Bibliometry is also used to make a quantitative analysis of academic literature [4]. It contains the examination of books, journals, conference proceedings, and other written communication media using mathematical and statistical techniques [3-4]. Bibliometric studies indicate productivity of authors, countries, growth of literature, and distribution of scientific publications by country or by language [5]. These data help to monitor the growth and patterns of a scientific fields[6].

The purpose of this study was to investigate the "diabetic retinopathy" literature using the Web of Science (WoS) database. In addition, we analyzed whether there were possible correlations between economical productivities [gross domestic product (GDP), GDP per capita and GDP per hour worked], population, technological advancement levels in terms of the number of internet users and HDI data associated with diabetes and the productivity of publication DR disease in the countries. We also estimated the publication number in 2015 for DR disease by using cumulative publication numbers for 1980 and 2014.

SUBJECTS AND METHODS

The data of this study were based on the database of WoS (Thomson Reuters, New York, NY, USA). "Diabetic Retinopathy" was used as the keywords to search the WoS database. Documents published in 2015 were excluded. The period of statistical analysis of the documents published during 1980-2014 was performed. Regression analysis was performed for the statistical estimation. Correlation analysis was assessed and finalized by Spearman test since the data were not normally distributed [7].

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional and/or National Research Committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

RESULTS

Total Number of Published Items We identified a classification of research areas of DR. It involved over a hundred research subjects; about three out of four were in ophthalmology (3557) and endocrinology & metabolism (1995). The top ten research subject areas are listed in Table 1.

Types of Publications As the keyword "diabetic retinopathy" was used to search articles, the WoS database search retrieved a total of 7706 publications from the beginning of 1980 to the end of 2014. It was found that 55.5% of the total DR publications were original articles followed by abstracts (26.3%), letter (6.0%), and meeting abstracts (4.7%) (Table 2).

Top journals of diabetic retinopathy research articles The top ten journals are shown in Table 3. The main publications were *Investigative Ophthalmology & Visual Science* (871), *Diabetologia* (491) and *Diabetes* (424) which was the highest in record count but *Archives of Ophthalmology* has the highest in average citations per item (64.65) and *Ophthalmology* has the highest H-index (54).

The main authors of diabetic retinopathy research articles The main authors of DR research by ISI WoS database are shown in Table 4. We found that Dr. Klein had published 229 records, who has the highest in sum of the times cited and H-index but Dr. Moss has the highest in average citations per item (78.92).

Table 1 Research areas of DR study

No.	Subject areas	Record count	Percentage (%)
1	Ophthalmology	3557	47.13
2	Endocrinology & metabolism	1995	26.43
3	General internal medicine	642	8.51
4	Research experimental medicine	255	3.38
5	Biochemistry molecular biology	222	2.94
6	Pharmacology, pharmacy	165	2.19
7	Cardiovascular system, cardiology	156	2.07
8	Engineering	115	1.52
9	Public environmental occupational health	111	1.47
10	Cell biology	91	1.21

Table 2 Types of publications on DR

Document types	Topic	
	n	%
Article	4275	55.5
Abstract	2026	26.3
Letter	459	6.0
Meeting	365	4.7
Review	305	4.0
Editorial material	211	2.7
Correction	34	0.4
News	25	0.3
Other	3	0.0
Book	2	0.0
Biography	1	0.0
Total	7706	100

The main supporter funding agencies for diabetic retinopathy trials The leading funding agencies are listed in Table 5. National Institutes of Health (121) are followed by Research to Prevent Blindness (62) and Juvenile Diabetes Research Foundation (59).

Total number of published items The top 10 countries were ranked by the number of total indexed publications (Figure 1). The United States ranked first in the "DR" field with 1840 publications and 24.38% of the world production. The United States was followed by England and Japan (762 papers-10.10% and 519 papers-6.88%, respectively; Figure 1).

Publication productivity of the countries We measured productivity scores of the countries by a simple formula (production numbers/population ×100 000) and ranked the countries [8]. The most productive countries in DR were Iceland, Denmark and North Ireland (Figure 2). Figures 1 and 2 taken together, England and Australia were only found both groups.

Correlation analysis between diabetic retinopathy and productivity indicators The correlation analysis results between socio-economic development data and number of DR publications were given in Table 6. We found a low correlation between country population and number of DR publications (r=0.416, P<0.001). The highest correlation

Table 3 Top publications

No.	Source titles	Record count	Total times cited	Average citations per item	H-index	Percentage
1	*Investigative Ophthalmology & Visual Science*	871	6389	7.34	45	11.54
2	*Diabetologia*	491	4558	9.28	40	6.51
3	*Diabetes*	424	7348	17.33	47	5.62
4	*Diabetes Care*	239	7460	31.21	48	3.17
5	*Ophthalmology*	213	10143	47.62	54	2.82
6	*British Journal of Ophthalmology*	192	4760	24.79	40	2.54
7	*Diabetic Medicine*	181	2764	15.27	31	2.40
8	*American Journal of Ophthalmology*	169	5381	31.84	37	2.24
9	*Archives of Ophthalmology*	167	10797	64.65	51	2.21
10	*European Journal of Ophthalmology*	166	334	2.01	11	2.20

Table 4 The main authors of DR research articles

No.	Author	Record count	Total times cited	Average citations per item	H-index	Percentage
1	Klein R (US)	229	14694	64.17	57	3.03
2	Klein BE (US)	141	9116	64.65	47	1.86
3	Moss SE (UK)	104	8208	78.92	45	1.38
4	Kohner EM (UK)	87	2082	23.93	25	1.15
5	Wong TY (Singapore)	84	2466	29.36	24	1.11
6	Aiello LP (US)	73	4978	68.19	23	0.97
7	Simo R (Spain)	71	972	13.69	19	0.94
8	Kern TS (US)	70	3047	43.53	23	0.93
9	Hernandez C (Spain)	61	868	14.23	18	0.81
10	Kowluru RA (US)	58	1488	25.66	23	0.77

Table 5 The main funding agencies

No.	Funding agencies	Record count
1	National Institutes of Health	121
2	Research to Prevent Blindness	62
3	Juvenile Diabetes Research Foundation	59
4	National Natural Science Foundation of China	47
5	National Eye Institute	43
6	Thomas Foundation	29
7	American Diabetes Association	17
8	Novartis	14
9	Velux Foundation	12

was found between number of publications and 2014 GDP values of 81 countries (r=0.800, P<0.001). GDP is everything that a country's economy produces in a year and is a basic measure of the economic well-being of a country. We found a moderate correlation between the number of publications and 2014 GDP per capita based on purchasing power parity (PPP) values of the countries producing DR publications (r=0.600, P<0.001). GDP per capita takes a country's production, as measured by GDP, and divides it by the country's total population. A moderate correlation was also found between the number of DR publications and GDP (PPP) per hour worked (r=0.608, P<0.001). The GDP per hour worked (PPP) is an objective measure of the productivity of a country's economy. We found a moderate correlation between number of internet users and number of publications for the countries producing papers in DR (r=0.600, P<0.001). Nearly the same correlation was also measured between the number of papers and percentage of individuals using the internet (r=0.522, P<0.001). Internet users are those who use the internet from any location. Internet usage can be an indicator of a countries development. We found a significant correlation between number of publications and HDI (r=0.645, P=0.001). The HDI is a combined statistic of income, education and life expectancy markers and used to rank countries into tiers of human development [9].

Correlation analysis between diabetic retinopathy and diabetic data of the countries The correlation analysis results between the diabetes datas [10] and number of DR publications are shown in Table 7. There is a moderate correlation between people with diabetes and number of DR publications for 81 countries (r=0.514). There is low correlation between death related to diabetes, diabetes prevalence and number of DR publications. (r=0.391, r=0.411).

Prediction of the Publications A significant correlation was found between the year and cumulative number of DR publications as shown in Figure 3. The publication number for 2015 was estimated by using cumulative publication numbers for 1980 and 2014. It could be analysed that estimated publication number with DR title will be 445

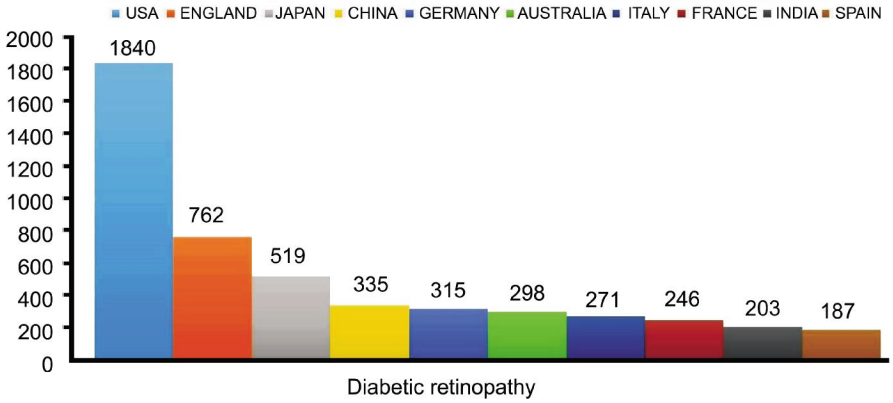

Figure 1 Top 10 countries publishing DR publications by total number of items.

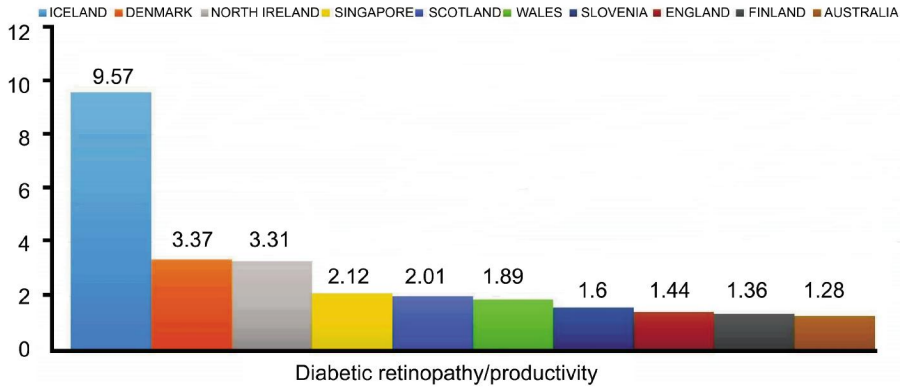

Figure 2 Top 10 countries in productivity in DR publishing.

Table 6 Correlations between publication numbers and productivity and development indices of countries

Development indices	Population	GDP	GDP (PPP) per capita	GDP (PPP) per hour worked	No. of internet users	PIUI	HDI
DR (n=81)	r=0.416	r=0.800	r=0.600	r=0.608	r=0.600	r=0.522	r=0.645
	P=0.000[b]	P=0.000[b]	P=0.000[b]	P=0.000[b]	P=0.000[b]	P=0.000[b]	P=0.001[b]

[b]Correlation is significant at the 0.01 level. Statistically significant ($0.00<r<0.25$: little if any correlation; $0.26<r<0.49$: low correlation; $0.50<r<0.69$: moderate correlation; $0.70<r<0.89$: high correlation; $0.90<r<1.00$: very high correlation). DR: Diabetic retinopathy, GDP: Gross domestic product; PIUI: Percentage of individuals using the Internet (according to total population of a country); HDI: Human development index; PPP: Purchasing power parity.

Table 7 Correlations between publication numbers and data associated with diabetes and obesity data of countries

Diabetes data	Deaths related to diabetes	Diabetes cases[1]	Diabetes national prevalence[2]
DR (n=81)	r=0.391	r=0.514	r=0.411
	P=0.001[b]	P=0.000[b]	P=0.012[b]

[b]Correlation is significant at the 0.01 level. [1]Total cases with diabetes of each country's; [2]Actual percentage of each country's.

according to the regression curve constituted with cubic model in 2015 (R^2=1.000).

DISCUSSION

DR is caused by microvascular complications of diabetes and is a leading cause of vision loss and blindness in adult population, particularly in developed countries. Each year in the United States, DR accounts for 12% of all new cases of blindness. It is the most frequent cause of new cases of blindness for people aged 20 to 64y [11]. In the Wisconsin Epidemiologic Study of DR, 3.6% of younger-onset patients (type 1 diabetes) and 1.6% of older-onset patients (type 2 diabetes) were legally blind [12]. Over the past 4 decades, the number of DR publications has gradually increased as shown

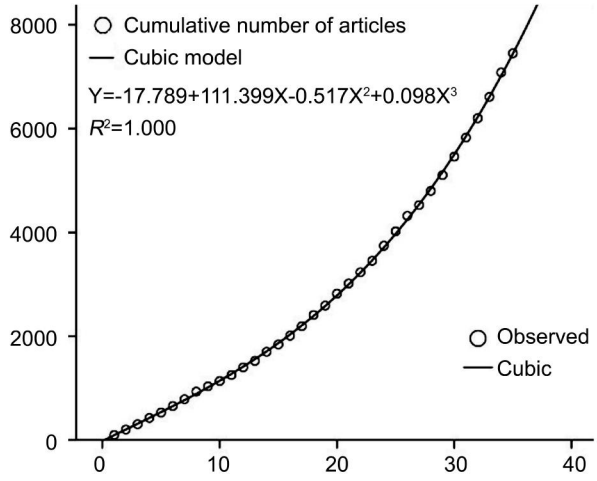

Figure 3 Cumulative number of DR publications by year.

in Figure 3. It showed a positively accelerated curve with cubic model over the years. While the publication numbers were 97 in 1980, they were 419 in 2014. DR has increased by more than 89%, while those in the United States population 40 and older grew by 19.5% between 2000 and 2010 like all

over the world because of burgeoning diabetes rate to several factors, including an aging population, growing trends of obesity and sedentary lifestyles, and an increase in minority populations that are at high risk for developing diabetes. In 2010, of an estimated 285 million people worldwide with diabetes, over one-third have signs of DR, and a third of these are afflicted with vision-threatening retinopathy[13].

The United States ranked first in the "DR" field with 1840 publications considering the total number of published items that showed in Figure 1. Liu *et al*[14] reported that the United States ranked first and followed by Japan and England, respectively in DR fields. In our study, England and Japan followed the United States, respectively. The most productive country in DR was Iceland considering the publication productivity of the countries in our study as shown in Figure 2. Diabetes occurs throughout the world and affects the majority of people in developed countries and is increasing rapidly in developing countries. Type 2 diabetes is a global crisis that threatens the health and economy of all nations, particularly developing countries. The increase in incidence in developing countries follows the trend of rapid urbanization, transition, nutrition, obesity and sedentary lifestyle changes. The diabetes epidemic in Asia, particularly China and India, is characterized by onset at lower body mass index levels and younger ages compared with Caucasian populations[15]. As the global prevalence of diabetes increases, so will the numbers of people with DR. In our study, India has been included in the top 10 list instead of Canada in comparison with Liu *et al*'s [14] study considering the total number of published items in DR fields. Besides, China has increased from 7th to 4th place in our study in comparison with Liu *et al*'s[14] study. Development in China and India during the past decades has transformed the economic situation. However, these transformations have not been sufficient to increase the prevalence of diabetes, a side-effect noted in all countries that undergo fast economic changes. In addition to expanding ageing population, low-activity lifestyle and an increasingly westernized diet habits have contributed to the increasing incidance of diabetes. For example, more than one in ten people in China have diabetes, amounting to more than 100 million adults with the disease-more than any other country in the world. In 2013, one in four people with diabetes worldwide were in China, where 11.6% of adults had diabetes and 50.1% had prediabetes. It also affects more than 62 million Indians, which is more than 7.1% of India's adult population. All these situations affect the risk of diabetes and its complications in Chinese and Indian people. The incidance of diabetes and DR in China and India has increased substantially over recent decades. As shown in this bibliometric analysis, the number of DR studies therefore are increasing in China and India.

GDP, GDP per capita and per hour worked are a measure of the economic well-being of a country. Each of these parameters is also a measurement of how prosperous a country feels to each of its citizens and is a developmental indicator. A high correlation was found between the number of DR publications and 2014 GDP values of 81 countries. The United states ranked first in the world in both the number of DR publications (1840 papers) and GDP ($16.72 trillion)[9]. A modarate correlation was found between the number of DR publications and 2014 GDP per capita (r=0.600, P=0.000) and per hour worked (r=0.618, P=0.000). Number of internet users, individual internet using and HDI have a moderate correlation with number of DR publications. HDI emphasize that people and their capabilities should be the ultimate criteria for assessing the development of a country. The number of internet users is an indicator of a country's development. However, the growth in the number of internet users was greatest in developing countries. All these data are the basic indicator of the development level of countries. It can be concluded that there is a correlation between the number of DR studies and developmental level of countries.

In developing countries, the majority of individuals with diabetes are aged between 45 and 65y while in developed countries, the majority are older than 64y. Diabetes is now being shown to be associated with a spectrum of complications and to be occurring at a relatively younger age in developing world. Based on demographic changes by 2030, the number of people older than 64y with diabetes will be more than 82 million in developing countries and more than 48 million in developed countries. The greatest relative increases are expected to occur in the developing world like the Middle East crescent, sub-Saharan Africa, China and India[16]. Awareness of diabetes is low, and underdiagnosis and undertreatment are major problems in developing countries. Diabetes and DR are a public health problem in developing countries and education should be a high priority for intervention for all developing countries and regions.

Our study had some limitations. Because we used only the WoS database to search publications, we could reach back to 1980. We found a lower number of publications because we did not search databases including more journals than WoS such as Medline, Scopus, or Index Copernicus. Because it is the more reliable service for publications and citations, we preferred to research the WoS database. All the journals indexed in the WoS database had impact factors. We included only one term as keyword to prevent the results being incomprehensible.

Diabetes and its complications are a growing public health problem affecting people worldwide both in developing and developed countries, and they pose major socio-economic challenges. However, more DR studies have been published

in developed countries, DR and other complications of diabetes have gradually increased in developing countries over recent decades. Research and intervention must be done to try to prevent the potentially catastrophic increase in DR that is predicted for the upcoming years. Preventive healthcare, programmes, awareness, campaigns, and public health policies designed for the developing world will be essential. It can be expected that the number of DR studies will gradually increase in developing countries, particularly China and India.

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