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A bibliometric and mapping analysis of glaucoma research between 1900 and 2019

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Abstract

Purpose: The aim of this study is to explore the relevance of scientific production on glaucoma using bibliometric tools.

Design: Bibliographic study

Subjects: Original articles published in the timeframe 1900-2019

Methods: We performed a search in Web of Science for documents published between 1900 and 2019. We used bibliometric indicators to explore documents production, dispersion, distribution, time of duplication and annual growth, as characterized by Price's law of scientific literature growth, Lotka's law, the transient index and the Bradford model. We also calculated the participation index of different countries and institutions. Finally, we explored with bibliometric mapping the co-occurrence networks for the most frequently used terms in glaucoma research.

Main outcome measure: Bibliometric indicators for individuals, institutes and countries

Results: A total of 33,631 original articles were collected from the timeframe 1900-2019. Price's law shows an exponential growth. Scientific production is better adjusted to exponential growth ($r = 0.967$) than linear growth ($r = 0.755$). Literature on glaucoma research increased its growth in the last 30 years at a rate of 5.1% per year with a production that doubles its size every 13.9 years. The transience index is 60.08%; this indicates that most of the scientific production is due to very few authors. Bradford's law shows a high concentration of articles published in a small core of specialized journals. Lotka's law indicates that the distribution of authors is heavily concentrated in small producers. USA and University of London have the highest production of original articles. Map network visualization shows the generated term map detailing clusters of closely related terms.

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Conclusions: Glaucoma literature has had exponential growth. There is a very high rate of transience that indicates the presence of numerous authors who sporadically publish on this topic. No evidence of a saturation point in the glaucoma literature was observed.

Keywords

glaucoma; scientific production; bibliometric indicators; bibliometric mapping; collaborative networks

INTRODUCTION

Glaucoma affects more than 70 million people worldwide with approximately 10% being bilaterally blind, making it the leading cause of irreversible blindness in the world.¹ It is a multifactorial optic neuropathy characterized by slowly progressive neurodegeneration of retinal ganglion cells (RGC) and their axons characterized by a specific pattern of optic nerve head (ONH) and visual-field damage.^{2,3} Examination of the structure and the function of the ONH and the retinal nerve fibers is essential to diagnose and monitor glaucoma.⁴⁻⁶ 1, 21, 21, 2 Considerable efforts have been made to show the efficacy, side effects and, costs of the medications, and laser as initial treatment of glaucoma. Surgical approaches to lower IOP and treat glaucoma have had an increasing role in disease management, particularly with development of less invasive and safer procedures.¹⁶⁻¹⁸

The quantity and quality of articles published in peer-reviewed biomedical journals indexed in different databases are constantly increasing. Bibliometrics analysis includes the collection, processing and management of quantitative bibliographic data from scientific publications,¹⁹ and their statistical indicators allow measurement of the growth, size and distribution of scientific literature on the topic in question during a given time period. It is the most commonly used tool to identify important discoveries and studies which have had a disproportionate influence in a particular field.²⁰ Studying the origin, format, type and citation count of published journal articles provides an insight into the quantity and scholarly impact of research produced within a certain field. Citation analysis can also be an important parameter to prioritize research funding in this era emphasizing cost-effectiveness. Without objective information about current research output it is difficult to plan for necessary improvements in infrastructure related to the understanding, treatment and prevention of glaucoma diseases.

Bibliometric analyses have been published in many specialties and subspecialties.²¹⁻²⁶ Our group has used a bibliometric approach to study the evolution of scientific literature in different areas of the biomedical sciences.²⁷⁻⁴³ However, to date, little is known about the contributions of individual researchers and research centers in glaucoma. In this article, we examine the patterns and trends of published glaucoma-related research worldwide. In particular, the performance of researcher and the types of their glaucoma-related articles are evaluated.

MATERIAL AND METHODS

Data Source

The initial data search was conducted through two databases, considered to be the most exhaustive within the biomedical field: SCOPUS (Elsevier BV, Amsterdam, The Netherlands) and the main collection of Web of Science (WoS) (Institute for Scientific Information (ISI) and Clarivate Analytics, Philadelphia, USA). According to the search strategy, a largest set of references was retrieved for WoS, and therefore it was chosen to carry out the digital file selection. The WoS was preferred over PubMed because it indexes journals with a high scientific quality and provides a unique citation report function.

Search strategy

Remote downloading techniques were used to select references published from 1900 to 2019. The selection of references was limited to those available in the chosen field for *TI* (title) as main descriptor “*glaucoma*”. To minimize the inclusion of off-topic items, we searched only in the “title”. Data were extracted from WoS database at one day (May 21, 2020) to avoid bias because of daily updating in the database.

This study took into account all original articles, brief reports, reviews, editorials, letters to the editor, and so on; it was also made sure that the duplicated documents were eliminated.

Data categorization

After downloading the metadata and exact bibliographic details of all glaucoma publications, the results were analyzed according to the criteria of chronological distribution, country of origin, affiliation, sources and authors of the documents, keywords and descriptors used. The methodology applied in this study was comparable to recent bibliometric studies of our group.^{39–43}

Bibliometric indicators

For this analysis, the most common bibliometric indicators were used: Price index, doubling time, annual growth rate, Price transience index, Lotka’s law and the Bradford zones.

Price’s law was chosen as bibliometric indicator of production,⁴⁴ because it is the most widely used to analyze productivity on a specific discipline or a particular country. In order to assess whether the growth of scientific production in this field follows Price’s Law of Exponential Growth, we carried out a linear adjustment of the data obtained, and another adjustment to an exponential curve.

Time of duplication and the annual growth rate is related to the growth of a subject of study. The first is an indicator that informs us of the time required for the scientific production of a given subject to double. The form of growth was studied from the equation of Egghe and Ravichandra;⁴⁵ this function is represented mathematically as: $C(t) = cg^t$, where $C(t)$ is the total number of documents produced at time t ; c and g represent estimated constants of the observed data, taking into account that $c > 0$, $g > 1$, and $t \geq 0$; t is the number of chronological years studied in the research period ($t = 0, 1, 2, \dots, n$). The model not only

provides an average rate of growth, but also offers a rate of duplication. To estimate the duplication time (D) of the scientific literature, the following equation is used: $D = LN(2) / LN(g)$.

As a bibliometric indicator for dispersion of scientific literature, Bradford zones' model was applied.⁴⁶ In order to show the distribution of literature, this model shows that the highest percentage of bibliographic production on a specific subject tends to be concentrated in a small numbers of journals. He proposed a template of concentric zones of productivity with decreasing density of information that allows for faster performance expanding the search outside its core. This model helps to determine which journals are preferred by authors to publish and, therefore, which are the most specific ones on a subject or discipline. The number of journals on the nucleous (core) and successive zones are expressed by a ratio as $1, n, n^2, \dots$

To assess the influence of publications, the Impact Factor (IF) is used. This indicator, developed by the Institute for Scientific Information (Philadelphia, PA, USA), is published annually in the *Journal Citation Reports* (JCR) section of the Science Citation Index (SCI). The IF is calculated taking into account the times a journal has been cited in the SCI database in the last two years and the total number of articles published in this journal in those same years. Despite its limitations⁴⁷, IF has been traditionally considered an index of journal's prestige.⁴⁸

Lotka's law, also named "inverse square law of scientific production" was used to provide information of author's distribution based on number of publications.⁴⁹ This law establishes the number of authors (A) who have published a number (n) of references in a period of several years of activity $A(n)$, is equal to the number of those who have published a single reference $A(1)$, in the same period of time, divided by the square of n . Its function is mathematically expressed as: $An = Kn^{-b}$, $n = 1, 2, 3, \dots$, where An represents the probability that an author produces n publications on a subject, while K and b are parameters to estimate depending on the data. According to this law, if the studied period is long enough and the bibliographic search is as complete as possible "the number of authors that publish n papers is inversely proportional to n^2 ".

Other indicators that have been included is the author's productivity index (PI). PI allows the establishment of three levels of productivity: $PI = 0$ (transience index: authors with a single paper), $0 < PI < 1$ (those authors that published between 2 and 9 papers), and $PI = 1$ (very productive authors with 10 or more papers).

We have used the h-index to quantify the authors' activity. This index is one of the bibliometric indicators most widely used to rate the success of a researcher's performance.⁵⁰ Nevertheless, the h-index also has its limitations, as it tends to penalize those authors that prioritize quality over quantity and do not publish extensively, while favouring others with a more protracted career,⁵¹ who have managed to publish more.⁵² The g-index was introduced to measure the global citation performance of a set of articles,⁵³ together with the p index, which stems from the interrelationship between the two, and is calculated as its coefficient: $p = h/g$.^{53,54}

Bibliometric mapping

For bibliometric mapping,⁵⁵ we studied the keywords, and the co-occurrence networks for the most frequently used terms in the titles and abstracts of the publications related to glaucoma over the time interval. Each term is demonstrated by a circle, where its diameter and the size of its label illustrate the frequency of the term, and its color reflects most frequently encountered topics in this field.⁵⁶

The analysis of keywords is included within the classification of relational and multidimensional indicators.⁵⁷ By keyword analysis, we mean the study of the co-occurrences or joint appearances of two terms in a given text in order to identify the conceptual and thematic structure of a scientific domain.

We have also analyzed bibliographic coupling, a measure that uses citation analysis to establish a similarity relationship between documents. Bibliographic coupling occurs when two articles reference a third common article in their references. Bibliographic coupling was introduced by Kessler as a method of grouping technical and scientific documents and facilitating the provision of scientific information and the retrieval of documents.⁵⁸

Finally, we have applied the mapping to identify the collaborative networks of the institutions and authors, to determine which authors produce, how much and how they relate and collaborate. These maps show the importance of the use of relational indicators in studies to analyze the scientific production of research groups, in order to determine their publication dynamics, with emphasis on measures such as centrality, density and size of the network.⁵⁹

Statistical Analysis

Statistical analysis tests were performed using the Statistical Package for the Social Sciences (SPSS) version 23.0, to evaluate the growth pattern of research output, linear and exponential regression adjustments were compared for trend in the publication. The software VOSviewer (Centre for Science and Technology Studies, Leiden University, The Netherlands) was used to perform the bibliometric mapping.⁵⁶

RESULTS

Using the search criteria, we retrieved 33,631 documents in a 118 years period, from 1900 to 2019. The chronological distribution of the publication showed a notable increase in the number of articles generated in glaucoma research (Figure 1), especially from 1999.

If we analyze the distribution by five-year periods, we see that the last two (2010-2014 and 2015-2019) contain the greatest number of documents, with 18.39% and 28.30% respectively. In these periods, there was a significant increase with respect to the previous period of 62.14 and 53.88% respectively.

To assess whether the scientific production on glaucoma follows the Price law, a linear trend curve expressed in the following way $y = 10,243x - 19795$ was created. Similarly, an exponential trend line was created according to the equation $y = 1E-50e^{0.0606x}$.

As reflected in Figure 1, the mathematical adjustment to a linear curve reveals a correlation coefficient of 0.7552, indicating that 24.48% cannot be explained by this adjustment. On the other hand, the exponential adjustment of the measured values provides a 0.9676 coefficient and therefore a residual variability percentage of 3.24%. These results suggest that the repertoire analysis is more suitable for an exponential fitting than a linear one. Therefore, it does comply with the postulates of the Price Law, and the growth in the area of glaucoma is exponential.

Table 1 shows the parameters and values obtained from the application of the exponential model by the non-linear regression method. In order to contextualize the growth of publication on glaucoma, we compared it with two period one covering 88 years, from 1900 to 1989, and another more specific one, which includes the last 30 years, from 1990 to 2019.

In the first case (Table 1, Model 1), the value of c is 2.735 and that of g 1.070. With these values, the Egghe and Ravichandra Rao equation can be established, and thus predict the growth of the published literature on glaucoma: $C(t) = 3.772 * 1.0051^t$. According to this method, literature on glaucoma has grown at a rate of 6.6% per year, with a production that doubles its size every 10.8 years. This model is explained at 92.1%.

In the second case (Table 1, Model 2), the value of c is 298,617 and that of g 1.069. The equation of Egghe and Ravichandra Rao is $C(t) = 298.617 * 1.069^t$, the publication doubles in size every 13.9 years and grows at 5.1% per year. This model is explained at 90.9%.

After applying the Lotka law, the distribution of the authors was heavily concentrated in small producers. Only 4.99% of the authors ($n = 2,437$) have a production of 10 or more articles. The data shows a high index of transience (occasional authors) of 60.08% (29,342 authors). The total number of authors for 33,631 papers was 48,836 authors, representing an index of co-authorship of 1.45. After manual filtering of the data, due to the lack of standardization of the authors' names, two authors stand out for their production, Robert N. Weinreb and Robert Ritch, with 1.62% and 1.17% of the articles published on glaucoma (Table 2). Likewise, the importance of the authors who research on this topic is demonstrated, since among the first 10, we find 7 with an h-index above 60 and 2 above 90. If we take into account the p-index, there are 5 authors above 1.6.

The map represented in Figure 2 shows the collaboration networks between the authors. The diameter of the nodes is related to the productivity of each of the authors, the lines or links establish the existence of a relationship between a pair of authors, and the thickness of the lines refers to the intensity of the communication between two or more authors. In this way, we can verify that the two largest nodes correspond to the two most productive authors, as indicated above. There also are strong collaborative networks among other authors.

Table 3 shows the distribution of journals per Bradford zone. It should be noted that only three journals make up the core. These are *Investigative Ophthalmology & Visual Science*, with just over 20% of total production, specifically 21.91%, *American Journal of Ophthalmology* and *Journal of Glaucoma* with 5.16 and 5.11%, respectively, which implies a high concentration of articles published in a small core of more specialized journals. These

more specialized journals in glaucoma research, present a high IF of 3,470, 4,013 and 1,661 respectively, which shows the interest in this area of research.

The geographical and affiliation distribution of the documents is presented in Figure 3. This analysis shows that 10 countries represent 72.46% of production, with the United States being the largest producer, with 32.82% of the documents. As far as the most productive institutions are concerned, we can say that most of the research on glaucoma takes place in academic settings. Thus, among the 10 most productive, 8 are in academic settings. In this respect, the University of London stands out with 6.23% of the total production of research on glaucoma, and University of California is the second (6.10% of the total production).

Figure 4 shows the collaboration networks between institutions and countries. In the first case, there is a strong relationship between Johns Hopkins University and Harvard University with the clusters in red, and in blue the relationship between the University of California San Diego and the New York Eye and Ear Infirmary. With regard to the networks between countries, we found the United States as the central cluster.

The map presented in Figure 5 shows the terms most frequently used in the titles and abstracts of publications related to glaucoma. The larger the circle, the higher the frequency of occurrence of the specific term and the smaller the distance between two terms/circles, the higher the co-occurrence of the terms. Colors indicate clusters of closely related terms. Cluster analysis based on term co-occurrence identified five major clusters (green, red, purple, blue and yellow), being the main term (glaucoma task) situated in the red cluster, highly connected with terms from the other clusters. Important terms are related with characteristics of the glaucoma task as open-angle glaucoma, intraocular pressure and ocular hypertension. The common use in recent decades of optical coherence tomography techniques is reflected in the yellow cluster. We can also highlight the use of pharmacological treatments, such as timolol or latanoprost reflected in a purple cluster. Other types of treatment are reflected in the blue cluster, for example trabeculectomy or phacoemulsification.

DISCUSSION

This study assessed glaucoma-related research conducted between 1900 and 2019. Bibliometric indicators were used to explore the research productivity of ophthalmologists, optometrists, and vision scientists worldwide. We demonstrated that literature on glaucoma research has undergone an exponential growth with a production that doubles its size every 10 years until 1990 and every 14 years in the last three decades. This increase was more pronounced after 2000 with publications of landmark studies and randomized clinical trials. In addition, payers and regulatory authorities became more aware of the burden of glaucoma disease on the burden and economic consequences of glaucoma upon healthcare systems and patients, especially elderly patients. The rapid increase in publications also was accompanied by the development and proliferation of imaging technology for diagnosis and monitoring of the disease, and a prominent proportion of the publications focused on this field of research.

Another interesting quantitative aspect of this bibliometric analysis is the quality of the scientific production. We approached this problem with the evaluation of the repercussion index of the publications included in the dataset. It is notable the main journals studied have a high IF. Likewise, the importance of the authors who research on this topic is demonstrated, since the first ten presents an h-index above 30 and six above 60 (see Table 2).

In the present study, the US, the UK, and Germany had the highest account of glaucoma articles published within the literature and together consisted of 40% of the published papers. Although no reviews have reported glaucoma research productivity, there have been a few studies of ophthalmology productivity, as measured by publications.^{26,60–62} Guerin et al⁶² examined the publications from five ophthalmology journals over 5 years (2002 to 2006) and found that the overall number of articles published increased by over 29% during this period. In another study, the US, the UK and Europe account for around 60% of articles published within the ophthalmology literature between 2009 and 2013.²⁶

Prior studies also provided interesting correlations with economic support for research:^{26,62} The US, which ranked first in ophthalmic research productivity, contributed 40% of the papers identified and devoted 2.7% of gross domestic product (GDP) to research and development. They showed that research expenditure and GDP was significantly correlated with both research output and scholarly impact and expected that the US to remain the dominant figure in ophthalmic research for at least the next 10 years. In a study by Mandal et al⁶⁰, published in 2004, it was found that researchers in the developing world contributed only 5% of the literature, compared to 90% from the developed world. Although this trend was changed over the next 10 years,²⁶ similar results were found in the present study and 30% of the glaucoma publications of the last 10 years now originated from the developing countries.

The fact that the USA is responsible for 32.82% of all the documents that were studied can be correlated with the documents that express the funding of the research by different North American Agencies: the United States Department of Health Human Services (n = 2,916), the National Institutes of Health (NIH) (n = 2,878), the NHI National Eye Institute (n = 2,409), and the Research to Prevent Blindness (n = 980). In this regard, it should be made clear that a country's scientific production in a given field tends to reflect a science research and development policy. In general, there is confirmation of the notion that the higher the funds invested, the greater the research production.^{32,34}

University of London, University of California and John Hopkins University had the largest contributions to glaucoma research in the present study. It is clear that the academic climate is a significant indicator of basic and clinical science research activity. Collaborations are another main reason that is linked to publishing productivity.^{63–65} Collaboration in research can take many forms of activity ranging from offering general advice and opinion to active and sustained participation and contribution of physical and intellectual resources. Scientists employed in different organizations may collaborate by sharing data or ideas through correspondence or at conferences, visiting each other's research facilities, or actually performing parts of a project separately and then integrating the results.⁶³

There is abundant evidence that research collaboration has become the norm in every field of scientific and technical research.⁶⁶ The co-author concept of collaboration has several advantages, including verifiability, stability over time, data availability and ease of measurement.⁶⁷ Moreover, funding agencies, particularly government agencies, facilitate active research collaboration as part of their funding conditions.⁶⁵ In addition, large population-based health administrative databases, clinical registries, and data linkage systems are a rapidly expanding resource for health research.⁶⁸ The last decade has seen a dramatic increase in the use of large databases for ophthalmic research which requires collaborations with many health care institutes.⁶⁹ Glaucoma research has benefited from the use of these databases in expanding the breadth of knowledge in areas such as disease surveillance, disease etiology, health services utilization, health outcomes, and more recently use of artificial technology diagnosis and management of the disease.

One study⁷⁰ that examined 22 different fields of science showed that at least 60% of publications are co-authored. Although the average index of signatures / paper of the documents is 1.45, team-working research and author collaborations are reflected in our repertoire. This low figure is explained by the temporal amplitude of our repertoire, since the index signatures / document was much lower in the articles published before the nineties. Since then, it is clear that a tendency exists towards the increment in the number of authors on scientific papers, and that this effect is mainly due to a higher degree of collaboration in glaucoma research between different investigators. We also found that the most productive glaucoma authors have intensive collaboration in their field (Figure 2). Besides, some relationships, such as those between the University of California San Diego and the New York Eye and Ear Infirmary or between Johns Hopkins University and Harvard University, are particularly productive in glaucoma research. However, the specifics of these relationships often depend on the relationships among individuals, and not the institutions, and that they can change, particularly if researchers change institutions. But, we must also bear in mind that the index of transience is very high. This indicates that 29,342 authors (60% of the total) are occasional authors, who have contributed to the scientific production on glaucoma only tangentially.

Although we did not examine specific research topics, some terms like open angle glaucoma, intraocular pressure, optical coherence tomography, prevalence, trabeculectomy were more commonly used terminology in the literature (see the VOSviewer co-occurrence keywords and terms maps in Figure 5) and can provide some hints for future direction of global ophthalmic research. Of note, the disease burden varies from country to country and therefore, that the research priorities will also differ. Research in high output countries has focused on open angle glaucoma, which accounts for 90% of glaucoma cases in these populations.¹ This is in comparison to angle closure glaucoma, which blinds ten times more people than open angle glaucoma, and of which 85% of cases are to be found in China, India, and south-east Asia.¹ Schulz et al²⁶ showed a significant positive trend in ophthalmology publications in these countries and expected that as the research contribution of these countries grows, future scientific advances will reflect the differing ophthalmic needs of these populations.

Limitations

Bibliometry has become a fundamental tool for evaluating the results of scientific activity.⁷¹ However, previous bibliometric studies have addressed limitations characteristic of this sociometric approach.⁷² This study has some limitations. We have chosen to narrow the search to only the title of the manuscripts, and not the abstract. Otherwise, the sample might include less representative documents that are not focused on the study of the glaucoma. The articles included in the analyzed repertoire only constitute a partial sample of the international production on glaucoma research. In particular, the limits introduced by the bibliographic databases determine the subsequent analysis. For example, if the authors did not specify the term “glaucoma” in the title of their manuscript, this document would not appear in our database. Moreover, most of the papers (92%) that were included in the present study were published in English, which is the predominant language in current medical research.⁷³ This may produce a bias toward English-speaking countries. However, all the records in the WoS contain the title in English, regardless of the language in which the article is published and this reduces this bias.

On the other hand, articles were identified and categorized according to the country of the first author using data submitted to the literature. It is possible that considering only the primary author’s institution missed the contribution of other countries in a global research network, particularly where the senior author is from another country. Unfortunately, when multiple authors are assigned to an article, it is difficult to make any decision about the relative contribution of each author. As in almost all cases the first author will have played a key role in the research and article submission process,⁷⁴ using the primary author’s country of affiliation is probably the most reliable indicator for comparing the research contribution of different countries and institutes.

Finally, we did not look at articles published in journals that are not ophthalmology-specific. Although the proportion of those articles that are published in more general medical and scientific journals is unclear, these articles might be skewed particularly toward higher-quality research with a higher rate of citation.⁷⁵

However, the well-known reputation of the journals included in the database used and its wide coverage make for a representative sample of the international research on glaucoma.

In conclusion, publications of glaucoma research have grown considerably during the past three decades. The US contributes approximately one-third of the worldwide articles, followed by UK and Germany. Institutional and individual collaborations have had a key role for glaucoma research productivity and will be a mainstay of future glaucoma studies.

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Acronyms:

GDP	gross domestic product
IOP	intraocular pressure
JCR	Journal Citation Reports
ONH	optic nerve head
RGC	retinal ganglion cells
SCI	Science Citation Index
WoS	Web of Science

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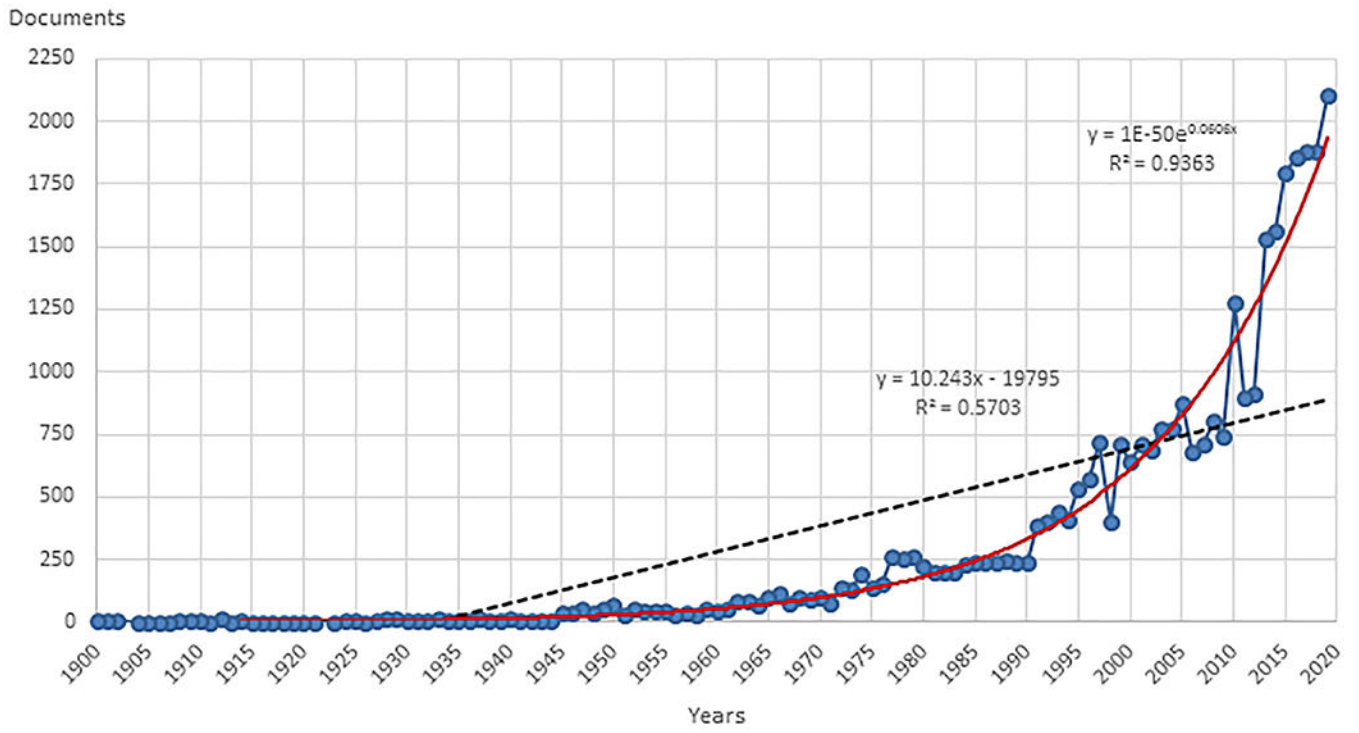


Figure 1.
 Chronological distribution. Linear adjustment (black): $y = 1.5972x - 3153.6$ ($r = 0.7552$).
 Exponential adjustment (red): $y = 1E-50e^{0.0606x}$ ($r = 0.9676$).

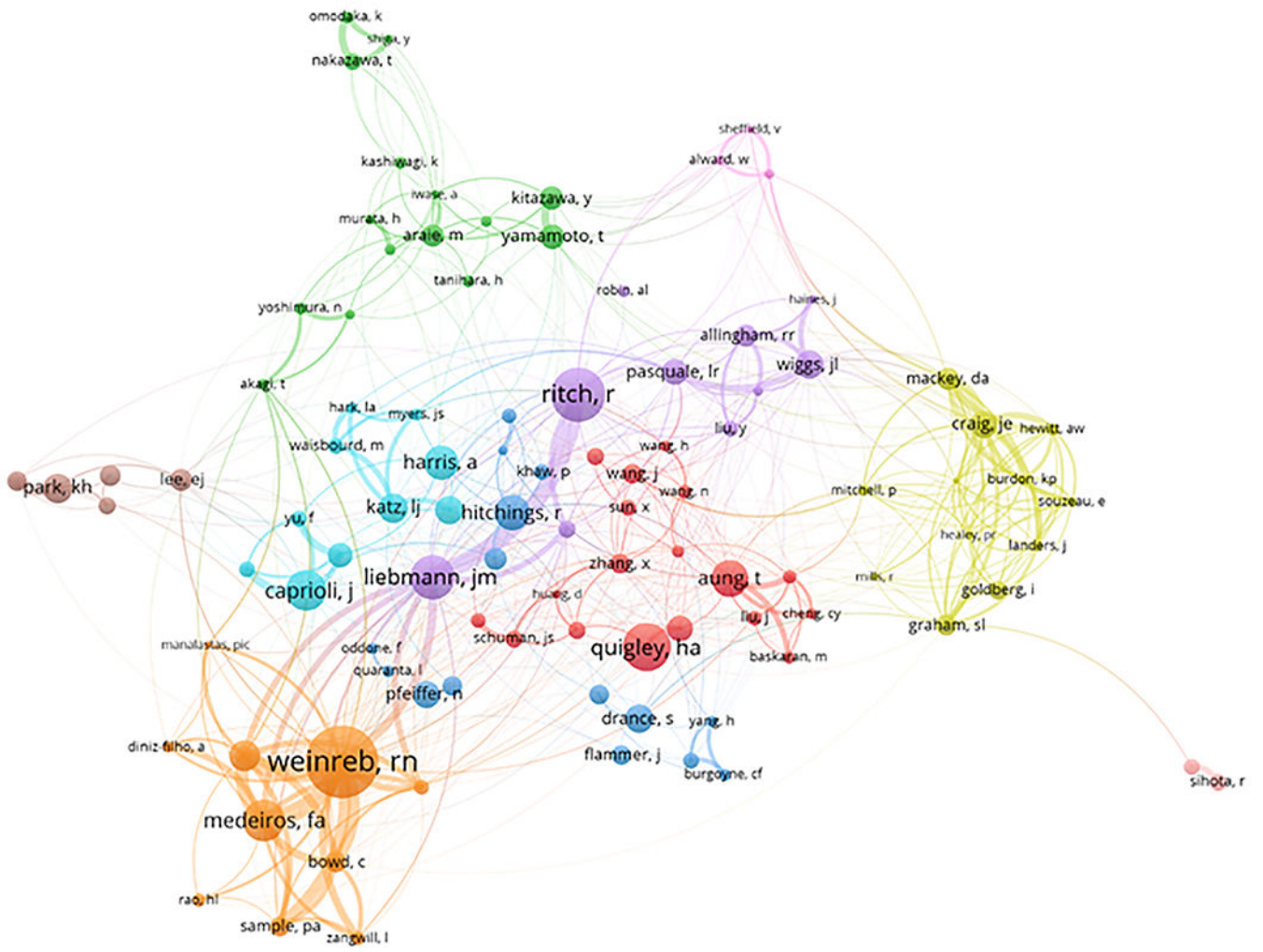


Figure 2.
Collaborative network of the most productive author

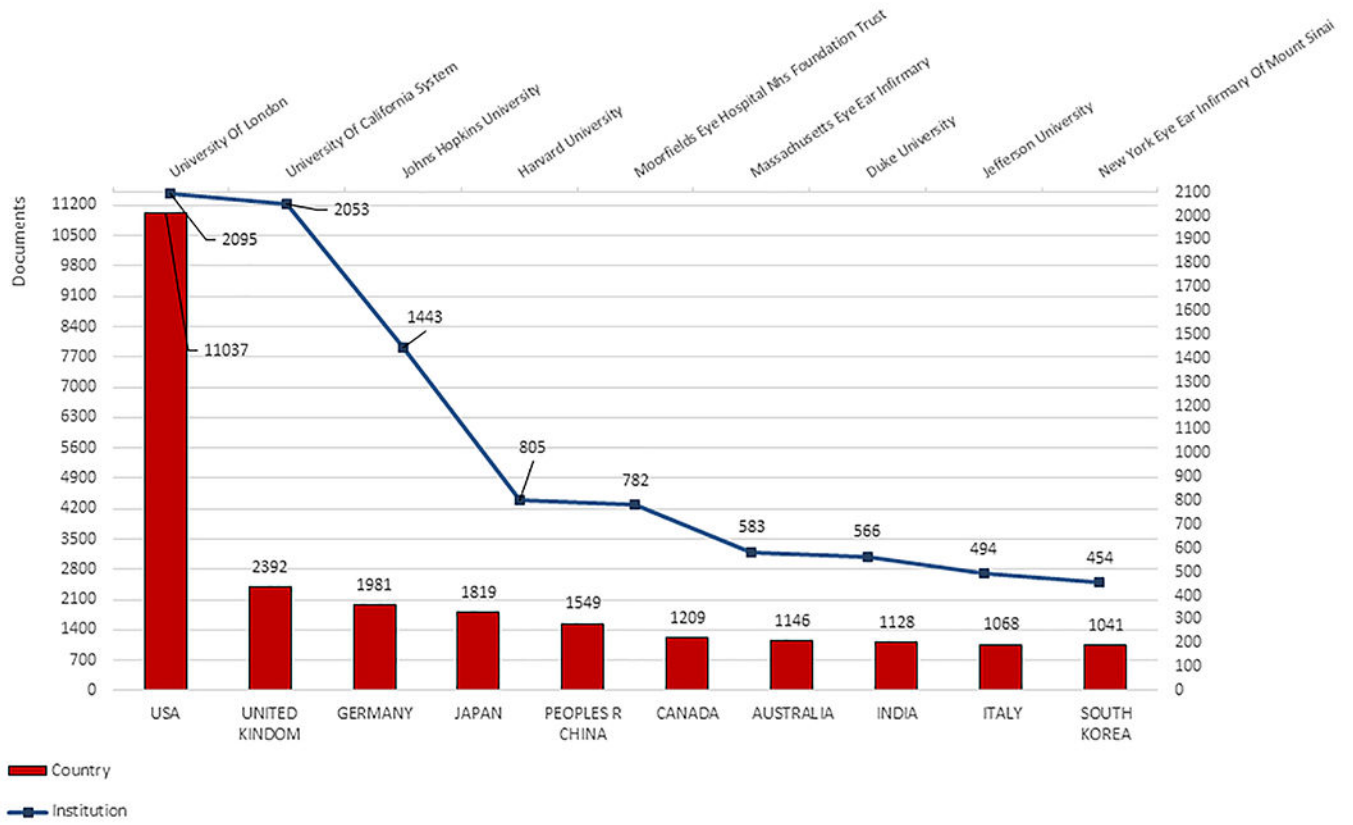


Figure 3. More productive countries and institutions in the generation of scientific literature on glaucoma.

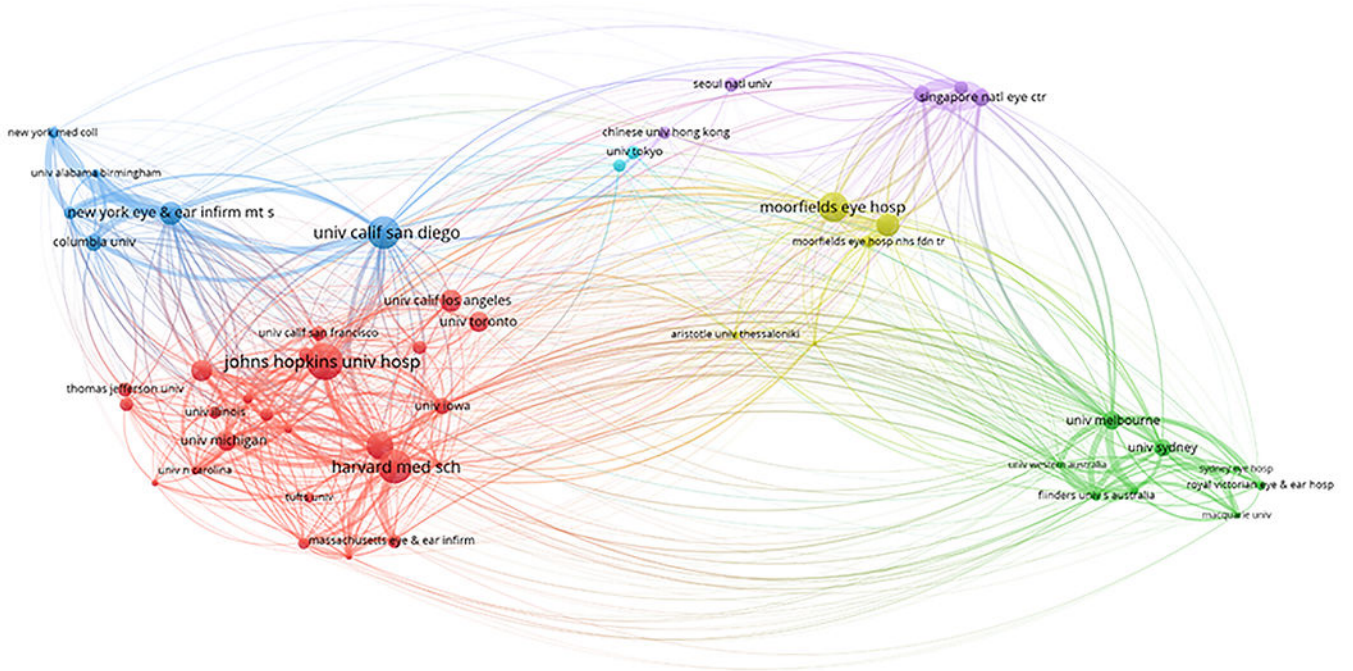


Figure 4.
Collaborative network of the most productive institutions

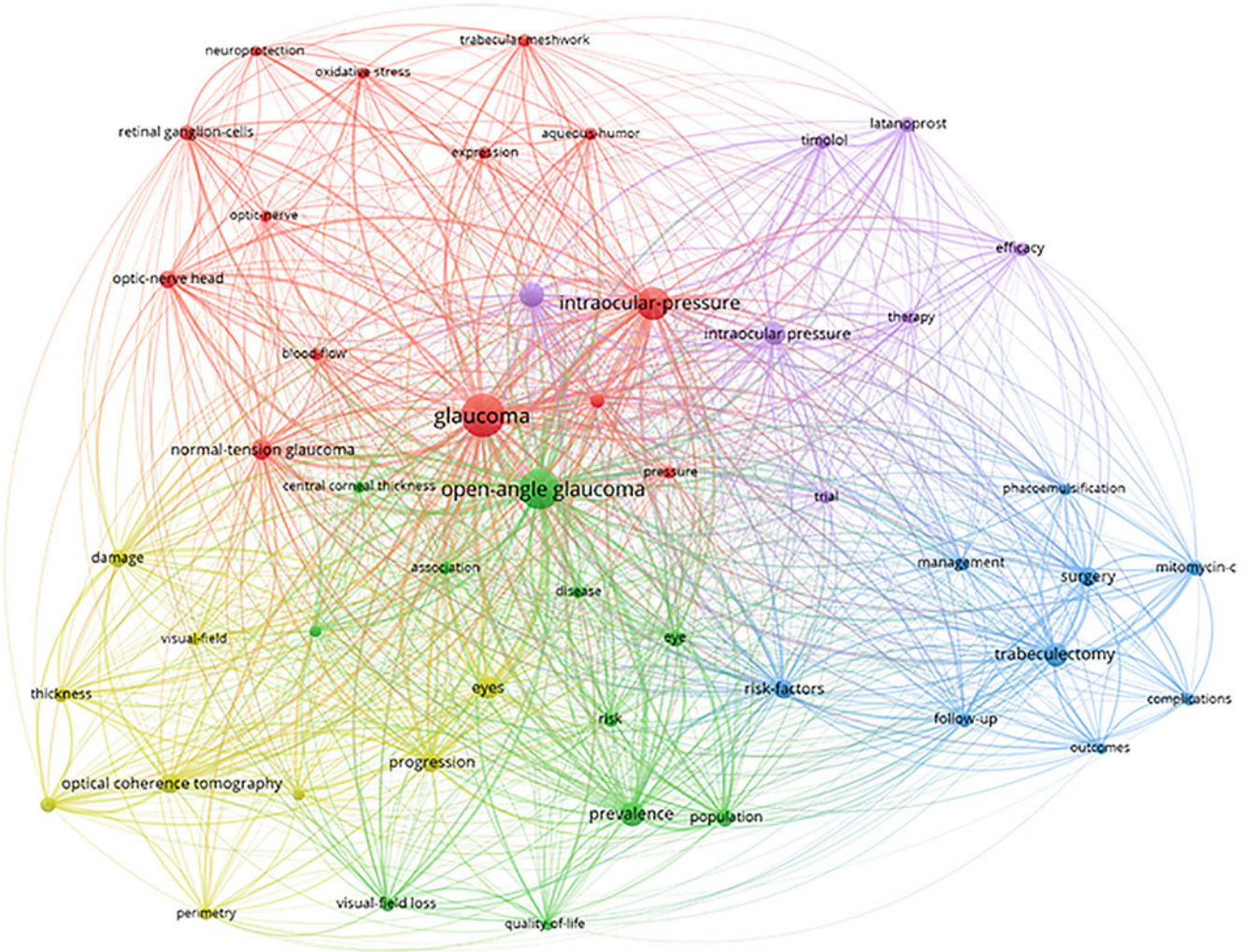


Figure 5.
VOSviewer co-occurrence keywords map.

Table 1.

Values of the parameters obtained with the exponential model.

	Parameter	Estimate (95% CI)	Model r^2
Model 1 (Period 1900-1989)	c	3.772 (2.343, 5.201)	0.921
	g	1.051(1.046, 1.056)	
Model 2 (Period 1990-2000)	c	298.617 (233.676, 363.558)	0.909
	g	1.069 (1.059, 1.079)	

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Table 2.

Most productive authors.

Author	N°. Documents	%	h-index*	g-index	p-index	Affiliation
Weinreb RN	545	1.62	97	145	1.495	University of California San Diego
Ritch R	393	1.17	75	133	1.773	New York Eye & Ear Infirmary of Mount Sinai
Quigley HA	322	0.96	98	199	2.031	Johns Hopkins University
Caprioli J	274	0.81	62	105	1.694	University of California Los Angeles
Aung T	258	0.77	79	145	1.835	Singapore National Eye Center
Liebmann JM	305	0.91	60	91	1.517	Columbia University
Medeiros FA	247	0.73	57	94	1.649	Duke University
Zangwill LM	245	0.73	63	95	1.508	University of California San Diego
Harris A	226	0.67	30	46	1.533	Indiana University System
Spaeth GL	220	0.65	52	81	1.558	Jefferson University

*Web of Science 2020 data.

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Table 3.

Distribution of journals in Bradford's zones.

	N° of journals	% of journals	N° of articles	% of articles	Bradford multiplier
Core	3	0.13	10,826	32.19	
Zone 1°	23	1.00	11,212	33.34	7.66
Zone 2°	2,276	98.87	11,593	34.47	98.96
Total	2,302	100.00	33,631	100.00	53.31

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