

COVID-19 and ophthalmology: A scientometric analysis

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Purpose: Coronavirus disease pandemic has impacted global healthcare tremendously and ophthalmology is one of the high-hit specialties. An increasing number of research items are upcoming with COVID-19-related research in ophthalmology and this report aims at performing a scientometric analysis of all the available research pertaining to COVID-19 and ophthalmology. **Methods:** A Web of Science (<https://webofknowledge.com>) query TS = (“novel coronavirus 2019” OR “coronavirus 2019” OR “COVID 2019” OR “COVID 19” OR “nCOV” OR “SARS-CoV-2” OR “COVID-19”) AND WC = (“Ophthalmology”) was deployed on February 22, 2021, to retrieve all research items on the topics of interest. R software (v4.0.1) with Bibliometrix library was deployed to visualize metrics to quantify geographical distribution, source metrics, author metrics, document metrics, and keyword metrics. **Results:** A total of 616 research items appeared in our search results that were drafted by 2398 authors and published in 63 sources. India, USA, UK, and China had the greatest number of research items among others. Indian Journal of Ophthalmology, Eye, and Graefe’s Archive for Clinical and Experimental Ophthalmology were sources with greatest number of research items. Documents per author were 0.257 and authors per document were 3.89. The collaboration index was noted to be 4.28. **Conclusion:** Our scientometric analysis presents descriptive quantitative metrics for COVID-related research in the field of ophthalmology and provides evidence for the increased global collaboration that global researchers have fostered to fight this pandemic.

Key words: Bibliometric analysis, coronavirus and eye, coronavirus disease 2019, COVID-19 and ophthalmology, COVID-19 research trends, pandemic and ophthalmology research

Coronavirus disease 2019 (COVID-19) outbreak that started in December 2019, is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and has become a global emergency.^[1,2] Ever since, the pandemic has taken its toll with an increasing number of cases and deaths.

Till date, the World Health Organization (WHO) and the US Center for Disease Control and Prevention (CDC) have provided guidelines only for the management of patients with COVID-19 in terms of infection control and symptomatic relief. No specific vaccines or antiviral drugs are currently available for the SARS-CoV-2. Therefore, it is important to keep an eye on world literature for possible ideas and breakthroughs. The first scientometric analysis for COVID-19 research was published in March 2020.^[3] The author explored the PubMed database and the WHO database for publications pertaining to COVID-19 from December 2019 up until March 18, 2020. Felici and Poleminin carried out another bibliometric analysis of the publications on COVID-19 up until April 20, 2020.^[4]

Ophthalmologists are at high risk of exposure to the disease due to close contact with patients during the slit-lamp examination and manifestation of disease as ocular conjunctivitis.^[5,6] In addition, the major patient volume seeking ophthalmic care comprises the elderly population,

which has been reported to be a high-risk population.^[7] With a growing interest in COVID-19 research all over the world, a scientometric study of specifically the ophthalmology-related COVID-19 research is needed. This quantitative analysis of the data will provide meaningful insight for future research in the context of ophthalmology. There is no bibliometric analysis available to date that specifically focuses on developments in COVID-19 research in the ophthalmology field.

Methods

The current descriptive, scientometric study targeted a schematic view of a scientific map in the field of glaucoma. We used a web of science (<https://webofknowledge.com>), as our database for our analysis on February 23, 2021, using institutional access. The search query was TS = (“novel coronavirus 2019” OR “coronavirus 2019” OR “COVID 2019” OR “COVID 19” OR “nCOV” OR “SARS-CoV-2” OR “COVID-19”) AND WC = (“Ophthalmology”), where TS represents the topic and WC represents the web of science category. Since the study is based on public access bibliometric data, and did not involve any human subjects or any patient data, ethics committee deemed that a committee review was not required for this study.

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The query was done using all the variations of this term for the duration up to February 22, 2021. The data were exported in WoS raw data (.txt) file format that was used as a data source in the Bibliometrix R library (Aria M & Cuccurullo C) and Biblioshiny app. All analyses were performed in the R environment (v4.0.1, John Chambers and colleagues, Bell Laboratories). Articles about COVID-19 in ophthalmology were analyzed using different metrics as described below.

General information

These metrics included the overall composition of our dataset pertaining to the total number of research items, total number of authors, total number of references cited, research item type, and the total number of sources.

Geographical distribution

Country-wise scientific production and total country citations were used to quantify contributions made by a certain geographic area to this body of research and ascertain the impact of these contributions. Metrics such as Single-Country Production (SCP) and Multi-Country Production (MCP) were used to ascertain the extent of intercountry collaboration.

Source metrics

Total scientific production by the source was deployed as a metric to identify the distribution of research items across various contributing sources.

Hirsch index (h-index) and a total number of citations (TC; total times cited count) are two important author-level parameters. h-index is a metric that attempts to measure both the productivity and citation impact of the publications of a scientist. While initially proposed for authors, the h-index has been successfully applied for papers and journals.^[8] In addition to the metrics obtained from our local dataset, we also collected h-indices for the top-ranking journals from Scimago JR (<https://www.scimagojr.com/>) to compare the overall impact of a source to the impact contributed to COVID-19 in ophthalmology.

Bradford's law

Bradford's law of scattering helps to identify the core journals relevant to the research field. It is based on the principle of centric productivity zones, where the journals are divided into different zones having the same number of articles.

Document metrics

Local citation score and global citation score are metrics that represent the number of times a research item is cited either locally or globally, respectively. These metrics were used to identify the most commonly cited local and global research items.

Author profile

As previously highlighted, the Hirsch index (h-index) and a total number of citations (TC; total times cited count) are author-level parameters that have proven insightful for measuring the impact of a scientist. We used these metrics to compare author impact in this study. Corresponding author affiliations and their contributions were identified and compiled to analyze affiliation-wise contributions. Collaboration index (CI) is another metric used to quantify collaboration between authors and can be calculated as total authors of multi-authored articles/total multiauthored articles.

Cocitation network

A cocitation measures the frequency that two research items are cited together by a research item in that field of research. Cocitation network is visualized by drawing an arc between two articles that are cocited by a research item. "Betweenness" is a measure of how often a node is located on the shortest path between other nodes in the network. "Closeness" is less dependent on relations between individual nodes because a node can be close to two (or more) densely connected clusters.

Keyword metrics

KeyWords Plus® is unique to Web of Science and consists of words and phrases harvested from the titles of the cited articles and are also searched in the topic search. Author keywords are those keywords that are provided by authors at the time of submission of the research item for publication. Frequency metrics were used to identify commonly occurring keywords, topics, and themes.

Co-occurrence network

The nodes represent the keywords and their size reflects the occurrence frequency. The edges represent the connections between the nodes and their thickness reflects the co-occurrence frequency of nodes. The stronger connection or higher co-occurrence frequency is reflected by a thicker edge. The color of nodes represents their community/theme, where the nodes present in the same theme are more similar to each other than the nodes present in the other themes.

Thematic map

In a thematic map, each community/theme is represented on a two-dimensional plot of centrality vs density. Centrality can be interpreted as the importance of a theme in the research field and density can be treated as a measure of the development of the theme. Based on the centrality and density values, themes can be divided into four types:

- Motor themes: Themes in the upper-right quadrant with the higher values of centrality and density, which are both developed and form an important pillar in shaping the research field.
- Basic and transversal themes: Themes in the lower-right quadrant with higher values of centrality and lower values of density, which are weakly developed but important for a research field.
- Niche themes: Themes in the upper-left quadrant with higher values of density but lower values of centrality reflect the highly developed but isolated themes.
- Emerging or declining themes: Themes in the lower-left quadrant, both weakly developed and marginal in the research field.

Country-keyword-source three-field plot

This plot helps visualize the distribution of topic/keywords in this body of research across countries and sources. Such visualization helps better understanding the kind of research that is being conducted in different geographical spaces and which leading sources are featuring this research.

Results

A total of 616 research items appeared in our search results. These items were drafted by 2398 authors and published in 63 journals. There were a total of 6172 references in this result

and the average citations per document is 4.019. The search results were comprised of original articles ($n = 237$, 38.5%), letter ($n = 182$, 29.5%), editorial material ($n = 138$, 22.4%), review articles ($n = 54$, 8.8%), and correction ($n = 5$, 0.8%).

Geographic distribution

The most relevant countries by the number of publications were India ($n = 138$, Single Country Publication (SCP) = 122), United States of America ($n = 95$, SCP = 84), United Kingdom ($n = 63$, SCP = 53), China ($n = 60$, SCP = 47), and Italy ($n = 39$, SCP = 32) among others. Most relevant country by the number of citations were China ($n = 940$), Singapore ($n = 455$), India ($n = 266$), United States of America ($n = 204$), and Italy ($n = 130$) among others. Global collaboration network over the period analyzed in the study is represented in the Fig. 1. Table 1 enlists country wise production of articles, both single country and multiple country productions. Supplementary Table 1 enlists countries by number of citations.

Source metrics

The most relevant journals in terms of scientific production were Indian Journal of Ophthalmology (IJO) ($n = 127$), Eye ($n = 54$), Graefe's Archive for Clinical and Experimental Ophthalmology ($n = 43$), Ocular Immunology and Inflammation ($n = 26$), and Ophthalmology ($n = 26$) among others.

Most cited journals were JAMA Ophthalmology ($n = 298$, SCIMAGO h-index = 190), Graefe's Archive for Clinical and Experimental Ophthalmology ($n = 278$, SCIMAGO h-index = 96), Ophthalmology ($n = 248$, SCIMAGO h-index = 229), Ocular Immunology and Inflammation ($n = 237$, SCIMAGO h-index = 53), and Indian Journal of Ophthalmology ($n = 227$, SCIMAGO h-index = 47) among others.

In terms of source impact where TC = total citations and NP = number of publications, Graefe's Archive for Clinical and Experimental Ophthalmology (h-index = 7,

g-index = 16, TC = 278, NP = 43, SCIMAGO h-index = 96), Indian Journal of Ophthalmology (IJO) (h-index = 7, g-index = 10, TC = 227, NP = 127, SCIMAGO h-index = 47), Acta Ophthalmologica (h-index = 7, g-index = 13, TC = 192, NP = 20, SCIMAGO h-index = 82), Eye (h-index = 6, g-index = 11, TC = 151, NP = 54, SCIMAGO h-index = 93), and Ocular Immunology and inflammation (h-index = 3, g-index = 6, TC = 47, NP = 6, SCIMAGO h-index = 53) were sources that had the highest impact contributions to this body of research [Supplementary Table 2].

Bradford's law of scattering

Bradford's law of scattering yielded top core sources contributing to this body of research. These top sources were identified as IJO, Eye and Graefe's Archive for Clinical, and Experimental Ophthalmology [Supplementary Fig. 1].

Document metrics

Wu 2020 (Local Citation Score [LCS] = 100, Country = China), Seah 2020 (LCS = 74, Country = Singapore), Lai 2020 (LCS = 66, Country = Hong Kong, SAR), Seah 2020 (LCS = 62, Country = Singapore), and Chen 2020 (LCS = 45, Country = China) were the most locally cited references (LCRs). Supplementary Table 3 enlists the top LCRs.

Global citation score (GCS) provides the citation frequency based on the full Web of Science count at the time the data was downloaded. Wu 2020 (GCS = 259, Country = China), Seah 2020 (GCS = 156, Country = Singapore), Lai THT 2020 (GCS = 121, Country = Hong Kong, SAR), Seah 2020 (LCS = 74, Country = Singapore), and Li 2020 (GCS = 90, UK) had the greatest number of global citations. Table 2 enlists top global citation documents.

Author profile of publications

There was a total of 2398 authors and 3218 author appearances. Sixty-two research items had a single author. Documents per

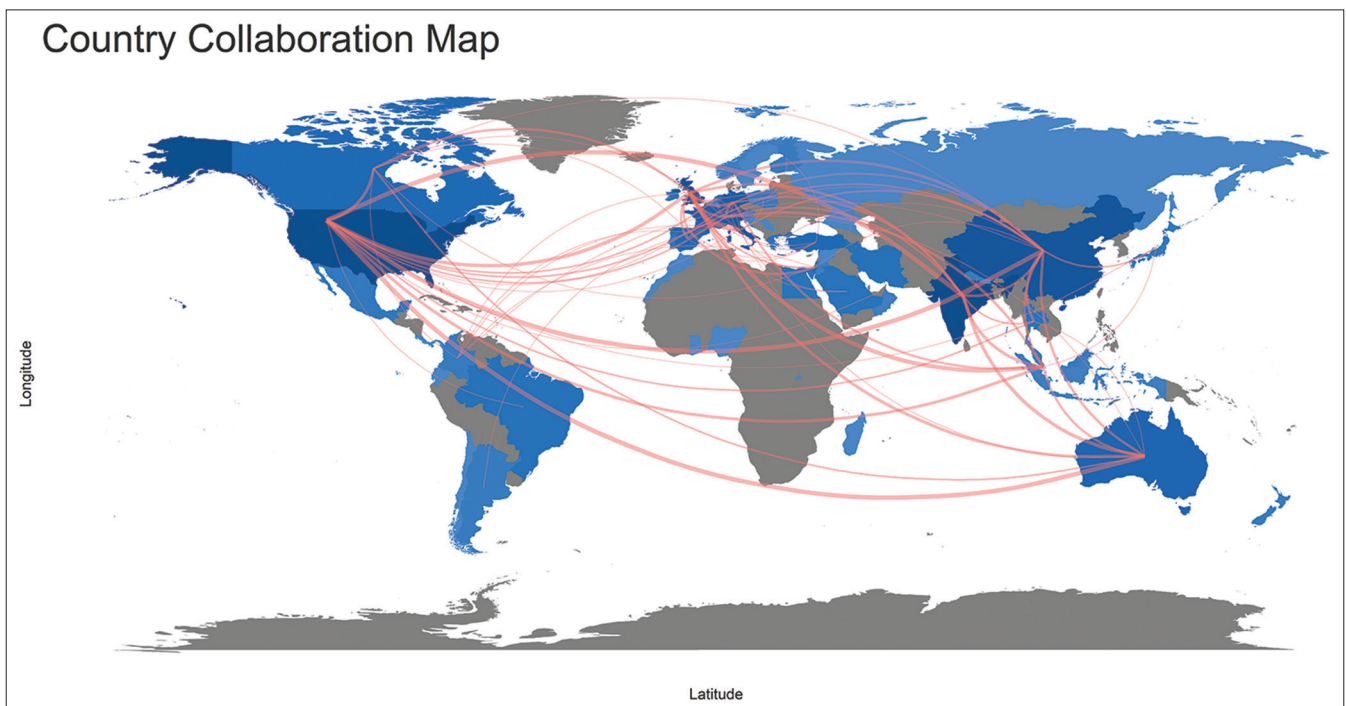


Figure 1: Global collaboration network

author was 0.257 and authors per document was 3.89. In our collection, 80.0% ($n = 1918$) of the authors have published only one article, 18.4% ($n = 441$) have published between 2 and 4 articles, 1.62% ($n = 39$) have published five or more articles and 0.25% ($n = 6$) have published 10 or more articles. The greatest number of research items were by Sharma ($n = 16$), Shetty ($n = 12$), Banello ($n = 10$), Honavar ($n = 10$), Li ($n = 10$), and Sachdev ($n = 10$) among others. The collaboration index was noted to be 4.24.

Table 1: Country-wise production of articles: Single-country and Multi-country productions

Country	Articles	SCP	MCP	MCP Ratio
INDIA	138	122	16	0.1159
USA	95	84	11	0.1158
UNITED KINGDOM	63	53	10	0.1587
CHINA	60	47	13	0.2167
ITALY	39	32	7	0.1795
GERMANY	34	30	4	0.1176
FRANCE	29	22	7	0.2414
SINGAPORE	18	8	10	0.5556
TURKEY	13	11	2	0.1538
SPAIN	12	11	1	0.0833
ISRAEL	11	10	1	0.0909
CANADA	8	6	2	0.2500
AUSTRALIA	7	6	1	0.1429
BRAZIL	7	4	3	0.4286
IRAN	7	5	2	0.2857
SAUDI ARABIA	6	3	3	0.5000
EGYPT	5	3	2	0.4000
AUSTRIA	4	3	1	0.2500
GREECE	4	3	1	0.2500
IRELAND	4	3	1	0.2500

SCP: Single-Country Publication (Intracountry); MCP: Multiple-Country Publication (Intercountry); MCP Ratio: Refers to MCP as proportion of total publication number

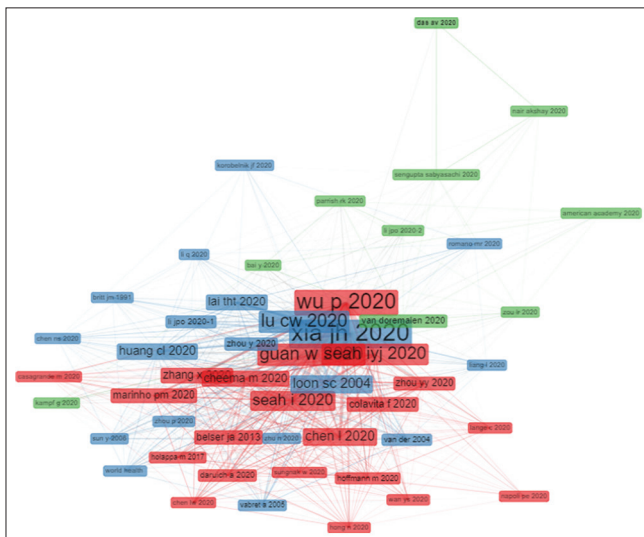


Figure 2: Cocitation network

Anonymous ($n = 74$), WHO ($n = 59$), Lu ($n = 36$), Seah ($n = 31$), and Xia ($n = 30$) were the authors with the greatest number of local citations among others whereas the most impactful authors were Li (h-index = 4, g-index = 10, TC = 144, NP = 10), Agrawal (h-index = 4, g-index = 8, TC = 302, NP = 8), Lam (h-index = 4, g-index = 8, TC = 121, NP = 8), Honavar (h-index = 4, g-index = 6, TC = 47, NP = 10), and Banello (h-index = 4, g-index = 5, TC = 33, NP = 10) among others. Supplementary Table 4 elucidates the author impact of top 20 authors.

The most relevant author affiliations by total number of research items published include LV Prasad Institute, Hyderabad, India ($n = 52$), All India Institute of Medical Science, New Delhi (AIIMS) ($n = 34$), Center for Sight, New Delhi ($n = 25$), United Christian Hospital, Hong Kong ($n = 14$), Anglia Ruskin University, and Cambridge, UK ($n = 13$) among others. Supplementary Table 5 elucidates the number of research items from various affiliations.

The cocitation network of references pertaining to COVID-19 research in ophthalmology was created as shown in Fig. 2. The names that appeared the most were Xia (Betweenness = 99.6, Closeness = 0.020), Wu (Betweenness = 80.07, Closeness = 0.020), Lu (Betweenness = 39.4, Closeness = 0.020), Guan (Betweenness = 33.9, Closeness = 0.0196), and Seah (Betweenness = 32.2, Closeness = 0.0196) among others.

Keywords plus and author keywords

The most frequent keywords plus were coronavirus (25), SARS (16), COVID-19 (16), telemedicine (13), and ace2 receptor (12) among others. The most frequent author keywords were COVID-19 (173), SARS-CoV-2 (67), coronavirus (51), ophthalmology (38), and conjunctivitis (22).

A co-occurrence network is shown in Supplementary Figs. 2. A thematic map was generated and is depicted in Fig 3.

- Motor themes: These were receptor, prevalence, and inactivation.
- Basic and transversal themes: These were telemedicine, retinopathy, coronavirus, and inactivation.
- Niche themes: The themes covered were outcomes, impact, and transmission.
- Emerging or declining themes: Ranibizumab, keratitis fell in the lower left quadrant.

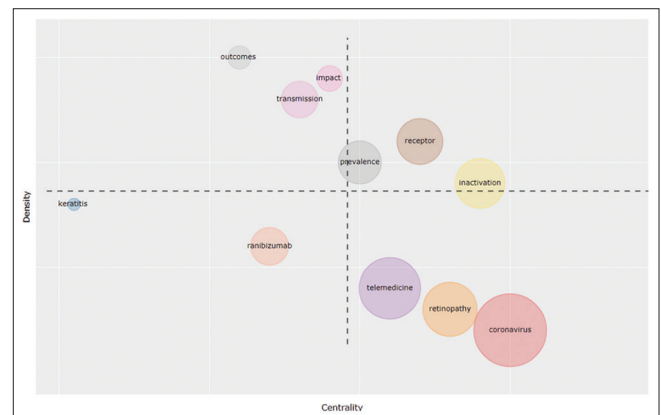


Figure 3: Thematic map based on author keywords

Table 2: Top 20 globally cited documents

Paper	Title	DOI	Total Citations	TC per Year	Normalized TC
WU P, 2020, JAMA OPHTHALMOL	Characteristics of Ocular Findings of Patients With Coronavirus Disease 2019 (COVID-19) in Hubei Province, China	10.1001/jamaophthalmol.2020.1291	259	129.5	51.971
SEAH I, 2020, OCUL IMMUNOL INFLAMM	Can the Coronavirus Disease 2019 (COVID-19) Affect the Eyes? A Review of Coronaviruses and Ocular Implications in Humans and Animals	10.1080/09273948.2020.1738501	156	78.0	31.303
LAI THT, 2020, GRAEF ARCH CLIN EXP	Stepping up infection control measures in ophthalmology during the novel coronavirus outbreak: an experience from Hong Kong	10.1007/s00417-020-04641-8	121	60.5	24.280
SEAH IYJ, 2020, OPHTHALMOLOGY-a	Assessing Viral Shedding and Infectivity of Tears in Coronavirus Disease 2019 (COVID-19) Patients	10.1016/j.ophtha.2020.03.026	117	58.5	23.477
LI JPO, 2020, BRIT J OPHTHALMOL	Novel Coronavirus disease 2019 (COVID-19): The importance of recognising possible early ocular manifestation and using protective eyewear	10.1136/bjophthalmol-2020-315994	90	45.0	18.060
CHEN L, 2020, BRIT J OPHTHALMOL	Ocular manifestations of a hospitalised patient with confirmed 2019 novel coronavirus disease	10.1136/bjophthalmol-2020-316304	88	44.0	17.658
ZHANG X, 2020, OCUL SURF	The evidence of SARS-CoV-2 infection on ocular surface	10.1016/j.jtos.2020.03.010	58	29.0	11.638
CHEEMA M, 2020, CAN J OPHTHALMOL	Keratoconjunctivitis as the initial medical presentation of the novel coronavirus disease 2019 (COVID-19)	10.1016/j.cjco.2020.03.003	50	25.0	10.033
LIANG L, 2020, ACTA OPHTHALMOL	There may be virus in conjunctival secretion of patients with COVID-19	10.1111/aos.14413	46	23.0	9.230
ROMANO MR, 2020, CURR EYE RES	Facing COVID-19 in Ophthalmology Department	10.1080/02713683.2020.1752737	42	21.0	8.428
HONG N, 2020, ACTA OPHTHALMOL	Evaluation of ocular symptoms and tropism of SARS-CoV-2 in patients confirmed with COVID-19	10.1111/aos.14445	40	20.0	8.026
ZHOU YY, 2020, OPHTHALMOLOGY	Ocular Findings And Proportion With Conjunctival Sars-Cov-2 In Covid-19 Patients	10.1016%2Fj.ophtha.2020.04.028	40	20.0	8.026
LI JPO, 2020, OPHTHALMOLOGY	Preparedness among Ophthalmologists: During and Beyond the COVID-19 Pandemic	10.1016/j.ophtha.2020.03.037	38	19.0	7.625
MA D, 2020, EYE	Expression of SARS-CoV-2 receptor ACE2 and TMPRSS2 in human primary conjunctival and pterygium cell lines and in mouse cornea	10.1038/s41433-020-0939-4	37	18.5	7.424
CHEN LW, 2020, ACTA OPHTHALMOL	Ocular manifestations and clinical characteristics of 535 cases of COVID-19 in Wuhan, China: a cross-sectional study	10.1111/aos.14472	29	14.5	5.819
QING HL, 2020, ACTA OPHTHALMOL	The possibility of COVID-19 transmission from eye to nose	10.1111/aos.14412	28	14.0	5.619
SALEEM SM, 2020, AM J OPHTHALMOL	Virtual Ophthalmology: Telemedicine in a COVID-19 Era	10.1016/j.ajo.2020.04.029	27	13.5	5.418

Contd...

Table 2: Contd...

Paper	Title	DOI	Total Citations	TC per Year	Normalized TC
CASAGRANDE M, 2020, OCUL IMMUNOL INFLAMM	Detection of SARS-CoV-2 in Human Retinal Biopsies of Deceased COVID-19 Patients	10.1080/09273948.2020.1770301	27	13.5	5.418
KOROBELNIK JF, 2020, GRAEF ARCH CLIN EXP	Guidance for anti-VEGF intravitreal injections during the COVID-19 pandemic	10.1007/s00417-020-04703-x	24	12.0	4.816
ZHOU LL, 2020, OCUL SURF	ACE2 and TMPRSS2 are expressed on the human ocular surface, suggesting susceptibility to SARS-CoV-2 infection	10.1016/j.jtos.2020.06.007	24	12.0	4.816

Country-Keyword-Source three-field plot was generated for the data [Supplementary Fig. 3].

Discussion

Globally, as of February 23, 2021, there have been 111,419,939 confirmed cases of COVID-19, including 2,470,772 deaths, reported by WHO.^[8] This highly transmittable and pathogenic viral infection not only affects the respiratory system but has the potential to involve other organs such as the eye. Possible theories for ocular involvement include direct inoculation of the ocular tissues from aerosolized viral particles or respiratory droplets, migration from the nasopharynx via the nasolacrimal duct, or even hematogenous spread through the lacrimal gland.^[9,10]

COVID-19 and conjunctivitis

Authors used the keyword “conjunctivitis” in 22 research items in this body of research of which the highest number of citations was merited to the research item published in *The Ocular Surface* by Xian *et al.* Xian Zhang and colleagues reported that out of the 72 laboratories tested patients with COVID-19, only two patients had conjunctivitis and only one patient had reverse transcriptase-polymerase chain reaction (RT-PCR) proven viral RNA fragments in the ocular discharge.^[11] Several studies have tried to explore the evidence of viral transmission from ocular secretions but no consensus has been reached on the definitive mode of ocular transmission. None of the studies till date have cultured the virus itself from the ocular secretions and it is only the viral RNA that has been reported in some studies to have been detected using RT-PCR.^[12]

Trends in COVID-19 research in ophthalmology

Knowing the current trends in research would help develop an interprofessional approach, which will not only help to manage the COVID-19 patients with/without ophthalmic manifestations but also help to mitigate the spread of disease successfully. With a tremendous increase in COVID-19-related publications and different research related to different remote care delivery models in the outpatient,^[13-15] inpatient, and emergency room^[16-19] settings a scientometric map must be generated of all the research currently existing in this area. We present a body of publications that quantified country-specific and worldwide coverage of COVID-19 literature pertaining to ophthalmology. To our knowledge, this is the first scientometric review focusing exclusively on ophthalmology and COVID-19. The volume and focus of publications showed a notable increase in the overall number of documents during the study period.

Besides, authors using keywords related to the coronavirus pandemic per se (COVID-19, SARS-Cov-2, corona, coronavirus, coronavirus disease 2019, 2019-nCov, COVID-19, pandemic, coronavirus; $n = 337$), telemedicine-related keywords had a high occurrence frequency (Telemedicine, teleophthalmology; $n = 44$) indicating a substantial surge in telemedicine-related research in ophthalmology during the pandemic. Conjunctivitis ($n = 43$), cornea ($n = 25$), guidelines ($n = 12$), and ocular surface ($n = 10$) were other common author keywords. While keywords plus had relatively fewer COVID-19-related keywords (Coronavirus, SARS, virus, COVID-19, Coronaviruses; $n = 68$). Telemedicine-related keywords (Telemedicine, teleophthalmology, telehealth, teleconsults, $n = 25$), Angiotensin-converting enzyme-related keywords (ACE2, angiotensin-converting enzyme, angiotensin-converting enzyme-2, $n = 21$), and respiratory symptom-related keywords (acute respiratory syndrome, pneumonia, $n = 11$) constituted other highly occurring keywords in keywords plus. With the new COVID variants and a potential new wave of COVID-19 and a possible COVID hurricane in the future, clinic schedule volumes may remain below pre-COVID-19 levels for the foreseeable future. Therefore, the role of telemedicine and teleophthalmology cannot be ignored.

From the three-field plot [Supplementary Fig. 3], it can be seen that the research pertaining to the author keyword “Guidelines” published in *Indian Journal of Ophthalmology* (IJO) and *Current Opinion in Ophthalmology* was performed in India, United Kingdom, Italy, and China. Telehealth, Telemedicine, and teleophthalmology were common keywords from sources viz., IJO, Graefe’s Clinical and Experimental Ophthalmology, Ophthalmology and Therapy, *Der Ophthalmologe*, *Journal Francais De Ophthalmologie*, *BMJ Open Ophthalmology*, *Current Opinion in Ophthalmology*, *Clinical Ophthalmology*, and *Contact Lens and Anterior Eye*. This research was conducted in countries viz. India, Israel, United Kingdom, United States of America, France, and Germany. *Current Opinion in Ophthalmology*, *European Journal of Ophthalmology*, *International Ophthalmology*, *Acta Ophthalmologica*, and *Contact lens and anterior eye* were sources that featured research from Spain, Egypt, Italy, China, UK, Germany, and USA with keywords PPE (personal protective equipment). Given the large population of India and China, these two countries had not only more people inflicted with the virus but also needed a strict set of standard guidelines, to curtail the spread.

Research pertaining to keywords transmission, conjunctivitis, and ocular surface symptoms was featured in Graefe's Clinical and Experimental Ophthalmology, Eye and Vision, Ocular Immunology and Inflammation, Acta Ophthalmologica, International Journal of Ophthalmology, Journal of Medical Virology, and Der Ophthalmologe. This research originated from countries viz. China, Italy, France, Spain, Finland, UK, USA, India, Turkey, Singapore, Australia, Canada, and Columbia.

The main limitation of this paper is its intrinsic bias. It was based on the Web of Science database and we know that the results may differ according to other databases or the inclusion of other search terms.

Conclusion

Our scientometric analysis provides a descriptive quantitative analysis and provides evidence that more global contribution toward COVID-related ophthalmic research can help in the prompt implementation of protocols and guidelines across the globe that will serve mankind in these tough times.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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Supplementary Table 1: Country by number of citations

Country	Total Citations	Average Article Citations
CHINA	940	15.667
SINGAPORE	455	25.278
INDIA	266	1.928
USA	204	2.147
ITALY	130	3.333
FRANCE	77	2.655
CANADA	74	9.250
UNITED KINGDOM	73	1.159
GERMANY	53	1.559
TURKEY	26	2.000
IRAN	22	3.143
ISRAEL	22	2.000
INDONESIA	21	10.500
SPAIN	18	1.500
AUSTRALIA	17	2.429
NORWAY	14	7.000
THAILAND	11	2.750
MEXICO	9	2.250
U ARAB EMIRATES	9	4.500
SAUDI ARABIA	6	1.000

Supplementary Table 2: Most impactful sources for COVID-19 research in Ophthalmology by h-index

Source	h-index	g-index	TC	NP
GRAEFES ARCHIVE FOR CLINICAL AND EXPERIMENTAL OPHTHALMOLOGY	7	16	278	43
ACTA OPHTHALMOLOGICA	7	13	192	20
INDIAN JOURNAL OF OPHTHALMOLOGY	7	10	227	127
OCULAR IMMUNOLOGY AND INFLAMMATION	6	15	237	26
OPHTHALMOLOGY	6	15	248	26
EYE	6	11	151	54
JAMA OPHTHALMOLOGY	4	17	298	17
OPHTHALMOLOGY AND THERAPY	4	5	34	11
EUROPEAN JOURNAL OF OPHTHALMOLOGY	4	4	25	18
CONTACT LENS & ANTERIOR EYE	3	7	56	9
JOURNAL FRANCAIS D OPHTALMOLOGIE	3	6	44	22
AMERICAN JOURNAL OF OPHTHALMOLOGY	3	6	43	13
ASIA-PACIFIC JOURNAL OF OPHTHALMOLOGY	3	4	25	9
JOURNAL OF CATARACT AND REFRACTIVE SURGERY	3	3	14	11
INTERNATIONAL OPHTHALMOLOGY	3	3	16	10
OPHTHALMIC PLASTIC AND RECONSTRUCTIVE SURGERY	3	3	15	7
JOURNAL OF GLAUCOMA	2	4	16	11
BMJ OPEN OPHTHALMOLOGY	2	4	17	9
ORBIT-THE INTERNATIONAL JOURNAL ON ORBITAL DISORDERS-OCULOPLASTIC AND LACRIMAL SURGERY	2	4	16	8
OPHTHALMOLOGE	2	2	23	26

*h-index: An author has a h-index of "h" when they have h papers that have been cited h times at least. g-index: Where the top "g" articles have together received "g" citations. TC: Total citations. NP: Number of publications

Supplementary Table 3: Top 20 locally cited references

Document	Title	DOI	Year	Local Citations
WU P, 2020, JAMA OPHTHALMOL	Characteristics of Ocular Findings of Patients With Coronavirus Disease 2019 (COVID-19) in Hubei Province, China	10.1001/jamaophthalmol.2020.1291	2020	100
SEAH IYJ, 2020, OPHTHALMOLOGY-a	Assessing Viral Shedding and Infectivity of Tears in Coronavirus Disease 2019 (COVID-19) Patients	10.1016/j.ophtha.2020.03.026	2020	74
LAI THT, 2020, GRAEF ARCH CLIN EXP	Stepping up infection control measures in ophthalmology during the novel coronavirus outbreak: an experience from Hong Kong	10.1007/s00417-020-04641-8	2020	66
SEAH I, 2020, OCUL IMMUNOL INFLAMM	Can the Coronavirus Disease 2019 (COVID-19) Affect the Eyes? A Review of Coronaviruses and Ocular Implications in Humans and Animals	10.1080/09273948.2020.1738501	2020	62
CHEN L, 2020, BRIT J OPHTHALMOL	Ocular manifestations of a hospitalised patient with confirmed 2019 novel coronavirus disease	10.1136/bjophthalmol-2020-316304	2020	45
ZHANG X, 2020, OCUL SURF	The evidence of SARS-CoV-2 infection on ocular surface	10.1016/j.jtos.2020.03.010	2020	34
LI JPO, 2020, BRIT J OPHTHALMOL	Novel Coronavirus disease 2019 (COVID-19): The importance of recognizing possible early ocular manifestation and using protective eyewear	10.1136/bjophthalmol-2020-315994	2020	34
LI JPO, 2020, OPHTHALMOLOGY	Preparedness among Ophthalmologists: During and Beyond the COVID-19 Pandemic	10.1016/j.ophtha.2020.03.037	2020	27
CHEEMA M, 2020, CAN J OPHTHALMOL	Keratoconjunctivitis as the initial medical presentation of the novel coronavirus disease 2019 (COVID-19)	10.1016/j.jcjo.2020.03.003	2020	27
ROMANO MR, 2020, CURR EYE RES	Facing COVID-19 in Ophthalmology Department	10.1080/02713683.2020.1752737	2020	23
KOROBELNIK JF, 2020, GRAEF ARCH CLIN EXP	Guidance for anti-VEGF intravitreal injections during the COVID-19 pandemic	10.1007/s00417-020-04703-x	2020	21
LIANG L, 2020, ACTA OPHTHALMOL	There may be virus in conjunctival secretion of patients with COVID-19	10.1111/aos.14413	2020	19
HONG N, 2020, ACTA OPHTHALMOL	Evaluation of ocular symptoms and tropism of SARS-CoV-2 in patients confirmed with COVID-19	10.1111/aos.14445	2020	18
CASAGRANDE M, 2020, OCUL IMMUNOL INFLAMM	Detection of SARS-CoV-2 in Human Retinal Biopsies of Deceased COVID-19 Patients	10.1080/09273948.2020.1770301	2020	18
CHEN LW, 2020, ACTA OPHTHALMOL	Ocular manifestations and clinical characteristics of 535 cases of COVID-19 in Wuhan, China: a cross-sectional study	10.1111/aos.14472	2020	16
SADHU S, 2020, OCUL IMMUNOL INFLAMM	COVID-19: Limiting the Risks for Eye Care Professionals	10.1080/09273948.2020.1755442	2020	15
DARUICH A, 2020, J FR OPHTHALMOL	Ocular manifestation as first sign of Coronavirus Disease 2019 (COVID-19): Interest of telemedicine during the pandemic context Présentation oculaire inaugurale du COVID-19 (Coronavirus Disease 2019): intérêt de la télé-médecine dans un contexte de pandémie	10.1016/j.jfo.2020.04.002	2020	14
MISHRA D, 2020, INDIAN J OPHTHALMOL	The impact of COVID-19 related lockdown on ophthalmology training programs in India – Outcomes of a survey	10.4103/ijo.IJO_1067_20	2020	14
SALEEM SM, 2020, AM J OPHTHALMOL	Virtual Ophthalmology: Telemedicine in a COVID-19 Era	10.1016/j.ajo.2020.04.029	2020	13
QING HL, 2020, ACTA OPHTHALMOL	The possibility of COVID-19 transmission from eye to nose	10.1111/aos.14412	2020	12

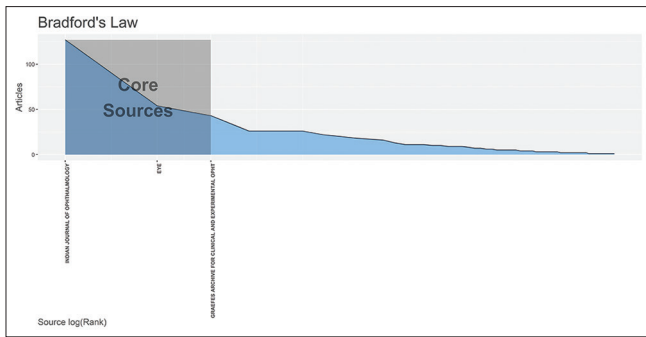
Supplementary Table 4: Author impact of top 20 authors

Author	h-index	g-index	TC	NP
LI KKW	4	10	144	10
AGRAWAL R	4	8	302	8
LAM DSC	4	8	121	8
HONAVAR SG	4	6	47	10
BANDELLO F	4	5	33	10
NAIR AG	3	5	35	7
ALI MJ	3	4	18	7
SHARMA N	3	3	21	16
SHETTY R	3	3	21	12
DAS S	3	3	15	6
GIANNACCARE G	3	3	15	6
KUMAR A	3	3	15	6
BORRELLI E	2	4	21	6
GUPTA V	2	4	19	6
KHAMAR P	2	3	12	6
SACHDEV MS	2	2	16	10
SINHA R	2	2	14	8
AGARWAL R	1	3	9	6
BAYYOUNG T	1	1	4	6
KAUR K	1	1	2	6

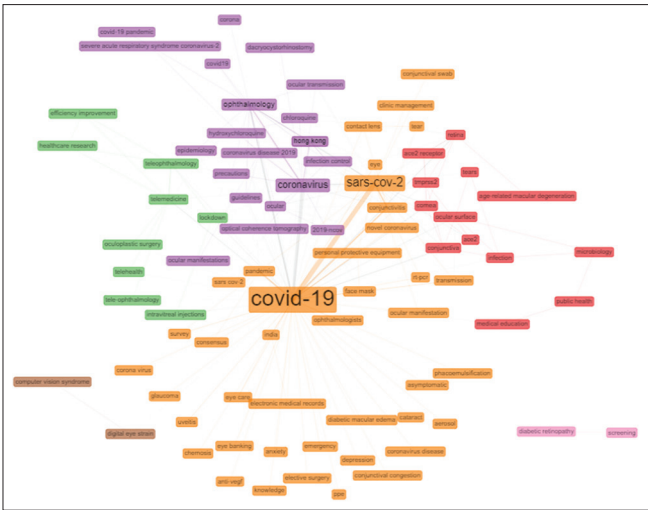
* h-index: An author has a h-index of "h" when they have h papers that have been cited h times at least. g-index: Where the top "g" articles have together received "g" citations. TC: Total citations. NP: Number of publications

Supplementary Table 5: Number of research items from an affiliation

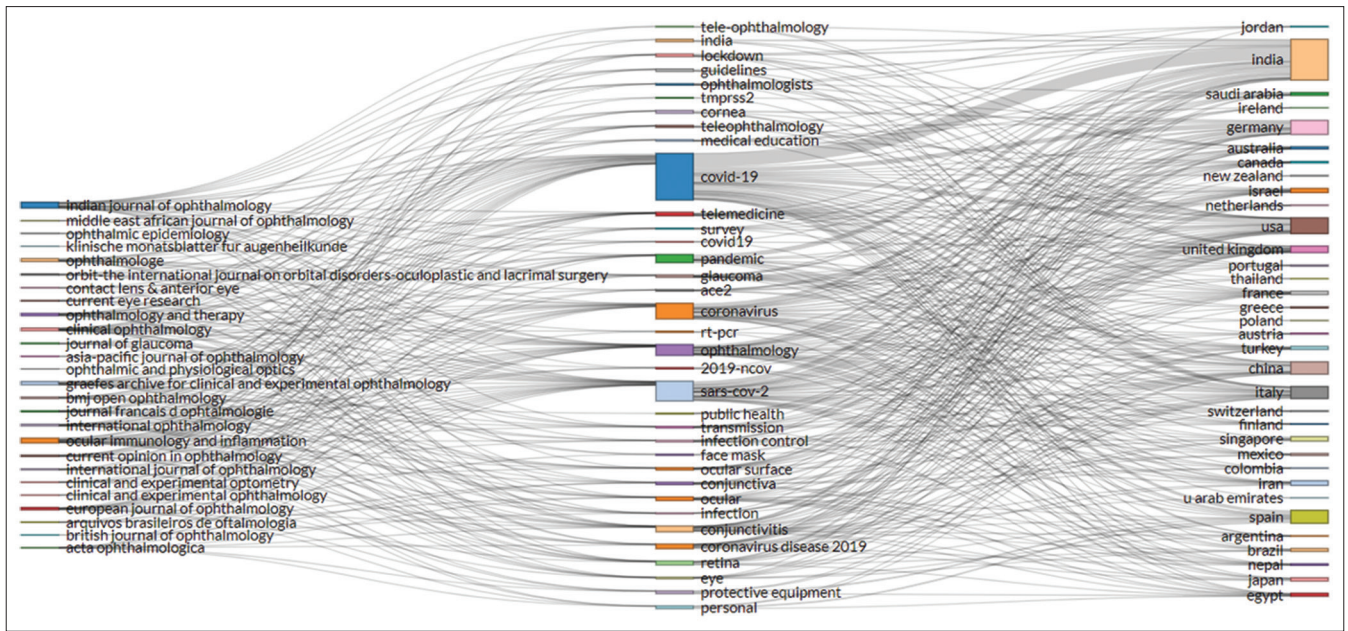
Affiliations	Articles
LV PRASAD EYE INST	52
ALL INDIA INST MED SCI	34
CTR SIGHT	25
UNITED CHRISTIAN HOSP	14
ANGLIA RUSKIN UNIV	13
ARAVIND EYE HOSP	13
HUAZHONG UNIV SCI AND TECHNOL	13
INDIANA UNIV SCH MED	13
MOORFIELDS EYE HOSP NHS FDN TRUST	13
CHINESE UNIV HONG KONG	12
STANFORD UNIV	12
ARAVIND EYE HOSP AND POST GRAD INST OPHTHALMOL	11
HARVARD MED SCH	11
MASHHAD UNIV MED SCI	11
MOORFIELDS EYE HOSP	11
UNIV CALIF SAN FRANCISCO	11
UNIV MIAMI	11
NOTREPORTED	10
UNIV SYDNEY	10
ADITYA JYOT EYE HOSP	9



Supplementary Figure 1: Bradford's law of scattering



Supplementary Figure 2: Co-occurrence based on author keywords



Supplementary Figure 3: Three field plot between Counties (left), Keywords (middle), and Sources (right) showing the country of origin of research pertaining to a particular keyword and the destination source for publication