

## BIBLIOMETRIC ANALYSIS OF CATARACT RESEARCH FROM 1991 THROUGH 2006, ANALYZED WITH THE SCIENCE CITATION INDEX

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**Objective:** The purpose of the study is to investigate the quantity and quality of studies on cataract in the category of ophthalmology to provide valuable information for future cataract-related research and aid researchers to focus their research findings on a specific subject.

**Methods:** A bibliometric analysis based on the *Science Citation Index* (SCI) distributed by the Institute of Scientific Information (*ISI*) was conducted on cataract-related studies published between 1991 and 2005 in ophthalmology field based on year of publication, authorship, international collaborations, and keyword trends. 8,186 articles of 41 journals were analyzed totally.

**Results:** Among the 8,186 articles, Journal articles were the most frequent document type. English was the dominant language of most publication in the subject category of ophthalmology. *Journal of Cataract and Refractive Surgery* accounts for mostly published papers on cataract. USA is the most popular international collaborator and single country publication in various research fields. Dr. R. Menapace at the University of Vienna in Austria was the highest contributing author. The average number of authors per article, from 1991 to 2005, was 4.5. Additionally, the most frequently used keyword was 'cataract' which was used in 729 articles followed by 'cataract surgery'.

**Conclusion:** Cataract studies in the *ISI*/subject categories of ophthalmology have tripled and steadily increasing trend was noticed during the last 15 years. The top-ranking countries in terms of number of articles published were the United States. Scientists from Japan were ranked as the most prolific first author and corresponding author the top three most frequently used author keyword were 'cataract', 'cataract surgery', and 'phacoemulsification'. In non-cataract related keywords, glaucoma was the most frequently used one. The top journal with the most articles addressing cataract research was *Journal of Cataract and Refractive Surgery*.

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## INTRODUCTION

A cataract is an opacifying process of the lens of the eye that causes disturbance of vision. The major risk factor for lens opacification is aging. Previous studies had focused on genetic factors, environmental influences, metabolic and biochemical changes in the crystalline lens (West and Valmadrid, 1995). It is a common disease in ophthalmology field. Etiology and treatment of cataract had been extensively studied in the past several decades. Before 1960, cataract study was confined to etiology and epidemiology. Since microsurgery advanced after microscope developed, cataract research was began almost simultaneously after the demonstration of ocular microsurgery since 1970 (Shugar, 1997). More systemic study and review was developed since cataract surgery had advanced a lot over the years. ECCE was introduced in 1970 and many papers were explosively published. During the past two decades, the scientific output from medical institutions has been increasingly subjected to phacoemulsification which made it possible to establish vision after surgery. In these years, more sophisticated surgical skills were developed, and more documents were published in these years. In private clinic or hospital related to cataract research have expanded considerably and today encompasses many of the important areas of cataract study.

Later sections will describe the main features of cataract studies in these years. This part of the paper is not concerned to give full technical details of the studies, most of which are described in accompanying reference. Rather, it gives an account of the way the future trend in cataract study. In spite of significant expansion of literatures for cataract in ophthalmology, little is known about how future trends will be without gathering statistics. This information is of crucial importance, since researcher can have more direction to the future study. Besides, various academic study based on fund assistance needs more information to make more accurate decision.

The purpose of the present study was to gain insight into the trends of various contributing factors to the advancement of cataract-related research in the subject categories of ophthalmology. Data from SCI were analyzed to determine the quantitative impacts of cataract-related research, based on year of publication, authorship, international collaborations, and keyword trends.

## METHODOLOGY

In the 2004 edition of the *Journal Citation Reports* (JCR), 5,968 journals are listed in the SCI. Of these, the 42 journals in the subject categories of ophthalmology were analyzed in this study. A keyword search was performed to identify cataract-related studies published between 1991 and 2005, using 'cataract'. Articles originating from England, Scotland, Northern Ireland, and Wales were re-categorized as being from the United Kingdom. The reported impact factor (IF) of each journal was derived from the 2004 JCR. The IF of a journal is defined by the JCR, and is derived by dividing the number of current citations to articles published in the previous two years by the total number of articles published in those years. It is a measure of the frequency with which the average article in a journal has been cited in a particular year. The IF is used to evaluate a journal's relative importance, especially when compared to others in the same subject category. Collaboration type was determined by the address of each author, where the term 'single country' was assigned if the researchers' addresses were from the same country. The term 'international collaboration' was designated to those articles that were co-signed by researchers from multiple countries.

## RESULTS

The distribution of document types identified by ISI was analysed. These documents ranged from journal articles to biographical-items. Journal articles were the most frequent document type comprising 76% of the

total production, followed by meeting abstracts (1,372; 13%). Letters (596; 5.5%), editorial materials (209; 1.9%), reviews (209; 1.9%), notes (82; 0.76%), addition corrections (15; 0.14%), discussions (15; 0.14%), corrections (13; 0.12%), reprints (8; 0.074%), news items (7; 0.065%), item about an individuals (4; 0.037%), and biographical-items (3; 0.028%) showed lesser prevalence than articles and meeting abstracts. As journal articles represented the majority of document types that were also peer-reviewed within this field, a total of 8,186 relevant articles were identified and analysed. The predominant language in these journal articles was English followed distantly by German with 486 (5.9%), French with 226 (2.8%), and Russian with 1 (0.012%) articles. The finding that English is the dominant language of publication may serve to aid foreign researchers with targeting a larger audience by submitting their research findings not only to journals that publish in their native language, but also those that utilize the English language.

Table 1. Major characteristics of the production of cataract-related research

PY	P	AU	AU/P	NR	NR/P	PG	PG/P
1991	300	1,066	3.6	4,646	15	1,700	5.7
1992	341	1,150	3.4	5,012	15	1,898	5.6
1993	372	1,401	3.8	6,321	17	2,300	6.2
1994	295	1,199	4.1	5,196	18	1,838	6.2
1995	367	1,835	5.0	7,084	19	2,405	6.6
1996	478	2,452	5.1	10,790	23	2,928	6.1
1997	542	2,094	3.9	12,469	23	3,320	6.1
1998	539	2,307	4.3	12,045	22	3,216	6.0
1999	654	2,603	4.0	15,244	23	3,978	6.1
2000	750	3,291	4.4	17,236	23	4,538	6.1
2001	650	3,526	5.4	15,352	24	3,919	6.0
2002	677	2,993	4.4	15,998	24	4,054	6.0
2003	695	3,047	4.4	16,343	24	4,230	6.1
2004	750	3,905	5.2	19,599	26	4,722	6.3
2005	776	3,587	4.6	18,929	24	4,615	5.9
Total	8,186	36,456	4.5	182,264	22	49,661	6.1

PY: Publication year; P: Number of articles; PG: Page count; AU: Number of authors; NR: Cited reference count

### Publication Output

Between 1991 and 2005, the ratio of the annual page count versus the number of articles devoted to cataract-related research remained relatively constant (*e.g.*, range = 5.6 – 6.3, median = 6.1 between 1991 and 2005). However, annual page count and number of articles published increased about three-fold that is, the number of pages increased from 1,700 in 1991 to 4,615 in 2005, and the number of articles increased from 300 in 1991 to 776 in 2005. Further, the number of authors increased from 1,066 in 1991 to 3,587 in 2005. Despite the significant increase in the number of authors, the author count per publication was only slightly increased from 3.6 to 4.6 (median = 4.5) in 1991 and 2005, respectively. An increase was observed with the cited reference count between 1991 (cites = 4,646) and 2005 (cites 18,929); however, the ratio of the cited reference count to the number of articles did not change significantly during this time period (*e.g.*, range = 15 – 26, median = 22). A summary of the above values and ratios is provided in Table 1.

Figure 1 shows the cumulative progression in the number of articles from 1991 to 2005 using a logarithmic model and a linear model. The double logarithmic

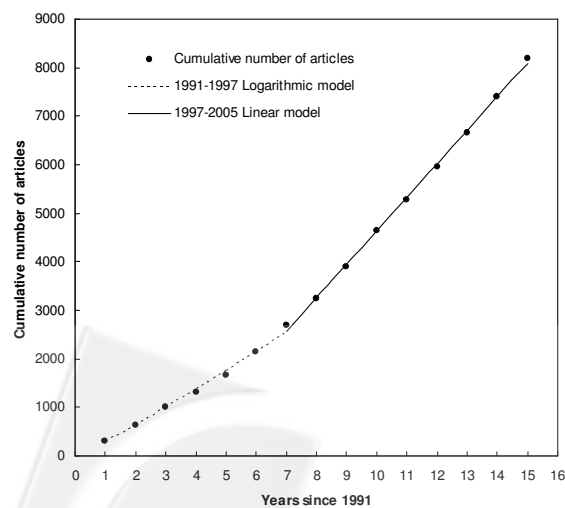


Figure 1. Cumulative number of publications by year.



plot of the data revealed a significant linear relation with a high coefficient of determination ( $r^2 = 0.998$ ) in the period 1991 to 1997 and linear plot with a high coefficient of determination ( $r^2 = 0.999$ ) in the period 1997 to 2005. The growth rate in earlier year was higher than that after 1997.

#### Publication Patterns

In total, 8,186 articles were published in 41 journals in the subject category of ophthalmology. Out of the 41 journals, 22 (54%) contained less than 100 articles and 8 (20%) contained 100 to 200 articles. A summary of the 41 journals in the subject category of ophthalmology with the articles published addressing cataract is provided in Table 2. The table also includes the respective IFs, rank of the journal within the subject category of ophthalmology, number of relevant articles, and the percentage of total articles. *Journal of Cataract and Refractive Surgery* published the most articles on cataract research (2,017; 25%), followed by *Ophthalmology* (707; 8.6%), *British Journal of Ophthalmology* (554; 6.8%), *American Journal of Ophthalmology* (443; 5.4%), and *Investigative Ophthalmology & Visual Science* (423; 5.2%). The distribution of the 8,186 articles, published in journals with IF information, are as follows: 14% of total articles came from 4 journals with an IF of  $\geq 3$ ; 22% articles came from 5 journals with  $2 \leq \text{IF} < 3$ ; 43% articles came from 14 journals with  $1 \leq \text{IF} < 2$ ; and 22% articles came from 18 journals with an IF of  $< 2$ . Only 5 articles were published in the *Journal of Toxicology-Cutaneous and Ocular Toxicology*, which is ranked as the top one journal in the ISI category of ophthalmology with an IF of 5.345. The results were valuable information that may aid researchers with targeting the largest audience possible. The use of the IF can be highly informative with assessing the importance of findings contributed in a specific field. However, although the IF is a useful tool, it is best viewed as a guide on, and not an absolute measure of the importance of a journal's content. As we found in our analysis, the categorical IFs of the top 1 and 3 journals, which contributed articles relevant to the focus on this study were 5 and 3 articles respectively. The most popular journal for the cataract

topic was *Journal of Cataract and Refractive Surgery* which ranked 10 in the subject category of ophthalmology with IF 1.937. This finding will be highly informative to researchers that may rely on the IF for determining where to submit an article.

#### Country of Publication

There were 85 articles (1.0%) without author address information in the ISI. For this reason, not all of the articles were included in this analysis. Table 3 shows the all countries for publishing articles on cataract-related research between 1991 and 2005. Among the 8,101 articles with author address information, international collaborations accounted for 12% of the articles compared to 88% from single countries. However, single-country articles were authored by investigators with representation from 75 different countries, most of which, originated from the USA (2,267; 32%) followed distantly by the UK (818; 11%). Twenty-six countries had no single-country articles, while 9 countries had no international collaborative articles. Eighteen countries contributed only one or two single-country articles, and 34 countries contributed only one or two international collaborative articles. The number of single-country articles in the USA was about three times the number of articles contributed by the UK (32% versus 11%, respectively). The USA had the most-frequent partners accounting for 58% of the international collaborative articles followed by the UK with 37%, and Germany with a 16% international collective contribution. In general, USA is the most popular international collaborator in various research fields (Arunachalam and Jinandra, 2000; Navarro and Martin, 2004; Hsieh et al., 2004).

#### Authorship

There were 4 articles without author information on the ISI. For this reason, these articles were excluded from the analysis and the total number of articles analyzed was 8,182. The average number of authors per article, from 1991 to 2005, was 4.5 (Table 1). The 8,182 published articles were authored by 17,602 authors, of which 11,301 authors (64%) contributed only 1 article, and 3,103 (18%) authored 2 articles. Dr. R. Menapace at the

University of Vienna in Austria was the highest contributing author (n = 77 articles). The second most prolific scientists at contributing articles addressing cataract

were Dr. D.J. Apple at the Medical University of South Carolina in USA, published 72 articles. Dr. O. Findl at the Medical University of Vienna in Austria was the

Table 2. All journals with the cataract publications including impact factor, the rank of the journal in the subject category of ophthalmology, and number of articles

Journal	IF	P (%)	Categorical Rank
Journal of Cataract and Refractive Surgery	1.937	2,017 (25)	10
Ophthalmology	3.21	707 (8.6)	4
British Journal of Ophthalmology	2	554 (6.8)	9
American Journal of Ophthalmology	2.332	443 (5.4)	8
Investigative Ophthalmology & Visual Science	3.577	423 (5.2)	2
Experimental Eye Research	2.846	367 (4.5)	7
Eye	1.496	355 (4.3)	15
Archives of Ophthalmology	2.926	344 (4.2)	5
Klinische Monatsblätter für Augenheilkunde	0.478	330 (4.0)	34
Acta Ophthalmologica Scandinavica	0.974	232 (2.8)	24
Journal Français d'Ophtalmologie	0.267	216 (2.6)	37
Graefes Archive for Clinical and Experimental Ophthalmology	1.513	199 (2.4)	14
Ophthalmologie	0.466	183 (2.2)	35
Ophthalmic Research	1	179 (2.2)	23
Current eye Research	1.097	177 (2.2)	21
Ophthalmologica	0.645	129 (1.6)	29
Japanese Journal of Ophthalmology	0.667	120 (1.5)	27
European Journal of Ophthalmology	0.534	105 (1.3)	31
Retina-the Journal of Retinal and Vitreous Diseases	1.207	100 (1.2)	20
Clinical and Experimental Ophthalmology	1.031	99 (1.2)	22
Cornea	1.29	95 (1.2)	17
Canadian Journal of Ophthalmology-Journal Canadien d'Ophtalmologie	0.442	82 (1.0)	36
Optometry and Vision science	1.36	77 (0.94)	16
Annals of Ophthalmology	0.081	76 (0.93)	40
Journal of AAPOS	0.761	76 (0.93)	26
Molecular Vision	2.9	61 (0.75)	6
Journal of Pediatric Ophthalmology & Strabismus	0.49	60 (0.73)	33
Journal of Glaucoma	1.73	58 (0.71)	12
Journal of Refractive Surgery	0	57 (0.70)	41
Ophthalmic Epidemiology	1.246	49 (0.60)	18
Journal of Ocular Pharmacology and Therapeutics	1.228	48 (0.59)	19
Ophthalmic Surgery Lasers & Imaging	0.508	44 (0.54)	32
Ophthalmic and Physiological Optics	0.925	39 (0.48)	25
Ocular Immunology and Inflammation	0.562	37 (0.45)	30
Vision research	1.812	23 (0.28)	11
Visual Neuroscience	1.554	6 (0.073)	13
Journal of Toxicology-Cutaneous and Ocular Toxicology	0.129	5 (0.061)	39
Progress in Retinal and Eye Research	5.345	5 (0.061)	1
Ophthalmic Plastic and Reconstructive Surgery	0.667	4 (0.049)	27
Survey of Ophthalmology	3.221	3 (0.037)	3
Neuro-Ophthalmology	0.182	2 (0.024)	38

Table 3. All countries for publishing articles on cataract-related research between 1991 and 2005

Country/ Territory	IP	IP (%)	CP	CP (%)	P	P (%)
USA	2,267	32	544	58	2,811	35
UK	818	11	215	23	1,033	13
Germany	749	10	152	16	901	11
Japan	594	8.3	99	11	693	8.6
Australia	211	2.9	89	10	300	3.7
India	183	2.6	106	11	289	3.6
France	245	3.4	30	3.2	275	3.4
Canada	172	2.4	89	10	261	3.2
Sweden	185	2.6	35	3.8	220	2.7
Turkey	192	2.7	14	1.5	206	2.5
Italy	167	2.3	31	3.3	198	2.4
Austria	176	2.5	15	1.6	191	2.4
Spain	119	1.7	39	4.2	158	2.0
Switzerland	109	1.5	46	4.9	155	1.9
Israel	118	1.6	24	2.6	142	1.8
Netherlands	79	1.1	50	5.4	129	1.6
Finland	83	1.2	13	1.4	96	1.2
Denmark	81	1.1	12	1.3	93	1.1
Hong Kong	52	0.73	26	2.8	78	1.0
South Korea	62	0.86	12	1.3	74	0.91
Taiwan	65	0.91	5	0.54	70	0.86
Greece	32	0.45	28	3.0	60	0.74
Singapore	24	0.33	35	3.8	59	0.73
Brazil	38	0.53	19	2.0	57	0.70
China	20	0.28	36	3.9	56	0.69
Saudi Arabia	26	0.36	19	2.0	45	0.56
New Zealand	32	0.45	8	0.86	40	0.49
Belgium	21	0.29	17	1.8	38	0.47
Norway	26	0.36	11	1.2	37	0.46
Ireland	23	0.32	12	1.3	35	0.43
Egypt	7	0.10	15	1.6	22	0.27
South Africa	15	0.21	7	0.75	22	0.27
Argentina	17	0.24	4	0.43	21	0.26
Nepal	1	0.014	17	1.8	18	0.22
Portugal	13	0.18	5	0.54	18	0.22
Hungary	7	0.10	8	0.86	15	0.19
Iran	15	0.21	0	0	15	0.19
Tanzania	2	0.028	10	1.1	12	0.15
Mexico	8	0.11	4	0.43	12	0.15
Morocco	11	0.15	1	0.11	12	0.15
Pakistan	2	0.028	9	1.0	11	0.14
Chile	4	0.056	6	0.64	10	0.12
Nigeria	4	0.056	6	0.64	10	0.12
Venezuela	6	0.084	4	0.43	10	0.12
Poland	7	0.10	3	0.32	10	0.12
Tunisia	9	0.13	1	0.11	10	0.12
Bangladesh	1	0.014	8	0.86	9	0.11
Czech Republic	5	0.070	4	0.43	9	0.11
Russia	6	0.084	3	0.32	9	0.11
Barbados	0	0	8	0.86	8	0.10
Iceland	1	0.014	7	0.75	8	0.10
Thailand	3	0.042	5	0.54	8	0.10
Estonia	5	0.070	3	0.32	8	0.10
Kenya	0	0	7	0.75	7	0.086
Oman	4	0.056	3	0.32	7	0.086
Bulgaria	1	0.014	5	0.54	6	0.074
Lebanon	4	0.056	2	0.21	6	0.074
Uganda	1	0.014	4	0.43	5	0.062
Colombia	3	0.042	2	0.21	5	0.062
Malaysia	3	0.042	2	0.21	5	0.062
Slovenia	5	0.070	0	0	5	0.062
Jordan	3	0.042	1	0.11	4	0.049
Philippines	3	0.042	1	0.11	4	0.049
Croatia	4	0.056	0	0	4	0.049
Senegal	4	0.056	0	0	4	0.049
Gambia	0	0	3	0.32	3	0.037
Ghana	0	0	3	0.32	3	0.037
Indonesia	0	0	3	0.32	3	0.037
W Ind Assoc St	0	0	3	0.32	3	0.037
Ethiopia	1	0.014	2	0.21	3	0.037
Sierra Leone	1	0.014	2	0.21	3	0.037
Slovakia	1	0.014	2	0.21	3	0.037
Kuwait	2	0.028	1	0.11	3	0.037
USSR	3	0.042	0	0	3	0.037
Malawi	0	0	2	0.21	2	0.025
U Arab Emirates	0	0	2	0.21	2	0.025
Cameroon	1	0.014	1	0.11	2	0.025
Mali	1	0.014	1	0.11	2	0.025
Malta	1	0.014	1	0.11	2	0.025
Togo	2	0.028	0	0	2	0.025
Armenia	0	0	1	0.11	1	0.012
Botswana	0	0	1	0.11	1	0.012
Cent Afr Republ	0	0	1	0.11	1	0.012
Cyprus	0	0	1	0.11	1	0.012
Dominica	0	0	1	0.11	1	0.012
Jamaica	0	0	1	0.11	1	0.012
Latvia	0	0	1	0.11	1	0.012
Liechtenstein	0	0	1	0.11	1	0.012
Macedonia	0	0	1	0.11	1	0.012
Madagascar	0	0	1	0.11	1	0.012
Paraguay	0	0	1	0.11	1	0.012
Peru	0	0	1	0.11	1	0.012
Tonga	0	0	1	0.11	1	0.012
Turkmenistan	0	0	1	0.11	1	0.012
Ukraine	0	0	1	0.11	1	0.012
Uzbekistan	0	0	1	0.11	1	0.012
Vietnam	0	0	1	0.11	1	0.012
Yemen	0	0	1	0.11	1	0.012
Martinique	1	0.014	0	0	1	0.012
Sri Lanka	1	0.014	0	0	1	0.012
Zaire	1	0.014	0	0	1	0.012

P, total publications;

IP, single-country publications;

CP, international collaborative publications



Table 4. Top 10 authors with the greatest number of articles in cataract-related research

Author	Institute	Country	P
Menapace, R	University of Vienna	Austria	77
Apple, DJ	Medical University of South Carolina	USA	72
Findl, O	Medical University of Vienna	Austria	66
Klein, R	University of Wisconsin	USA	59
Mitchell, P	University of Sydney	Australia	56
Oshika, T	University of Tsukuba	Japan	56
Klein, BEK	University of Wisconsin	USA	51
Flynn, HW	Miami University	USA	50
Lam, DSC	Chinese University of Hong Kong	Hong Kong	50
Kuchle, M	University Erlangen-Nurnberg	Germany	48

P, Total number of articles

Table 5. The ten most productive corresponding authors between 1991 and 2005

Corresponding author	Country	Country	P
Mitchell, P	University of Sydney	Australia	39
Findl, O	Medical University of Vienna	Austria	32
Oshika, T	University of Tsukuba	Japan	31
Hayashi, K	Hayashi Eye Hospital	Japan	28
Apple, DJ	Medical University of South Carolina	USA	24
Auffarth, GU	University of Heidelberg	Germany	22
Lam, DSC	Chinese University of Hong Kong	Hong Kong	22
Spalton, DJ	St Thomas Hospital	UK	22
Vasavada, AR	Iladevi Cataract & IOL Research Centre	India	22
Lundstrom, M	Blekinge Hospital	Sweden	20
Nishi, O	Nishi Eye Hospital	Japan	20

P, Total publications

Table 6. The ten most productive first authors between 1991 and 2005

First author	Country	Country	P
Hayashi, K	Hayashi Eye Hospital	Japan	26
Nishi, O	Nishi Eye Hospital	Japan	23
Auffarth, GU	University of Heidelberg	Germany	22
Oshika, T	University of Tsukuba	Japan	22
Klein, BEK	University of Wisconsin	USA	18
Lundstrom, M	Blekinge Hospital	Sweden	18
Vasavada, AR	Iladevi Cataract & IOL Research Centre	India	18
Gimbel, HV	Gimbel Eye Centre	Canada	17
Dick, HB	University of Mainz	Germany	16
Jonas, JB	University of Mannheim	Germany	16
Scott, IU	University of Miami	USA	16

P, Total publications

third most prolific scientist with 66 articles. It should be noted that the analysis of authorship may be hindered by 1) different authors having the same name, 2) the same authors using different names in their publications, or 3) authors may have different affiliations over their career. To negate these latter concerns, recommendations to create an “international identity number” are proposed. Such a system would allow for easy tracking of authors based on an assigned number when they first publish a paper in an ISI listed journal. A summary of the top 20 most prolific authors for articles addressing cataract is provided in Table 4. In general, the most professional support and funding for published studies is provided by the corresponding author. In the ISI, a total of 7,080 articles from 3,781 corresponding authors (reprint author) were analyzed. Most corresponding authors (67%) published only one article as the corresponding author, whereas 16% (n = 620) of the corresponding authors had contributed two articles. Of the 78 corresponding countries that published articles on cataract, 9 countries contributed one article each with corresponding authors. Table 5 shows the most productive corresponding authors between 1991 and 2005. Three of these corresponding authors were from Japan, with the other corresponding authors representing the following countries: Australia, Austria, USA, Germany, Hong Kong, India, UK, and Sweden. Dr. P. Mitchell from University of Sydney in Australia contributed the most articles as a cor-

responding author, followed by Dr. O. Findl from Austria, who had 32 corresponding author articles and Dr. T. Oshika from University of Tsukuba in Japan had 31 articles. Twenty-nine percent (n = 2,074) of the corresponding authors were from the USA, 11% (n = 789) from the UK, and 11% (n = 772) from Germany.

Based on the assumption that the first author of an article performs most of the research, a distribution of first authors was undertaken. As mentioned previously, there were 4 articles without author information on the ISI. Hence, these articles were excluded from the analysis. A total of 5,070 first authors from the remaining 8,182 articles were analyzed. Among these first authors, 3,691 (73%) published only one article as the first author and 758 (15%) authors published two articles as the first author. Table 6 shows the most-productive first authors between 1991 and 2005. Three of these first authors were from Japan and Germany, respectively, while the other first authors on this list were from the following countries: Canada, India, USA, and Sweden. Dr. K. Hayashi from Hayashi Eye Hospital in Japan dominated with the most first author publications, followed by Dr. O. Nishi from Nishi Eye Hospital in Japan, Dr. G.U. Auffarth from University of Heidelberg in Germany and Dr. T. Oshika from University of Tsukuba in Japan, who each had 22 first author articles. The fact that the same authors ranked the highest in both first and corresponding author analyses is of noteworthy interest.

Distribution of Author Keywords

An analysis of the author keyword was undertaken for the articles from 1991 to 2005. A total of 3,267 articles with records of author keywords in the SCI database were analyzed. There were 6,817 keywords listed by authors, 5,025 (74%) keywords were used only once, and 825 (12%) keywords were used twice. The most frequently used keyword was ‘cataract’ which was used in 729 articles (22%) followed by ‘cataract surgery’ (n = 417, 13%). A summary of the top 20 most frequently used key words is presented in Figure 2.

The Most-Frequently Cited Articles

The most-frequently cited articles of each year in

the time span of 1991 to 2005 are selected as shown in Table 7. Seven of the most-frequently cited articles were published in *Archives of Ophthalmology*. Eleven articles were listed due to an identical citation number where most of them were published by the USA, two were published by Australia and Canada, respectively, and one article by Austria, UK, and Netherlands. Two of the most-frequently cited articles were international collaborative publications.

DISCUSSION

The distribution of document types mostly identified is Journal articles, followed by review. English is still the dominant language of publication that we are not surprise. Despite the significant increase in the number of authors, the author count per publication was only slightly increased, which means more cooperation and team work is needed for each paper production. The growth rate in earlier year was higher than that after 1997 which could be dramatic development of refractive surgery and phacoemulsification. The most popular journal for the cataract topic was *Journal of Cataract and Refractive Surgery* which ranked 10<sup>th</sup> in the subject

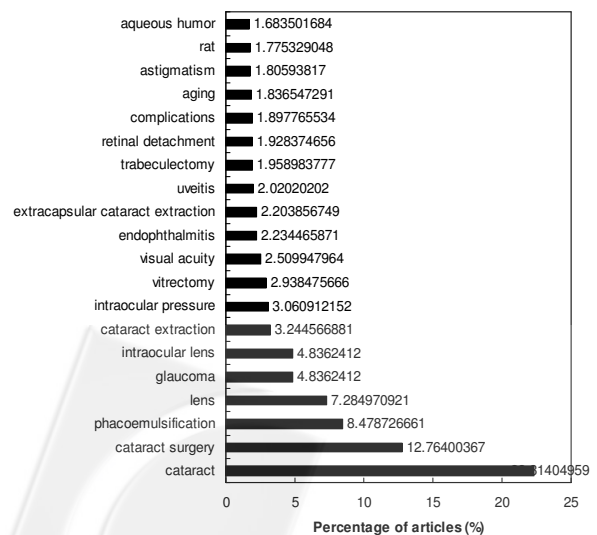


Figure 2. The top 20 most-frequently used keywords





Table 7. Most-frequently cited articles for each year from 1991 to 2005

No. AU	Article	Country	TC	PG	NR
1	Palmer, SS. (1991), Mitomycin as adjunct chemotherapy with Trabeculectomy. <i>Ophthalmology</i> 98 (3): 317-321.	USA	380	5	4
8	Rubinfeld RS, Pfister RR, Stein RM, Foster CS, Martin NF, Stoleru S, Talley AR, Speaker MG. (1992), Serious complications of topical Mitomycin-C after Pterygium surgery. <i>Ophthalmology</i> 99 (11): 1647-1654.	USA, Canada	261	8	26
9	Chylack LT, Wolfe JK, Singer DM, Leske MC, Bullimore MA, Bailey IL, Friend J, Mccarthy D, Wu SY. (1993), The lens opacities classification system-III. <i>Archives of Ophthalmology</i> 111 (6): 831-836.	USA	298	6	33
12	Steinberg EP, Tielsch JM, Schein OD, Javitt JC, Sharkey P, Cassard SD, Legro MW, Dienerwest M, Bass EB, Damiano AM, Steinwachs DM, Sommer A. (1994), The VF-14 - an index of functional impairment in patients with cataract. <i>Archives of Ophthalmology</i> 112 (5): 630-638.	USA	326	9	25
386	Vine AK et al. (1993), Results of the Endophthalmitis Vitrectomy study - a randomized trial of immediate Vitrectomy and of intravenous antibiotics for the treatment of postoperative bacterial Endophthalmitis. <i>Archives of Ophthalmology</i> 113 (12): 1479-1496.	USA	222	18	29
5	Dreyer EB, Zurawski D, Schumer RA, Podos SM, Lipton SA. (1996), elevated glutamate levels in the vitreous body of humans and monkeys with glaucoma. <i>Archives of Ophthalmology</i> 114 (3): 299-305.	USA	261	7	41
4	Klein R, Klein BEK, Jensen SC, Meuer SM. (1997), The five-year incidence and progression of age-related maculopathy - The Beaver Dam eye study. <i>Phthalmology</i> 104 (1): 7-21.	USA	209	15	46
32	Alward WL, Feldman F, Cashwell LF, Wilensky J, Geijssen HC, Greeve E, Quigley H, Skuta G, Lichter PR, Blondeau P, Anderson DR, Grajewski A, Balazsi G, Amyot M, Levene RZ, Minckler D, Heuer D, Drance SM, Mikelberg F, Douglas G, Johnstone M, Trope G, Hoskins HD, Pollack IP, Mills R, Kasner OP, Schwartz A, Liebmann L, Ritch R, Cohen J, Tuulonen A, Airaksinen PJ. (1998), The effectiveness of intraocular pressure reduction in the treatment of normal-tension glaucoma. <i>American Journal of Ophthalmology</i> 126 (4): 498-505.	Canada	139	8	12
7	Hollick EJ, Spalton DJ, Ursell PG, Pande MV, Barman SA, Boyce JF, Tilling K. (1999), The effect of polymethylmethacrylate, silicone, and polyacrylic intraocular lenses on posterior capsular opacification 3 years after cataract surgery. <i>Ophthalmology</i> 106 (1): 49-54.	UK	137	6	25
4	Danis RP, Ciulla TA, Pratt LM, Anliker W. (2000), Intravitreal Triamcinolone Acetonide in Exudative age-related macular degeneration. <i>Retina-the Journal of Retinal and Vitreous Diseases</i> 20 (3): 244-250.	USA	147	7	14
6	Mangione CM, Lee PP, Gutierrez PR, Spritzer K, Berry S, Hays RD. (2001), Development of the 25-item National Eye Institute Visual Function Questionnaire. <i>Archives of Ophthalmology</i> 119 (7): 1050-1058.	USA	96	9	24
7	Martidis A, Duker JS, Greenberg PB, Rogers AH, Puliafito CA, Reichel E, Baurnal C. (2002), Intravitreal Triamcinolone for refractory diabetic macular edema. <i>Ophthalmology</i> 109 (5): 920-927.	USA	173	8	27
8	Gillies MC, Simpson JM, Luo W, Penfold P, Hunyor ABL, Chua W, Mitchell P, Billson F. (2003), A Randomized clinical trial of a single dose of Intravitreal Triamcinolone. <i>Archives of Ophthalmology</i> 121 (5): 667-673.	Australia	70	7	18
10	Congdon N, O'Colmain B, Klaver CCW, Klein R, Munoz B, Friedman DS, Kempen J, Taylor HR, Mitchell P, Hyman L. (2004), Causes and prevalence of visual impairment among adults in the United States. <i>Archives of Ophthalmology</i> 122 (4): 477-485.	USA, Netherlands, Australia	41	9	37
5	Findl O, Menapace R, Sacu S, Buehl W, Rainer G. (2005), Effect of optic material on posterior capsule opacification in intraocular lenses with sharp-edge optics - Randomized clinical trial. <i>Ophthalmology</i> 112 (1): 67-72.	Austria	8	6	23

No. AU: Number of Author, TC: Times cited from it published to 2005, PG: Page count, PY: Publication year, NR: Cited reference count

category of ophthalmology with IF 1.937. Articles were published in 41 journals in the subject category of ophthalmology that seems to be quite reasonable. Cataract is highly related to refractive surgery which was spotlighted in these years could be the reason why *Cataract and Refractive Surgery* was shifted to the top of cataract publication. Ophthalmology has the highest impact factor (3.57) in these journals in contrast, *Cataract and Refractive Surgery* has lower impact factor (1.937) in general. Although impact factor is a critical index of paper importance, it is not an absolute measure index of paper. This finding will be highly informative to researchers with IF and popular publication.

USA was the article contribution followed by the UK and Germany. The USA had the most-frequent partners (58%). India was ranked 5 remarkable could be due to there are many cataract to be extracted and higher prevalence was noticed especially in a population living in the plains (4.2– 7.2%), before, so publication in the 5<sup>th</sup> position. In author review, Dr. R. Menapace at the University of Vienna in Austria was the highest contributing author (n = 77 articles) followed by Dr. D.J. Apple and Dr. O. Findl. In general, the most professional support and funding for published studies are provided by the corresponding author. Dr. R. Menapace from Austria was the highest contributing corresponding author.

The most frequently used keyword in non-cataract field is “glaucoma” ranked 5th (4.8%), followed by “intraocular pressure” (ranked 8th), “vitrectomy” (ranked 9th) and “visual acuity” (ranked 10th). The preceding 2 keywords (glaucoma, intraocular pressure) were included in glaucoma field which can be rationalized that the anatomic location of lens is quite close to aqueous humor flow route. As for the following 2 keywords (vitrectomy and visual acuity), statistics manifests future cataract-related research can focus more on complications and visual prognosis of cataract surgery.

### CONCLUSION

The bibliometrics of cataract-related research in the ISI subject categories of ophthalmology was analyzed over a period of 15 years, 1991-2005. Notable findings

from these analyses include the following. First, a steady increase was observed for the cumulative number of articles published throughout the observation period. Second, the three top-ranking countries of origin for articles addressing cataract research were the USA, UK, and Germany. Third, English was the dominant language in pertinent articles. Fourth, scientists from Japan were ranked as the most prolific first author and corresponding author for articles relevant for this analysis. Fifth, the three journals with the most articles addressing cataract research in the subject category of ophthalmology were *Journal of Cataract and Refractive Surgery*, *Ophthalmology*, and *British Journal of Ophthalmology*. Finally, the top three most frequently used author keyword were ‘cataract’, ‘cataract surgery’ and ‘phacoemulsification’ which captured 22, 15, and 8.5% of the articles analyzed respectively. In most-frequently used keywords, glaucoma was the most prominent one of non-cataract field ranked 5th (4.8%). In closing, the results of the bibliometric analyses presented herein provide valuable information about the directional trend of cataract-related research although not all non-English articles were included in our study. In addition, we have identified potential guides for that may aid researchers with maximizing the exposure of their research findings on a particular subject.

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## 1991 至 2006 年白內障相關研究之 文獻計量分析

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目的：本研究目的在調查眼科學領域當中有關白內障的研究，為從事白內障研究者提供有價值的資訊，了解未來白內障相關研究趨勢，並協助後續研究者將研究重點放在某些特定的主題上。

方法：本研究是以科學資訊機構（Institute of Scientific Information, ISI）所提供的科學文獻引用指標（Science Citation Index, SCI）為基礎，針對 1991 年到 2005 年眼科學領域 41 份期刊中 8186 篇有關白內障研究的文獻進行分析，分別對文獻中出版的年代、作者群分析、國際合作指標以及關鍵字的趨勢做分析。

結果：在 8186 篇文獻當中，期刊論文最常出現的格式，發表的語言最主要為英文，Journal of Cataract and Refractive Surgery 是眼科學領域中有關白內障研究中最主要的期刊。最常見的跨國合作論文為美國，同時美國也是不同研究領域中發表論文最多的國

家。奧地利維也納大學的 Dr. R. Menapace 則是貢獻於白內障研究最多的作者。統計自 1991 年到 2005 年間，平均每篇文章的作者數為 4.5 人。除了白內障收尋關鍵字外，最常見的作者關鍵字為超音波乳化術，總共有 277 篇文獻，而後是水晶體。

結論：在科學資訊機構所發布的資訊中顯示：眼科學領域中屬於白內障相關研究在過去十五年之間大幅成長三倍，且呈現穩定成長，在研究白內障的文獻當中居於領先地位的為美國，但若以個別作者來說，日本則居於第一作者首位，同時也是通訊作者的第一名。白內障文獻中作者最常用的前三個關鍵字依序為白內障、白內障手術以及超音波乳化術，而非白內障相關領域當中最重要關鍵字為青光眼。論文當中關鍵字含有最多白內障的期刊名稱為 Journal of Cataract and Refractive Surgery。

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