

Research Article

Evaluation of the Most Cited Articles on Strabismus From a New Perspective Using Bibliometric Analysis

 Erkan Bulut,¹  Emel Başar,²  Sümeyra Köprübaşı,³  Mehmet Dokur⁴

¹Department of Opticianry, Vocational School of Health Services, Istanbul Gelisim University, Istanbul, Türkiye

²Department of Ophthalmology, Faculty of Medicine, Biruni University, İstanbul, Türkiye

³Department of Ophthalmology, Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital, Istanbul, Türkiye

⁴Department of Emergency Medicine, Faculty of Medicine, Biruni University, İstanbul, Türkiye

Abstract

Objectives: Strabismus is one of the important areas of interest for ophthalmologists, because it can result in permanent vision loss and reduced binocular function. In this bibliometric study, we aimed to contribute to scientists in their research in the field of strabismus by performing multidimensional citation analysis and visualization of the 100 most cited articles regarding strabismus.

Methods: We used the term "strabismus" to search the Thomson Reuters' Web of Science database between 1975 and 2021 years. The top 100 cited articles were analysed by topic, first author, study type, level of evidence, period since publication, journal name, journal impact factor and H-index, total citation number (TCN), average citation per year (ACpY) and also correlation analyses were performed. The SPSS® 23.0 software package was used for all statistical analysis. VOSviewer software was used for visualization and analyses of country, organization, and keyword data of the top 100 cited articles.

Results: A total of 6,582 strabismus-related publications were retrieved, and the 100 most-cited were identified. The median values for journal impact factor, H-index, period since publication, TCN, and ACpY were 4.68 ± 2.65 (4,10), 160.29 ± 75.53 (186), 22.17 ± 8.92 (21), 77.98 ± 55.88 (63), and 3.90 ± 2.94 (2,84), respectively. Most of the articles were published between 1990 and 2010 years. The majority of articles were about treatment (n=30), epidemiology (n=21), quality of life and psychosocial aspects (n=14), and strabismus types and clinical features (n=12). The journal with the most articles published, "Ophthalmology," had 25 articles. Interestingly, the correlation analysis demonstrated no association between TCN and IF.

Conclusion: Most of the highly cited papers in the topic of strabismus are on strabismus treatment, particularly botulinum toxin treatment. Strabismus articles published in general ophthalmology journals received higher citations.

Keywords: Bibliometric, citation, impact factor, strabismus, VOSviewer

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Strabismus is a major concern for ophthalmologists because if it is not treated properly, it can result in permanent vision loss and reduced binocular function.^[1,2] Although strabismus prevalence, shows higher figures

Address for correspondence: Erkan Bulut, MD. Department of Opticianry, Vocational School of Health Services, Istanbul Gelisim University, Istanbul, Türkiye

Phone: +90 212 472 70 00 **E-mail:** erkanbulut@outlook.com

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in western countries and among the white population, it is seen all over the world and some studies declared that in every population strabismus can be seen and severely affects the quality of life.^[3] Because of significant physico-social effects on people, society has been interested in strabismus. In adults, patients with strabismus or diplopia, usually have negative changes in health-related quality of their life, but after the treatment with strabismus surgery, psychological and physical activities may change positively.^[4] The majority of pediatric patients may require routine referral, and it is known that early treatment initiation is associated with better long-term outcomes.^[5] Sometimes, an immediate referral should be organised in cases where a severe underlying pathology is suspected like prematurity of retinopathy, retinoblastoma or cataract which can be presented with strabismus. In addition, children with strabismus have impaired functional vision and reduced eye-related quality of compared to children without strabismus. Additionally, the quality of life of these children's parents reduced.^[5]

A bibliometric study is a sort of research that identifies current trends in a certain topic. Bibliometric studies allow researchers to rapidly and effectively identify the most important articles from a large number of studies on a given topic.^[6] According to bibliometric analysis, the quality of an article is mainly determined by the number of citations it receives and the impact factor (IF) of the journal in which it was published.^[7]

The Mapping Knowledge Domain (MKD) technique introduces a novel approach to literature for analysing and combining the fundamental structure of scientific data.^[8] VOSviewer is a software program that uses the MKD approach to analyse visual network data. This enables researchers to create and explore a bibliometric map of co-citation or co-occurrence data.^[9] It also aids academics in planning their research direction and predicting research trends by allowing them to determine the range of research subjects and identify new ones.^[10]

In this study, our aim is identification and assessment the most influential and valuable strabismus articles. It allows researchers to easily obtain and compare critical information on strabismus research. For these reasons, we have investigated the quality and quantity of the articles in the field of strabismus research to enlighten ophthalmologists and other people. We have analysed the most cited articles related to strabismus between 1975 and 2021 years. In general, we have tried to find out the main topics, study types, and publication years, as well as citation and quality analyses of articles related to strabismus using bibliometric analysis and MKD technique.

Methods

Study Design

This study is retrospective clinical research with a level of evidence of 3 or Group B (Scottish Intercollegiate Guidelines Network-SIGN 50).^[11]

Data Collection

The data for this bibliometric study were obtained from Thomson Reuters' Web of Science (WoS) Core Collection database (Philadelphia, Pennsylvania, USA) and PubMed (US National Library of Medicine-National Institutes of Health). We searched the WoS database for the keyword "strabismus" between 1975 and 2021 (Accessed date: June 6, 2021). We obtained 6.582 full-text articles and ranked them according to the number of citations that they have received, using the technique of Paladugu et al.^[12] Original research articles about human strabismus, editorials, letters, and review articles were included in our study; articles not related to "strabismus" were excluded. We also used PubMed to get further information about the articles. The top 100 cited articles (T100) were evaluated by each author independently and T100 list was generated by consensus of all authors. The title, first author's name, publication year, journal name, total citation number (TCN), average citation per year (ACpY), journal IF, and H-index of each article were identified, as well as the main topic, study type, Q category and level of evidence. The journals IF were registered according to the 2019 Clarivate Journal Citation Reports. The H-index and quartile (Q) scores of journals were determined using the 2020 Scimago Journal and Country Rank (SJCR). Reference information about the level of evidence was provided from SIGN 50.^[11]

The VOSviewer software version 1.6.16 was utilized to visualize the bibliometric data of T100 list. The data of T100 list was obtained from WoS in the "Full record and cited references" format. Distribution and co-occurrence analyses were performed on keywords, organizations, and countries of T100 list. Maps were created to represent the results.

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) program for Windows 23 (IBM SPSS Inc., Chicago, United States) was utilized to conduct statistical evaluations. The data distribution was determined using the Shapiro-Wilk test. Continuous variables having a normal distribution were determined to have a mean standard deviation, while those without a normal distribution were determined to have a median [Q1 and Q3]. Categorical variables are represented numerically and as a percentage. Continuous variables having a normal distribution

were compared using an independent sample t-test or ANOVA (post hoc: LSD), whereas those with a non-normal distribution were compared using the Mann–Whitney U or Kruskal Wallis (post hoc: Dunn) test, as appropriate. Pearson correlation coefficients were calculated to find linear correlations between numerical variables. Beta coefficients were obtained via univariate linear regression analysis. It was considered statistically significant if $p < 0.05$.

Compliance with Ethical Standards

All authors state that the research was conducted in accordance with the Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects" of the World Medical Association. This research did not require approval from an ethics committee because it was a bibliometric or citation analysis of previously published articles.

Results

We retrieved a total of 6,582 articles using the phrase "strabismus" from the WoS Core Collection database between the years 1975 and 2021. T100 list was generated by ranking according to citation number. Despite the fact that we did not filter the language choice, all of the articles in the T100 list were written in English. Each article's title, first author's name, publication year, TCN, ACpY, journal IF, and H-index are displayed in Appendix 1. The median values for journal IF, H-index, period since publication, TCN, and ACpY were 4.68 ± 2.65 (4,10), 160.29 ± 75.53 (186), 22.17 ± 8.92 (21), 77.98 ± 55.88 (63), and 3.90 ± 2.94 (2,84), respectively. Table 1 summarizes the main features of the articles in the T100 list according to different subcategories, as well as their distribution and comparison results based on bibliometrics.

Publication Year

Seventy-four articles in the T100 list in the field of strabismus were published between 1990 and 2010 years. When the articles were categorized by publication year, there was no statistically significant difference in the journal IF and H-indexes of the articles between decades (p values were 0.60, and 0.40, respectively). While there was no statistically significant difference in the TCN of articles published in different decades, we did find a statistically significant difference in the ACpY (p values were 0.623, and 0.001, respectively). It was remarkable to discover a statistically significant decrease in ACpY as time passed from the publication year. However, it was found that the TCN of the articles increased cumulatively over time (Fig. 1).

Study Type and Level of Evidence

Fifty-four articles in the T100 list were comparative studies. It was interesting that only 3 articles in T100 list were randomized controlled trial and systematic review with a level of evidence of 1, according to SIGN. However, TCN was statistically significantly higher than randomized controlled trials, systematic reviews, and descriptive studies when compared to other study categories ($p < 0.001$). In contrast to TCN, ACpY was statistically significantly higher than the case series, reviews, and comparative studies ($p < 0.001$).

Research Topic

The majority of articles in the T100 list were about treatment ($n=30$), epidemiology ($n=21$), quality of life about psychosocial aspects ($n=14$), strabismus types and clinical features ($n=12$). The topics that treatment research focused on were on surgical technique ($n=11$), surgical efficiency and safety ($n=10$), botulinum toxin treatment ($n=7$), and pharmaceutical protocol following surgery ($n=2$). Scott (10)'s case series entitled "Botulinum toxin injection into extra-ocular muscles as an alternative to strabismus surgery" published in 1980, was the most cited article in the field of strabismus research with a TCN of 507.

The top three ACpY papers (#2, #8, and #3) were all about the epidemiology. Among these articles, Friedman et al.'s epidemiologic study,^[1] entitled "Prevalence of amblyopia and strabismus in white and African American children aged 6 through 71 months the Baltimore pediatric eye disease study" published in 2009, had the highest ACpY of 17.31

Journal Perspective

Journals with the highest number of articles on strabismus in the T100 list were journal of "Ophthalmology" ($n=25$), "Journal of AAPOS" ($n=10$), "British Journal of Ophthalmology" ($n=10$), "Investigative Ophthalmology and Visual Science" ($n=10$), and "Jama Ophthalmology" ($n=10$). In accordance to this, the first three articles with the highest TCN and ACpY were published in the journal Ophthalmology. When we examined the top 100 cited articles that deal with strabismus, we noticed that most of them were published in eye-specific journals, except one article. Seventy-three of articles in the T100 list were published in journals classified as Q1 category. Although the journal IF and H-index of articles published in the Q1 category were higher than the other categories, we discovered that the Q categories of the journals did not produce a statistically significant difference in TCN and ACpY.

Table 1. Comparison of main fetures of articles based on metrics

	N	IF M[Q1 – Q3]	H-index M[Q1 – Q3]	TCN M[Q1 – Q3]	ACpY M[Q1 – Q3]
Publication year					
1980-1990	18	6.2 [4.01 – 8.47]	218 [153 – 244]	66 [59 – 83]	A36 [32 – 39]
1990-2000	35	4.01 [1.4 – 6.2]	153 [66 – 218]	61 [49 – 84]	A25 [22 – 29]
2000-2010	39	4.01 [1.34 – 5.69]	186 [66 – 218]	60 [48 – 84]	B16 [14 – 19]
2010 ve üzeri	8	5.11 [3.03 – 8.47]	191 [125.5 – 244]	52 [44.5 – 85]	C8 [7 – 9.5]
p		0.06	0.14	0.623	<0.001
Q category					
Q1	73	A4.8 [4.01 – 8.47]	A196 [186 – 244]	66 [51 – 84]	22 [14 – 30]
Q2	16	B1.34 [1.34 – 1.34]	B66 [66 – 66]	60 [46 – 77.5]	17 [16 – 20.5]
Q3	9	B1.4 [1.4 – 1.4]	B46 [46 – 46]	52 [46 – 118]	25 [21 – 27]
Q4	2	B3.36 [3.36 – 3.36]	B25 [25 – 25]	59.5 [59 – 60]	19 [18 – 20]
p		<0.001	<0.001	0.882	0.546
Study type					
Comparative Study	54	4.01 [1.4 – 6.2]	186 [66 – 218]	A59.5 [51 – 75]	A21 [17 – 29]
Descriptive study	28	4.8 [3.61 – 8.47]	207 [153 – 244]	B78.5 [63 – 115]	A 16.5 [12 – 28.5]
Case series and review	15	4.2 [2.46 – 6.2]	153 [98 – 218]	A47 [45 – 75]	B 27 [17 – 34]
Randomized controlled trial and Systematic review	3	4.21 [2.46 – 8.47] 0.317	98 [74 – 244] 0.356	B77 [56 – 184] <0.001	A17 [16 – 25] <0.001
Main topic					
Treatment	30	4.01 [1.4 – 8.47]	186 [66 – 244]	51.5 [47 – 66]	24.5 [18 – 30]
Epidemiology	21	6.2 [3.61 – 8.47]	196 [153 – 244]	79 [53 – 110]	16 [11 – 24]
Quality of life and psychosocial aspect	14	3.49 [1.34 – 4.01]	109.5 [66 – 186]	84 [60 – 112]	17 [13 – 21]
Strabismus types and clinical features	12	4.21 [3.49 – 8.47]	185.5 [104.5 – 244]	68.5 [60 – 76.5]	29 [19.5 – 33]
Diagnosis	7	2.46 [1.34 – 6.2]	98 [66 – 196]	75 [48 – 93]	19 [15 – 32]
Pathophysiology/neurophysiology	5	4.8 [2.46 – 5.69]	196 [98 – 218]	53 [53 – 62]	21 [19 – 25]
Genetic	3	4.8 [1.31 – 6.2]	196 [39 – 218]	46 [44 – 59]	17 [14 – 27]
Histopathological features	3	4.8 [4.8 – 8.47]	218 [218 – 244]	83 [66 – 84]	29 [25 – 41]
Prognostic features	3	1.34 [1.34 – 6.2]	66 [66 – 196]	60 [44 – 62]	21 [17 – 28]
Pathophysiology	2	4.8 [4.8 – 4.8]	218 [218 – 218]	75.5 [66 – 85]	18 [17 – 19]
p		0.158	0.08	0.2	0.195
Journal name					
Ophthalmology	25	8.47 [8.47 – 8.47]	244 [244 – 244]	70 [53 – 88]	28 [13 – 32]
Journal of aapos	13	1.34 [1.34 – 1.34]	66 [66 – 66]	60 [48 – 75]	17 [16 – 20]
British journal of ophthalmology	10	3.61 [3.61 – 3.61]	153 [153 – 153]	60 [51 – 70]	21.5 [15 – 29]
Investigative ophthalmology & visual science	10	4.8 [4.8 – 4.8]	218 [218 – 218]	74.5 [59 – 85]	19 [17 – 29]
Jama ophthalmology (formerly known as archives of ophthalmology)	10	6.2 [6.2 – 6.2]	196 [196 – 196]	64 [48 – 79]	25.5 [19 – 29]
American journal of ophthalmology	9	4.01 [4.01 – 4.01]	186 [186 – 186]	51 [47 – 64]	14 [12 – 22]
Journal of pediatric ophthalmology & strabismus	7	1.4 [1.4 – 1.4]	46 [46 – 46]	52 [46 – 123]	25 [21 – 30]
Eye	3	2.46 [2.46 – 2.46]	98 [98 – 98]	80 [43 – 184]	25 [6 – 25]
Survey of ophthalmology	3	4.2 [4.2 – 4.2]	132 [132 – 132]	60 [47 – 93]	30 [27 – 38]
Acta ophthalmologica scandinavica	2	3.36 [3.36 – 3.36]	25 [25 – 25]	59.5 [59 – 60]	19 [18 – 20]
Ophthalmic epidemiology	2	1.5 [1.5 – 1.5]	63 [63 – 63]	62 [44 – 80]	11.5 [7 – 16]
Annals of the new york academy of sciences	1	5.69 [5.69 – 5.69]	248 [248 – 248]	53 [53 – 53]	19 [19 – 19]
Clinical and experimental ophthalmology	1	4.21 [4.21 – 4.21]	74 [74 – 74]	56 [56 – 56]	16 [16 – 16]
Japanese journal of ophthalmology	1	1.73 [1.73 – 1.73]	56 [56 – 56]	75 [75 – 75]	36 [36 – 36]
Ophthalmic and physiological optics	1	2.62 [2.62 – 2.62]	66 [66 – 66]	45 [45 – 45]	24 [24 – 24]
Ophthalmic genetics	1	1.31 [1.31 – 1.31]	39 [39 – 39]	44 [44 – 44]	27 [27 – 27]
Ophthalmic plastic and reconstructive surgery	1	1.11 [1.11 – 1.11]	56 [56 – 56]	118 [118 – 118]	21 [21 – 21]
p		0.451	0.574	0.725	0.478

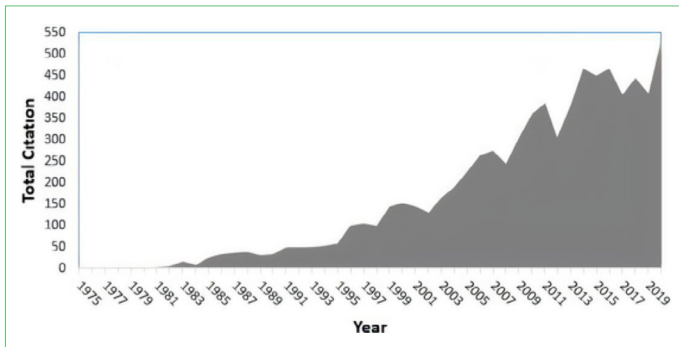


Figure 1. Total citation numbers according to the years.

Correlation Analysis

Correlation analysis is displayed in Table 2. There was a strong positive correlation between journal IF and H-index ($r=0.910$; $p=0.001$). There was a strong positive correlation between ACpY and TCN ($r=0.671$; $p=0.001$). There was moderate negative correlation between ACpY and period since the publication year ($r=-0.481$; $p=0.001$). Figure 2 illustrates the regression analysis. While IF and citation are associated, the correlation analysis in this study interestingly demonstrates that TCN has no effect on IF.

Mapping Knowledge Domain

Country Analysis

Twenty-one countries were identified using country analysis of articles in the T100 list (Table 3). The USA supplied the greatest number of publications (65 articles), followed by England (12 articles) and Turkey (5 articles). The countries

Table 2. Correlation analyses of metrics

	H index	TCN	ACpY	Article Age
IF				
r	0.910**	0.169	0.181	0.129
p	0.001	0.093	0.071	0.201
H-index				
r		0.127	0.168	0.083
p		0.207	0.095	0.414
TCN				
r			0.671**	0.151
p			0.001	0.133
ACpY				
r				-0.481**
p				0.001

IF: journal impact factor; TCN: total citation number; ACpY: average citation per year; r was obtained from Spearman rank or Pearson correlation coefficient analyses, $n=100$ ** $p<0.001$ * $p<0.05$.

with the highest TCN were the USA (4872 citations), England (1024 citations) and Australia (422 citations), respectively. The most productive country was the USA. The country co-authorship analysis is illustrated in Figure 3. More prominent countries in this domain are shown by larger nodes; the thickness and distance of linkages between nodes reflect collaborative relationships between countries.

Distribution of Research Organizations

When the articles in the T100 list were sorted by the primary research organizations, we discovered a total of 15 orga-

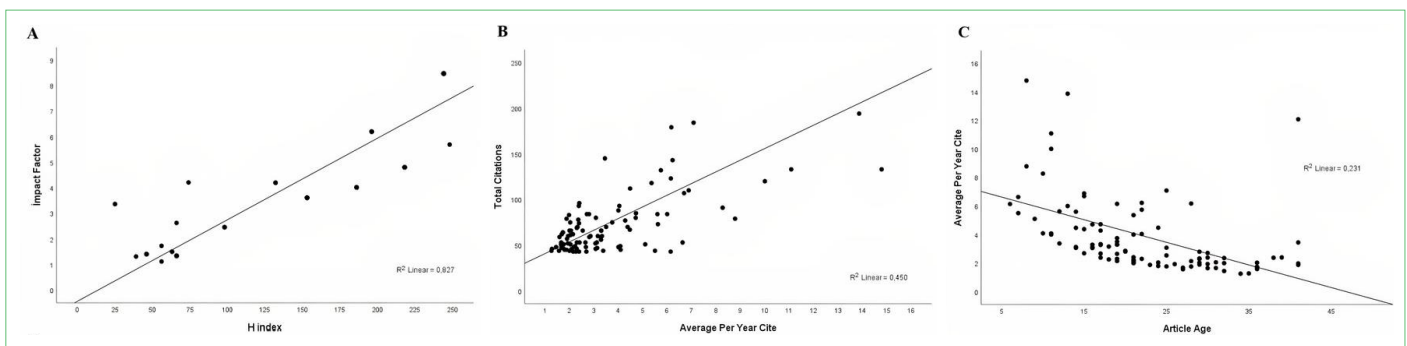


Figure 2. (a) Scatter plot between journal IF and H-index. There was strong positive correlation between journal IF and H index ($r=0.910$; $p=0.001$). According to univariate linear regression analysis ~83% of variation in Impact factor was explained by H Index. 10 unit increase in H Index resulted in 0.30 increase in Impact factor. Finally model to estimate Impact factor was: $Y_{\text{Impact factor}} = -0.441 + 0.03 * X_{\text{H Index}}$

(b) Scatter plot between Total citations and Average citation per year. There was a strong positive correlation between Total citations and Average citations per year ($r=0.671$; $p=0.001$). According to univariate linear regression analysis ~45% of variation in the Total cite was explained by Average citation per year. 1 unit increase in Average citations per year resulted in 12,77 increase in Total citations. The model to estimate total citations was: $Y_{\text{Total citation}} = 28.13 + 12.77 * X_{\text{Average citation per year}}$

(c) Scatter plot between Article age and Average citation per year. There was a moderate negative correlation between article age and Average per year cite ($r=-0.481$; $p=0.001$). According to univariate linear regression analysis ~23% of variation in the average citation per year was explained by article age. 1 unit increase in article age resulted in 0.16 decrease in average citation per year cite and model to estimate the Average citation per year was: $Y_{\text{Average citation per year}} = 7.41 - 0.16 * X_{\text{Article age}}$

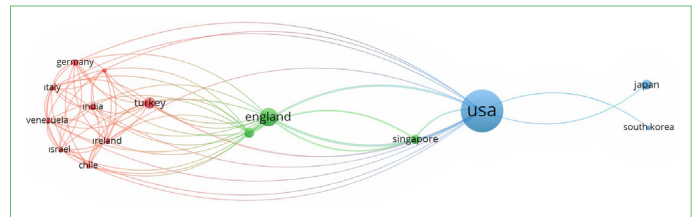
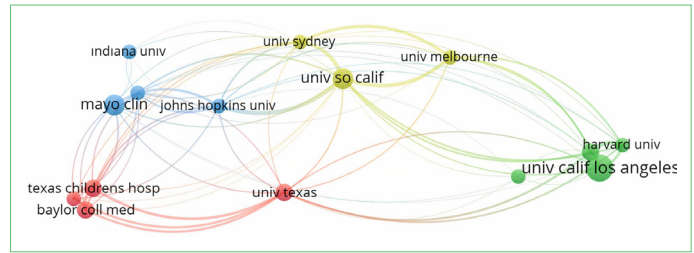
Table 3. Country analysis of top-100 cited articles

Rank	Country	Documents	Citations	Total link strength
1	USA	65	4872	1539
2	England	12	1024	848
3	Turkey	5	275	308
4	Australia	4	422	657
5	Japan	4	278	188
6	Peoples r China	4	213	184
7	Singapore	3	320	374
8	Germany	2	110	219
9	Sweden	2	146	34
10	India	2	182	254
11	Canada	1	51	0
12	Chile	1	59	202
13	France	1	43	25
14	Netherlands	1	49	7
15	Norway	1	59	0
16	Saudi Arabia	1	59	202
17	South Korea	1	66	121
18	Venezuela	1	59	202
19	Ireland	1	59	202
20	Israel	1	59	202
21	Italy	1	59	202

nizations with 3 or more articles (Table 4). The organization with the most articles (10 articles) and TCN (784 citations) in the T100 list was the University of California, Los Angeles. However, the University of Texas had the strongest total link strength and collaborated with most organizations (Fig. 4).

Table 4. Main research organizations of top-100 cited article

Rank	Organization	Documents	Citations	Total link strength
1	University of California Los Angeles	10	784	7
2	University Southern California	6	730	10
3	Mayo Clinic	6	311	2
4	Baylor College Medicine	4	262	6
5	Texas Children's Hospital	4	243	6
6	Children's Hospital	4	220	9
7	University of Texas	4	199	12
8	Johns hopkins University	3	389	2
9	University of Sydney	3	363	4
10	University of Melbourne	3	312	9
11	Indiana University	3	212	0
12	University of Wisconsin	3	206	0
13	Mayo Clinic & Mayo Fdn	3	184	1
14	Harvard University	3	175	8
15	Louisiana State University	3	139	6

**Figure 3.** Network visualization map of country co-authorship analysis of strabismus research.**Figure 4.** Network visualization map of country co-authorship analysis of strabismus research.

Distribution of Keywords

When the keyword co-occurrence analysis of the T100 list articles was performed, seven different clusters were discovered and represented with different colours (Table 5) (Fig. 5). Strabismus, amblyopia, children, monkey, and nystagmus were the keywords with the highest co-occurrence and total link strength, respectively.

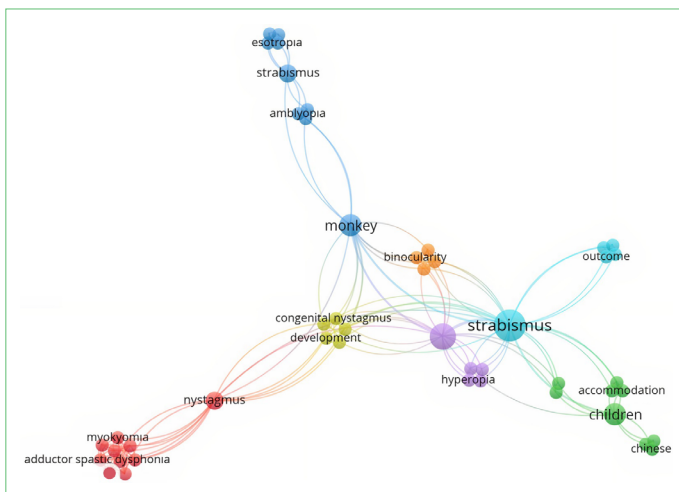
Discussion

Strabismus, not only disturbs binocular alignment with poor vision, which result in significant psychosocial defects, but also it is an aesthetic problem and majority of strabismus videos on YouTube have been related to aesthetic concern^[13], if it is left untreated, negative results can be seen on both sensorial function and quality of life. Amblyopia and poor stereopsis are permanent sensorial impairments. So, early recognition and intervention are crucial, either with surgical treatment or pharmacological treatment with botulinum toxin.^[14] Numerous studies have been conducted throughout the years to determine the prevalence and treatment of strabismus. The pooled prevalence of any strabismus, exotropia, or esotropia was estimated to be 1.93% (1.64–2.21), 1.23% (1.00–1.46), and 0.77% (0.59–0.97), respectively (95% CI).^[3] Recent classic surgical treatment of strabismus has been changing in favour of pharmacological treatment with botulinum toxin or bupivacaine injections treatments, which causes less surgical scar and minimize surgical anaesthesia.^[15]

The main topic of 30 articles in the T100 list was the treatment of strabismus. It was remarkable that the majority of the most cited articles were about treatment, and 7 of them

Table 5. Keyword cluster analysis of Top 100 cited articles

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7
Adductor spastic dysphonia	Accommodation	Amblyopia	Congenital nystagmus	Amblyopia	Outcome	Binocularity
Botulinum-a toxin	Binocular function	Anisometropia	Development	Hyperopia	Psychosocial	Cat
Essential blepharospasm	Children	Esotropia	Latent nystagmus	Infant Vision	Social bias	Primary visual cortex
Hemifacial spasm	Chinese	Exotropia	Stereovision	Refraction	Strabismus	Suppression
Lid retraction	Down syndrome	Genetics	Vision	Vision screening	Treatment	
Lower lid entropion	Epidemiology	Inheritance	Strabismus			
Motility	Glaucoma	Lateral geniculate nucleus				
Myokymia	Prevalence	Monkey				
Nystagmus	Steroid					
Spasmodic torticollis						

**Figure 5.** Network visualization map of keyword co-occurrence analysis of strabismus research.

were about botulinum toxin treatment. Moreover, the article with the highest TCN was Scott's case series.^[16] entitled "Botulinum toxin injection into extra-ocular muscles as an alternative to strabismus surgery". Due to the fact that this was the first study, proposing the pharmaceutical treatment of strabismus as a reasonable alternative to surgery. Our research has revealed that there was significant interest and curiosity is present in the treatment of strabismus, among the published articles, since 1980 up to time being, particularly, less invasive treatments as an alternative to surgery are popular. It seems that surgery of extraocular muscles and especially the chemodenervation takes the interest of practicing general ophthalmologists a lot.^[17] Epidemiology (n=21) and the psychosocial impacts of strabismus (n=14) were the second and third most impressive topics in the field of strabismus among the academic community. Psychosocial effects of strabismus on children or adult patients should not

be underestimated. The terms like 'shifty eyed', 'evil eyed' are used to still label squinter in rural areas.^[18] Professionals are interested in strabismus since it causes psychosocial problems as well as vision loss. It is worth noting that the survey studies used to discover these problems have received a lot of attention from society.^[13]

TCN can be misleading in assessing the worth of an article because it is a cumulative growing metric over time. We also used ACpY in conjunction with TCN to eliminate time bias.^[19] We found that TCN and ACpY were positively correlated, and the results were consistent with each other. However, we discovered a statistically significant decrease in ACpY as time passed from the publication year. Recently published articles have received more regular citations over time than articles that had previously been published.

In our correlation analysis revealed no association between TCN and IF for strabismus. We thought that this situation can be explained by the low number of ophthalmologists who are interested in strabismus in general ophthalmology, the articles about strabismus being mostly published in journals related to strabismus and less read by ophthalmologists who are not interested in this subject

It is worth noting that just three articles in the T100 list were randomized controlled trials or systematic reviews with a SIGN level of evidence of one. More research with level 1 evidence is needed in the strabismus field, as TCN was statistically significantly higher in randomized controlled trials and systematic reviews than in other study categories.

The fact that the majority of articles in the T100 list were published in the journal "Ophthalmology" (n=25), a general ophthalmology journal, this is an unexpected result. It is noteworthy that the "Journal of AAPOS" (n=10), an important journal specific to strabismus, came in second in the T100 list. Strabismus articles published in general

ophthalmology journals which are targeted to all ophthalmologists, rather than pediatric ophthalmology and strabismus specialists, they have received more citation than the articles published in specific strabismus journals. Furthermore, we discovered no link between the journal's Q category and the TCN and ACpY value of the articles. The Q category of the journal has no impact on the citations of articles in the field of strabismus.

Study Limitations

This scientific study only presents the overall number of citations (excluding self-citations) and the total number of self-citations, and no article-based self-citation analyses were done, which is a drawback for this study. Furthermore, doing bibliometric studies based on citations is a subjective limitation for proving the quality of a research, determining the number of publications by year, and evaluating authors' scientific efficiency or h-index.

Conclusion

This is a pioneering study to assess and compare the most cited articles in the field of strabismus. The majority of highly cited publications about strabismus deal with strabismus treatment. Ophthalmologists have a remarkable level of interest in botulinum toxin, one of the alternative strabismus treatments so, strabismus articles published in general ophthalmology journals tend to receive higher citations than articles published in specific strabismus journals.

In our study, we have emphasized the significance of strabismus within the world-wide society due to its aesthetic, psychosocial and serious medical problems that have a negative impact on the quality of life of the affected individuals and their families. In addition to these facts, the treatment of strabismus receives considerable attention among the people. It has been demonstrated that world-wide ophthalmological society is interested in the treatment of strabismus, and in particular, recently new pharmacological, less invasive medical drug injection techniques like botulinum toxin and bupivacaine are becoming popular rather than classical surgical procedures.

Disclosures

Ethics Committee Approval: All authors state that the research was conducted in accordance with the Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects" of the World Medical Association. This research did not require approval from an ethics committee because it was a bibliometric or citation analysis of previously published articles.

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