Systematic Review and Meta-Analysis

Medicine

OPEN

Citation trends in ophthalmology articles and keywords in mainland China, Hong Kong, and Taiwan since 2013 using temporal bar graphs (TBGs)

Bibliometric analysis

Sheng-Yao Hsu, MD[a,b], Tsair-Wei Chien, MBA[c], Yu-Tsen Yeh, MS[d], Shu-Chun Kuo, MD[b,e,*]

Abstract

Background: We selected authors from mainland China, Hong Kong, and Taiwan (CHT) to examine citation trends on articles and keywords. The existence of suitable temporal bar graphs (TBGs) for displaying citation trends is unknown. It is necessary to enhance the traditional TBGs to provide readers with more information about the citation trend. The purpose of this study was to propose an advanced TBG that can be applied to understand the most worth-reading articles by ophthalmology authors in the CHT.

Methods: Using the search engine of the Web of Science core collection, we conducted bibliometric analyses to examine the article citation trends of ophthalmology authors in CHT since 2013. A total of 6695 metadata was collected from articles and review articles. Using radar plots, the Y-index, and the combining the Y-index with the CJAL scores (CJAL) scores, we could determine the dominance of publications by year, region, institute, journal, department, and author. A choropleth map, a dot plot, and a 4-quadrant radar plot were used to visualize the results. A TBG was designed and provided for readers to display citation trends on articles and keywords.

Results: We found that the majority of publications were published in 2017 (2275), Shanghai city (935), Sun Yat-Sen University (China) (689), the international journal *Ophthalmology* (1399), the Department of Ophthalmology (3035), and the author Peizeng Yang (Chongqing) (65); the highest CAJL scores were also from Guangdong (2767.22), Sun Yat-Sen University (China) (2147.35), and the Ophthalmology Department (7130.96); the author Peizeng Yang (Chongqing) (170.16) had the highest CAJL; and the enhanced TBG features maximum counts and recent growth trends that are not included in traditional TBGs.

Conclusion: Using the Y-index and the CJAL score compared with research achievements of ophthalmology authors in CHT, a 4-quadrant radar plot was provided. The enhanced TBGs and the CJAL scores are recommended for future bibliographical studies.

Abbreviations: AI = artificial intelligence, CHT = mainland China, Hong Kong, or Taiwan, CJAL = combining the Y-index with the CJAL scores, DR = diabetic retinopathy, FP = publications of first author, IRA = individual research achievement, JIF = journal impact factor, RP = publications of corresponding author, SCI = Scientific Citation Index, SSCI = Social Sciences Citation Index, TBG = temporal bar graph.

Keywords: bootstrapping, CJAL score, ophthalmology author, radar plot, research achievement, temporal bar graph (TBG), Web of Science (WoS), Y-index

1. Introduction

Few bibliometric studies have been conducted in the field of ophthalmology in recent years.[1–3] The h-index is widely used in the scientific community around the world[4] in bibliometrics. Although the h-index has been widely used as an indicator of individual research achievement (IRA),[5] 2 major disadvantages have been noted, including all coauthors contributing equally

This study was supported by a grant from An Nan Hospital, China Medical University, Tainan, Taiwan (ANHRF105-07).

The authors have no conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are publicly available. All data used in this study are available at the link.[45]

[a] Department of Ophthalmology, An Nan Hospital, China Medical University, Tainan, Taiwan, [b] Department of Optometry, Chung Hwa University of Medical Technology, Tainan, Taiwan, [c] Medical Research Department, Chi-Mei Medical Center, Tainan, Taiwan, [d] Medical School, St. George's, University of London, UK, [e] Department of Ophthalmology, Chi-Mei Medical Center, Yong Kang, Tainan City, Taiwan.

** Correspondence: Shu-Chun Kuo, Chi-Mei Medical Center, 901 Chung Hwa Road, Yung Kung Dist., Tainan 710, Taiwan (e-mail: ophkuo@gmail.com).*

How to cite this article: Hsu S-Y, Chien T-W, Yeh Y-T, Kuo S-C. Citation trends in ophthalmology articles and keywords in mainland China, Hong Kong, and Taiwan since 2013 using temporal bar graphs (TBGs): Bibliometric analysis. Medicine 2022;101:52(e32392).

Received: 20 October 2022 / Received in final form: 1 December 2022 / Accepted: 2 December 2022

http://dx.doi.org/10.1097/MD.0000000000032392

Key points:

- A discussion was held regarding the importance of temporal bar graphs designed in this study.
- Since no appropriate visualizations were used to measure their research achievements (RAs) in mainland China, Hong Kong, and Taiwan, their RAs are rare in the literature, particularly using enhanced temporal bar graphs.
- Combining the Y-index with the CJAL scores on a radar plot is an innovative, modern method for comparing RAs between countries, regions, institutes, departments, and authors that have not yet been demonstrated in the literature.

to article bylines,[6–8] and the integer nature of the h-index making it difficult to identify IRAs among entities.[9] IRAs must be measured using the fair author-weighted scheme[6,7,10] (i.e., taking author contributions into account) and modified indicators (e.g., x-index[11] and Y-index[12,13]).

1.1. The Y-index and the combining the Y-index with the CJAL scores (CJAL) score used to measure IRAs

The Y-index[12,13] was proposed for evaluating IRAs using the number of publications in the positions of corresponding and first (co-first) authors (denoted by RP and FP, respectively, with equal credits in article byline). However, previous studies[12,13] have not illustrated how to draw the radar diagram,[14,15] particularly based on both quantity[12,13] and article quality (e.g., CJA score based on article quality, article category, journal quality, and author order[16]). IRAs should not be measured solely on the basis of publications (e.g., the Y-index = RP + FP as the radius shown in the first quadrant).[12,13] To complement the Y-index, the CJA score[16] was applied to examine the minimum requirements for faculty appointment and promotion in Taiwan medical schools.[16] The drawback of the CJA score is that no such article citations are included. Therefore, we intended to plot the Y-index[12,13] together with the CJAL score[15] combined with a 4-quadrant radar plot and the L-index,[17] and compare IRAs in visualizations for authors, institutes, and regions. Thus far, no such developments, but the one,[15] involving much information in a view, have been applied to bibliometrics.

1.2. Improved temporal bar graph (TBG) required in bibliometrics

A trend analysis of article citations is also commonly used in bibliographic studies to describe the development of topical entities over time.[18,19] Thus, a good bibliographic study provides a chronological view of the field (e.g., how the number of studies has evolved, how the topic has evolved, and how the outlet has changed). A TBG,[17,20–22] for interpreting the evolution of article entities, is one method of interpreting the influence of the most influential entities.

TBG plays an important role in any bibliographic study and should not be stopped at this point. Instead, TBG can be used as a starting point to explore bibliographic data using bibliometric methods, such as predicting citations in future articles. Therefore, a bibliographic study should use more sophisticated, multivariate statistical analyses (e.g., cocitation analysis) to derive results instead of simple article and citation counts in tables, as in those 100 top-cited studies[23–26] or the one[27] with 15 tables and 27 figures in an article. An example of an article that follows this approach is those[28–33] that identify a relevant and interesting "story" supported by their bibliographic data and bibliometric analysis on trend analysis.

TBG[17,19–21,34] traditionally has several limitations that should be addressed, including the lack of information about trend stages (e.g., increasing, ready to rise, decreasing, and slowdown). Due to this, the burst spot and burst strength alone are not sufficient (i.e., performing only the TBG tool of Sci2[35] or keywords only in CiteSpace[36]). Therefore, the improved TBG is proposed for this study. This study differs from a previous study[15] in demonstrating the improved application of TBG to bibliometrics.

1.3. Ophthalmology in mainland China, Hong Kong, and Taiwan

The field of ophthalmology has experienced rapid advancements in artificial intelligence (AI).[37,38] For example, fundus images have become a research hotspot due to their ease of acquisition and rich biological information.[39] AI research in health care, specifically machine learning and deep learning, has definite clinical relevance in ophthalmology.[40,41] The yearly growth of AI in ophthalmology publications has been 18.89% over the last 10 years,[42] indicating that AI in ophthalmology is a very attractive topic in science. Studies on AI have been conducted in the clinical screening, diagnosis, and prognosis of eye diseases, and the research results have gradually been applied to clinical practice, supported by evidence from publications and contributions from ophthalmology authors. The TBG should be used to examine the trend of AI keywords in ophthalmology.

The results of a survey on the attitudes of medical workers in China toward AI in ophthalmology indicated that medical workers had a higher understanding level of AI in ophthalmology than other professional technicians, making it necessary to promote training in ophthalmic AI, among other professional technicians.[43] Many medical workers did not have experience in the use of AI in ophthalmology, but the general acceptance of AI in ophthalmology was relatively high. Emerging AI articles in the field of ophthalmology need to be verified.

A number of academic publications on the rise in China have prompted the comparison of the results of over 40 studies conducted in mainland China, Hong Kong, and Taiwan (CHT).[43] The IRAs of ophthalmology authors in CHT should be compared rather than publications alone, as was done in previous studies.[44] The research funding opportunities and grants are very different in CHT. The IRAs would be distinctly disparate, and verification is needed.

1.4. Study aims

We proposed 2 hypotheses: the CJAL scores of ophthalmology authors differ based on regions in CHT, and the trend of AI keywords and the worth-reading articles in ophthalmology can be displayed using the TBG. Through the use of visualizations, this study aimed to verify the hypotheses.

2. Methods

2.1. Data sources

Searching the Web of Science (WoS) core collection for terms such as ([CU = China OR CU = Taiwan OR CU = Hong Kong] AND SG = Ophthalmology AND PY>=2013), we excluded letter articles, editorials, and comments. On October 2, 2022, a total of 6695 results were obtained in terms of one of the first and corresponding authors from the CHT. The study data are included at the link.[45]

As this study did not involve examination or treatment of patients or review of patient records, it was exempt from review and approval by our research ethics committee.

2.2. Four approaches used in this study

2.2.1. Enhanced TBG is required. CiteSpace (College of Computing and Informatics, Drexel University) [36] is commonly used for keyword citations using TBG. The disadvantage of this approach is that readers are provided with less information regarding maximum counts and growth trends on the TBG. Figure 1 shows the comparison of the 2 TBGs (i.e., TBG produced in CiteSpace,[46] and made in this study). The bubble sizes can provide information regarding the burst strength,[22] growth trends (e.g., increasing, ready to rise, decreasing, and slowdown[47]) and maximum counts that should also be displayed on the TBG, as shown in Figure 1.

2.2.2. Research achievements in comparison using radar plots. The most productive entities, including regions/areas, institutes, departments, and authors, were highlighted using a 4-quadrant radar plot.[15] Additionally, the counts and mean citations of journals, publication years, WoS categories, and research areas are also displayed on a radar plot.

IRAs cannot be measured solely on publications (e.g., the Y-index = RP + FP[12,13]). The CJA score[16] (i.e., taking into account article quality) is also insufficient due to the lack of article citations involved in IRAs. The CJAL score[15] was applied to this study via equations 1 to 3.

$$CJA\ score = \sum_{i=1}^{n} C_i \times J_i \times A_i, \tag{1}$$

$$CJAL\ score = \sum_{i=1}^{n} C_i \times J_i \times A_i \times L - index_i, \tag{2}$$

$$\mathrm{L-index} = \mathrm{round}\left(\log\left(\frac{Citation}{A_n \times Age} + 1\right), 0\right), >= 1. \tag{3}$$

Four factors are considered in the CJAL score for a published article: the category (C; e.g., review, original article, case report, etc.); the journal "quality" (J; e.g., journal impact factor (JIF), or ranking of the journal); the authorship order denoted by A); and the L-index.[16] The CJAL score is calculated by multiplying each of these 3 aspects. CJAL scores original research articles higher than other types of manuscripts; co-first authors (denoted RP and FP to compute the Y-index RP + FP[12,13]) score higher than other collaborators; for the journal's quality assessment, they use the JIF or Scientific Citation Index (SCI)/Social Sciences Citation Index (SSCI) journal rankings for SCI/SSCI-indexed papers.[16] SCI/SSCI journal rankings are based on JIF in each research domain; therefore, domain-specific journal rankings are usually not significantly different from those based on JIF.[15,16]

The choropleth map[48] was applied to present the CJAL scores in CHT. The term "choropleth map" was coined by John Kirtland Wright in 1938.[49] The most famous example of choropleth map used was the results of the 2000 US presidential election.[50] Other examples include showing the disparities in health outcomes across areas related to dengue outbreaks,[51,52] disease hotspots,[53] and the Global Health Observatory maps on major health topics.[54]

2.2.3. Citation trends of keywords and articles in ophthalmology. Citation trends of keywords and articles were displayed on the enhanced TBGs. The trend of AI keywords and the worth-reading articles in ophthalmology were displayed using TBG.

Keywords were extracted from the coword analysis[55–57] using Pajek.[58] The chief keywords are representative in its clusters. The top 5 keywords in the top 10 clusters and the AI keyword were displayed on TBG.

Similarly, the top-cited articles with at least 100 citations were selected to compute their growth trend (denoted by the correlation coefficient between citation counts and a series

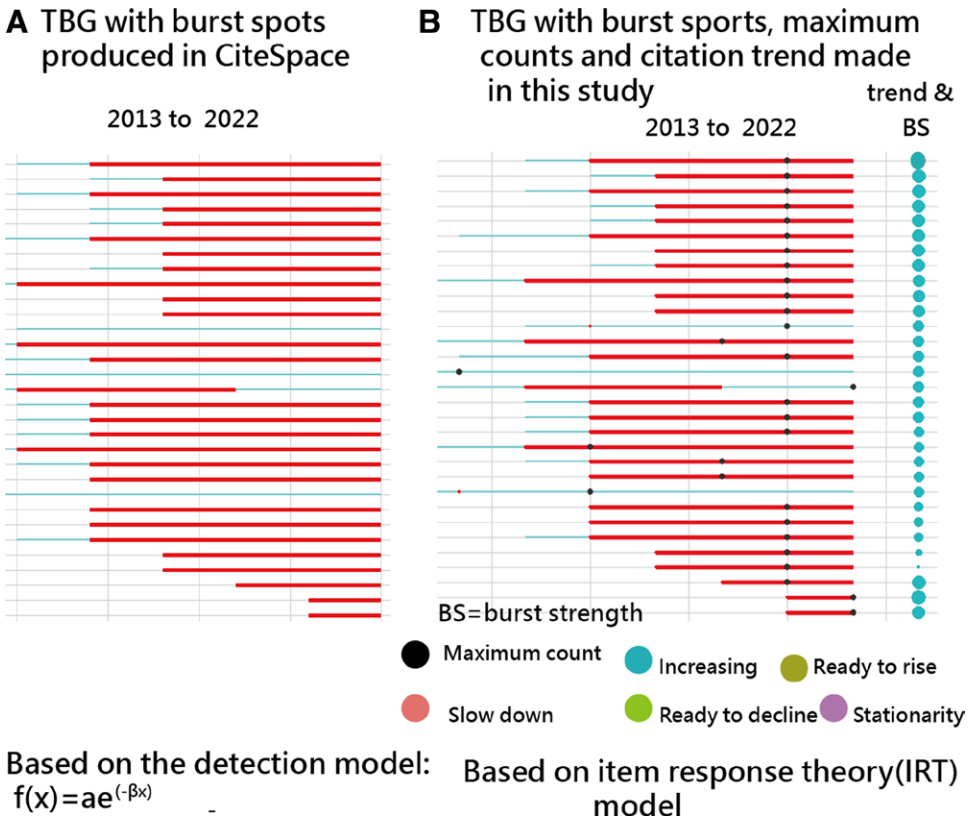

Figure 1. Comparison of 2 TBGs in traditional and newly designed modes. TBGs = temporal bar graphs.

of numbers from 1–4). Only the increasing growth type was demonstrated on TBG. The growth types refer to previous studies.[15,45,59]

2.2.4. The most worth-reading articles shown on the dot plot. The most worthy-reading articles were displayed on a dot plot (namely, the impact beam plot[60]). The method for drawing the dot plot is deposited at the link.[45]

2.3. Creating dashboards on Google Maps

All figures were drawn by author-made modules in Excel (Microsoft Corp). We created pages of HTML used for Google Maps. All relevant CJAL scores and Y-indices for each member can be linked to dashboards on Google Maps. The TBG can be zoomed in and out with a link to the website. The method of how to draw the TBG in R is deposited with a PDF file and an MP4 video at the link.[45]

3. Results

3.1. Research achievements in comparison using radar plots

The geographical distribution of CJAL scores in regions is shown on the choropleth map in Figure 2. The top 3 (i.e., Guangdong, Shanghai, and Beijing) are linked by lines. The darker colors (e.g., the other 2 of Zhejiang and Taiwan) indicate higher CJAL scores in comparison to other regions with a lighter color in Figure 2.

In Figure 3, we can see that the majority of publications were published in Shanghai city (935), Sun Yat-Sen University (China) (689), Department of Ophthalmology (3035), and the author of Peizeng Yang (Chongqing) (65), with the Y-index on coordinates in the 4-quadrant radar plot.

The highest CAJL scores were also from Guangdong (2767.22), Sun Yat-Sen University (China) (2147.35), and Ophthalmology Department (7130.96); the author Peizeng Yang (Chongqing) (170.16) had the highest CAJL.

The majority of publications were published in the journal of *Int. J. Ophthalmol.* (1399), 2017 (2275), *Ophthalmology* (6619) in the WoS category and in the research area (6548), with the counts in Figure 4. In contrast, the highest mean citations were published in the journal *Sci* (17.13), 2020 (21.88), *Surgery* (18.69) in the WoS category and neurosciences & neurology in the research area (20.50), as shown in Figure 4.

3.2. Citation trends of keywords and articles in ophthalmology

The top 10 clusters are separated using coword analysis and are shown in the top panel of Figure 5. The chief keywords with the highest centrality degree (denoted by the weighted counts) are representative in each cluster. The keyword artificial intelligence is located in cluster 1 (as labeled by prevalence in the green circle). The top 5 keywords in each cluster were extracted and are shown in the bottom panel of Figure 5. They are combined with the AI keyword to display the citation trends on the TBG in Figure 6.

The AI keyword is displayed at the bottom of Figure 6, with citations of (0, 0, 1, 0, 2, 0, 1, 1, 1, 3, 1) since 2013. There is a maximum count (=3) with a black dot in 2021. A burst spot with a red dot appears in 2021 and 2022 as a result of the next counts being not smaller than the count at the burst spot. In this

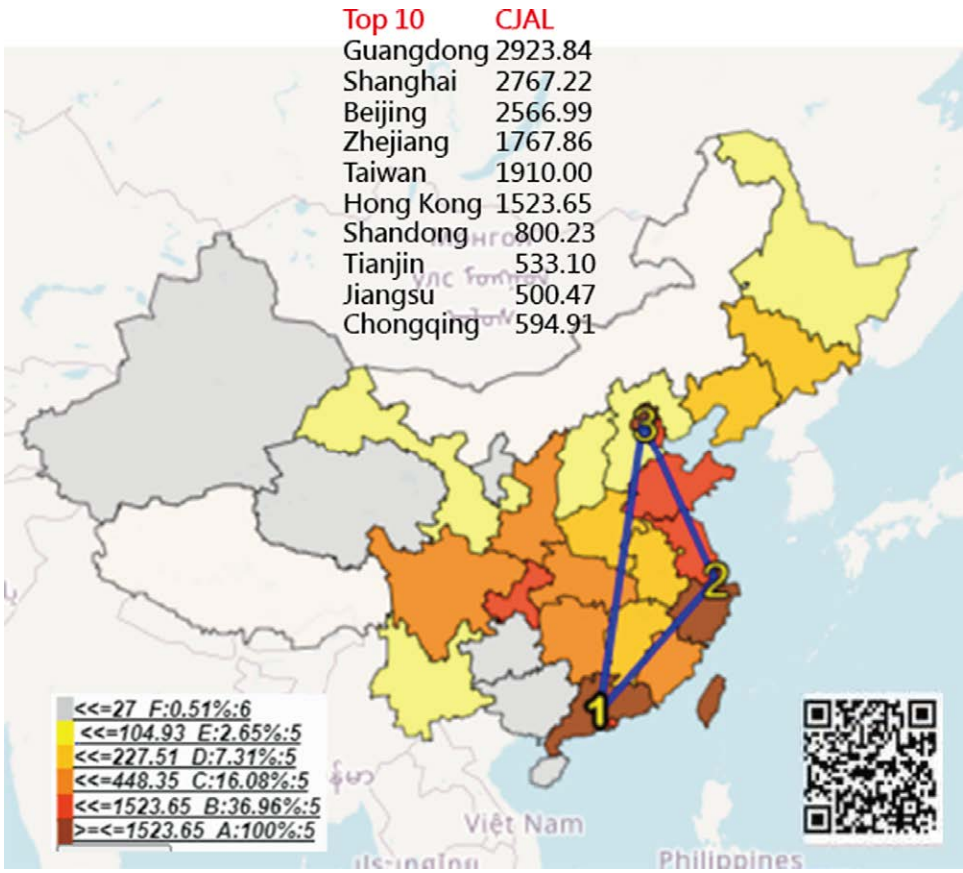

Figure 2. Geographical distribution of CJAL scores in regions (the top 3 are linked by lines, and darker colors indicate higher CJAL scores). CJAL = combining the Y-index with the CJAL scores.

Figure 3. The radar plot is used to display the Y-index and CJAL scores for the top 10 elements in each entity in the CHT. CHT = mainland China, Hong Kong, or Taiwan, CJAL = combining the Y-index with the CJAL scores.

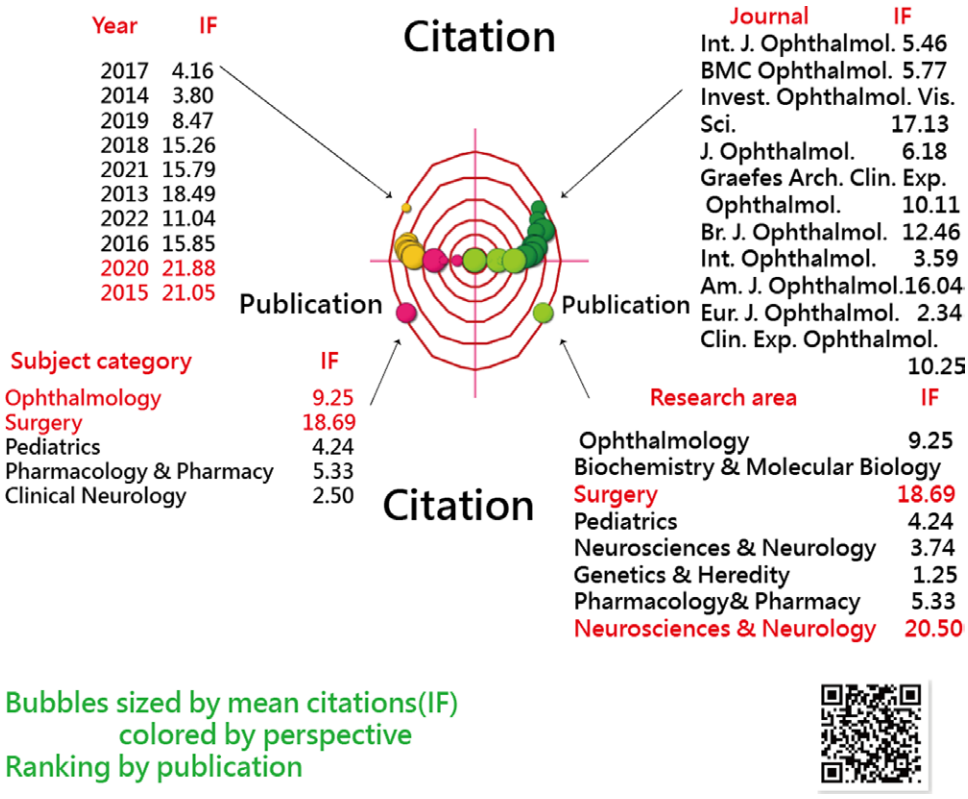

Figure 4. The radar plot is used to display the counts and mean citations for the top 10 elements in each entity in the CHT. CHT = mainland China, Hong Kong, or Taiwan.

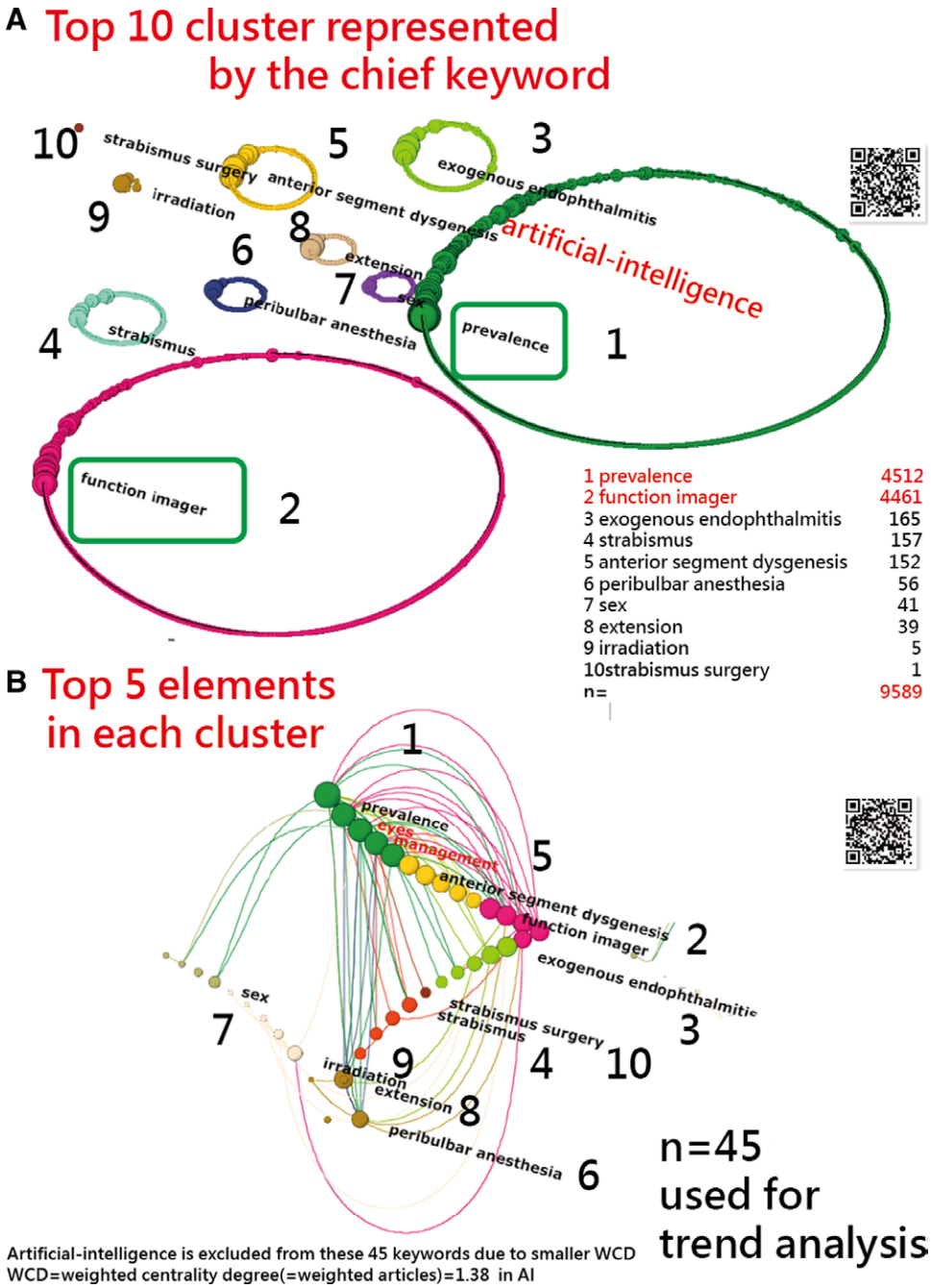

Figure 5. Coword analysis of keywords Plus in WoS and 10 clusters found in this study. WoS = Web of Science.

case, the red bar would extend to the right from the beginning of the burst. There is a green circle for the AI keyword at the extreme right of the TBG, indicating that the growth type is ready to decline (=–0.16 = correlation coefficient against series of numbers from 1–4 since 2019). A light green bubble indicates the burst strength (=1.18), as shown on the bottom-right corner of Figure 6.

In Figure 6, there are 3 keywords with a burst near 2022, including anterior segment dysgenesis, strabismus, and artificial-intelligence, although their trends belong to other types (i.e., ready to decline, slow down, and ready to decline, respectively). The reason may be that the citations were collected until October of 2022, instead of December.

Figure 7 illustrates 3 worth-reading articles that were selected from 86 articles with citations >100 based on the following 3 criteria: an increasing trend over the last 4 years (denoted by type 1 at the utmost right side of the TBG); a higher burst strength (e.g., >0.20); and a maximum count or burst spot near the recent years (e.g., 2022 or 2021 in this study). Three worth-reading articles[60–62] were selected and are shown with light-green circles labeled on the right-hand side in Figure 7.

3.3. The most worth-reading articles shown on the dot plot

According to the dot plot in Figure 8, articles with an increasing citation trend are displayed on the impact beam map (IBP).[59] The 3 papers with the highest citation counts are located on the right side of Figure 8, while the 3 papers[61–63] with the most noteworthy features can be found at the bottom of Figure 8. Readers are invited to scan the QR code in Figure 8 and click on the dot of interest to be directed to the PubMed article.

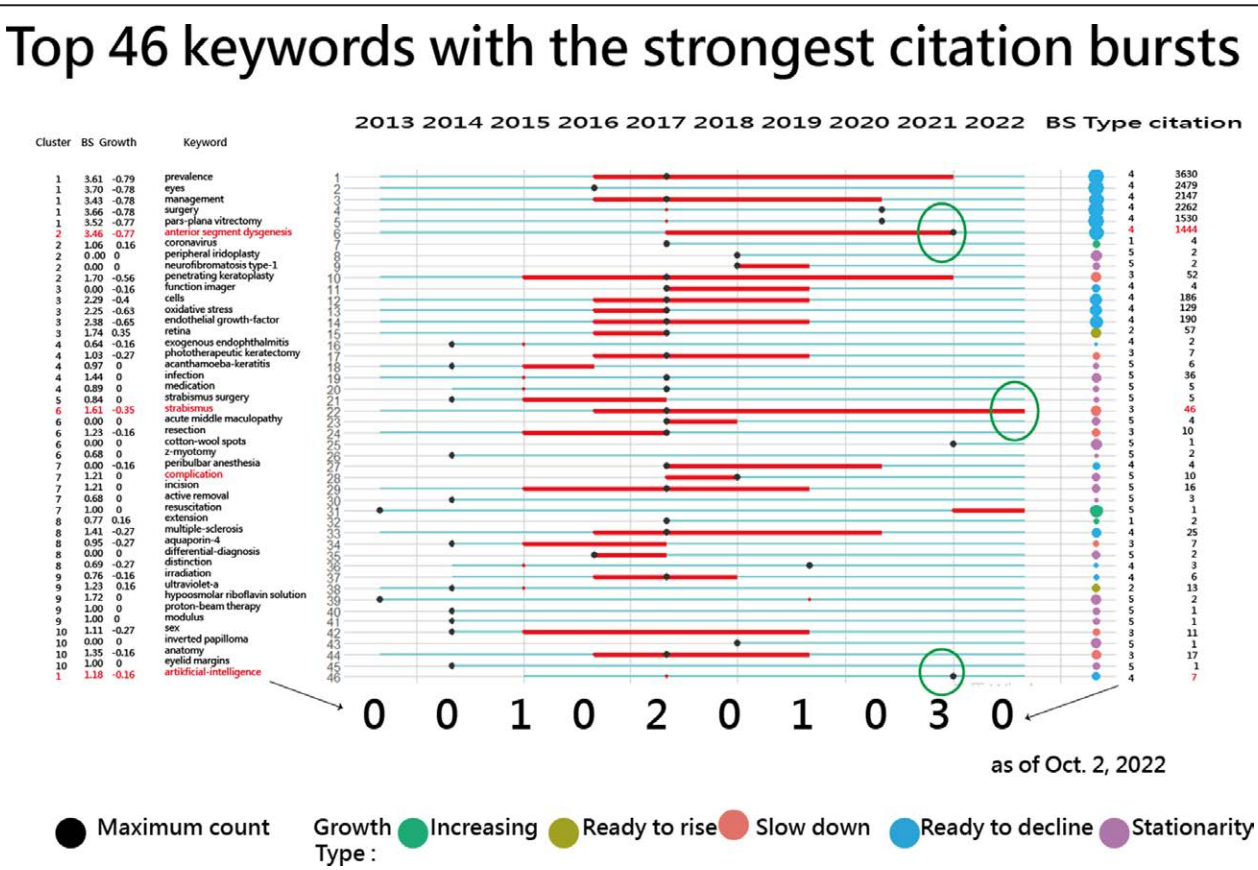

Figure 6. Citation trends of keywords shown on the enhanced TBG we developed in this study. TBG = temporal bar graph.

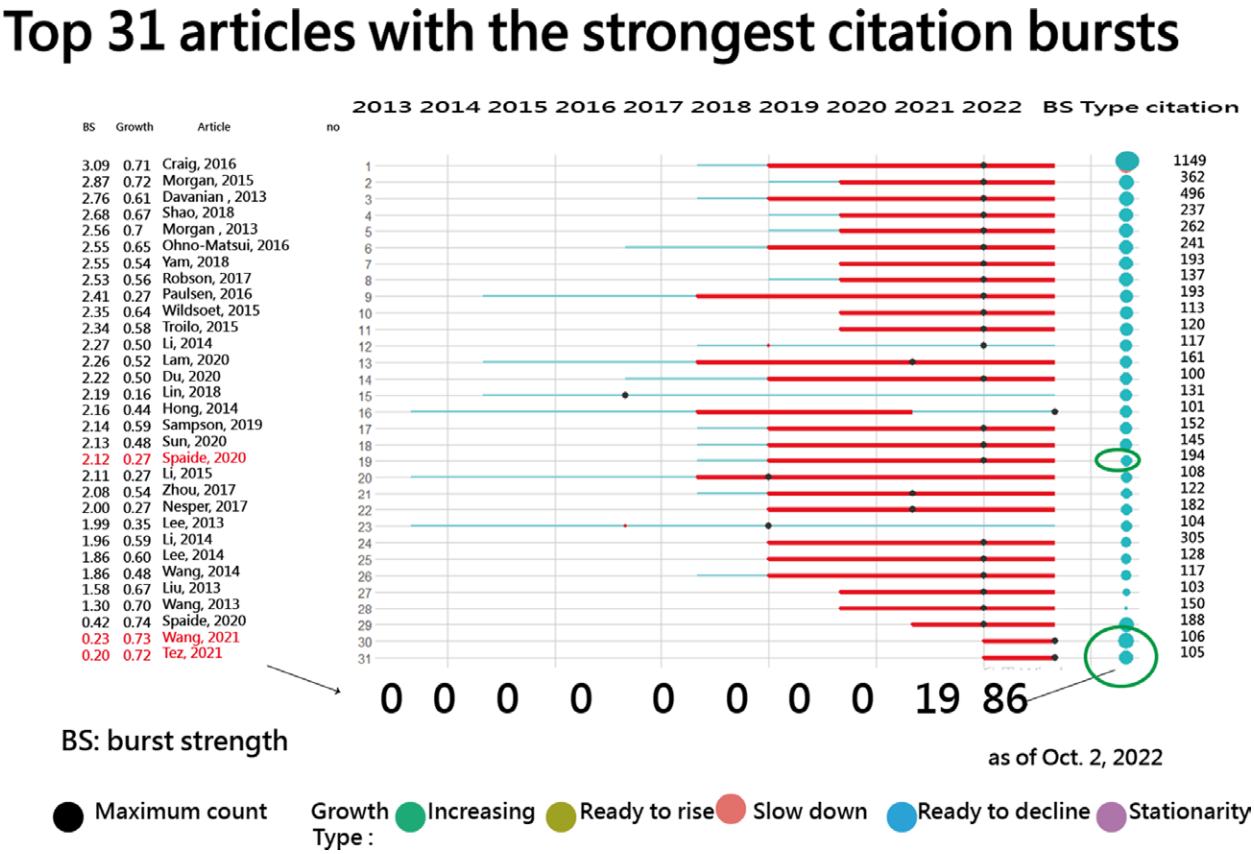

Figure 7. Citation trends of articles with the noteworthy feature shown on the enhanced TBG we developed in this study. TBG = temporal bar graph.

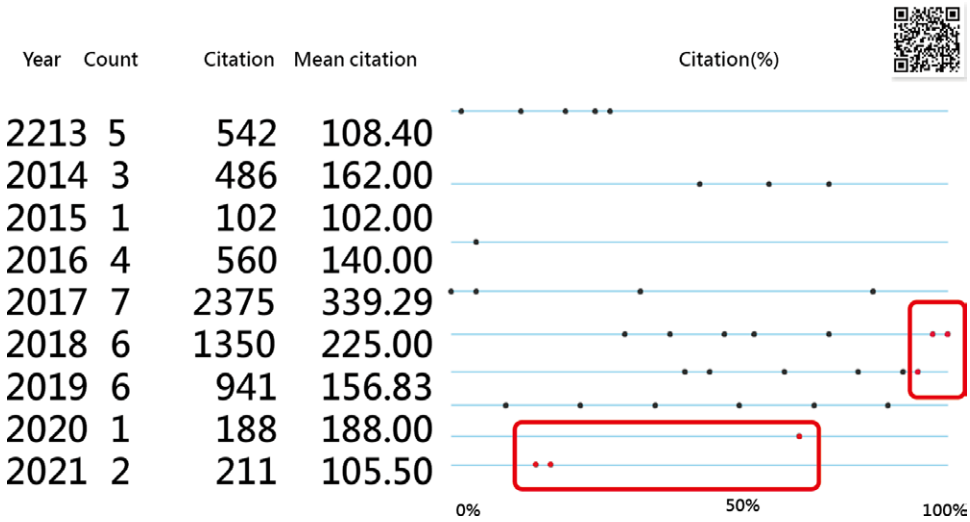

Figure 8. A total of 35 articles with noteworthy features shown on the dot plot we developed in this study.

3.4. Online dashboards shown on Google Maps

All the QR codes in figures[64–67] are linked to the dashboards. Readers are suggested to examine the displayed dashboards on Google Maps.

4. Discussion

We found that the majority of publications were published in 2017 (2275), Shanghai city (935), Sun Yat-Sen University (China) (689), the international journal *Ophthalmology* (1399), the Department of Ophthalmology (3035), and the author Peizeng Yang (Chongqing) (65); the highest CAJL scores were also from Guangdong (2767.22), Sun Yat-Sen University (China) (2147.35), and Ophthalmology Department (7130.96); the author Peizeng Yang (Chongqing) (170.16) had the highest CAJL; and the enhanced TBG featured maximum counts and recent growth trends that were not included in traditional TBGs.

4.1. Additional information

In this study, the number of publications published by ophthalmology authors has a slowdown trend over time (see the bottom of Fig. 7), based on the CHT only.

It is possible to explore many aspects of research in bibliometrics, including citation analysis, theme exploration, topic analysis, reference citations, research, research achievement, author collaboration, and trends and hot spots in terms and articles.[18,47,68–71] This study examined only research achievement (Figs. 2–4) and citation trends (Figs. 6 and 7). There were 3 features that were illustrated in this study: the 4-quadrant radar plot allows condensing the information of bibliographic data (e.g., authors, journals, countries, and institutes) with a glance rather than having many tables and graphs as in many traditional bibliographical studies[15,27] (e.g., the one[27] with 15 tables and 27 figures in an article); Y-index and CJAL scores are successfully combined on a radar plot (e.g., Figs. 3 and 4); and the enhanced TBG was applied to citation trends of keywords and articles (Figs. 6 and 7), distinctly different from the TBG solely applied to keywords in Citespace.[37] As such, the first hypothesis that institute CJA scores differ based on regions in CHT has been confirmed.

The field of ophthalmology has experienced rapid advancements in AI.[37,38] For example, fundus images have become a research hotspot due to their ease of acquisition and rich biological information.[39] AI research in health care, specifically machine learning and deep learning, has definite clinical relevance in ophthalmology.[40,41] The yearly growth of AI in ophthalmology publications has been 18.89% over the last 10 years[43] and was verified over the last 4 years in this study (at the bottom of Fig. 6). The second hypothesis has also been confirmed: AI is emerging in ophthalmology, particularly in mainland China.

The third hypothesis that the worth-reading articles in ophthalmology can be displayed on the TBG has been confirmed and shown in the next section.

4.2. Three worth-reading articles with a higher growth rate of citations in recent years

A study written by Spaide et al and published in 2020 was the most noteworthy article.[61] The article is entitled, "Consensus Nomenclature for Reporting Neovascular Age-Related Macular Degeneration Data: Consensus on Neovascular Age-Related Macular Degeneration Nomenclature Study Group." The framework for a consensus nomenclature system was developed, and the study group suggests that it should be used in future reported studies of neovascular age-related macular degeneration.

The second article[62] entitled, "Progression of Myopia in School-Aged Children After COVID-19 Home Confinement" was authored by Wang et al and published in 2021. The prevalence of myopia was calculated for each age group and compared between 2020 and the previous 5 years. In 2020, there was a substantial myopic shift in younger children aged 6 to 8 years compared with previous years, but the prevalence of myopia was higher than in previous years for children aged 9 to 13 years. Home confinement during the COVID-19 pandemic appeared to be associated with a significant myopic shift for children aged 6 to 8 years. However, numerous limitations warrant caution in the interpretation of these associations.

The third article[63] entitled, "Global Prevalence of Diabetic Retinopathy and Projection of Burden through 2045: Systematic Review and Meta-Analysis" was authored by Teo et al and published in 2021 as well. The authors conducted a systematic review and meta-analysis of population-based studies on diabetic retinopathy (DR), vision-threatening DR, and clinically significant macular edema to estimate global and regional prevalence and burden. The number of adults worldwide with DR, vision-threatening DR, and clinically significant macular edema is projected to increase by 2045. Diabetic retinopathy prevalence is highest in Africa and North America.

4.3. Implications and changes

The study has several distinctive features. First, the enhanced TBG was developed and demonstrated, particularly for any time-series data. Thus, the easy-use TBG can be drawn in

Rstudio (Boston, MA URL http://www.rstudio.com/) as shown (see Document of how to conduct this study at the link[45]).

Second, numerous bibliographical studies used visualizations to explore only 1 aspect of research (e.g., citation analysis, theme exploration, topic analysis, reference citations, research, research achievement, author collaboration; and trend and hot spot in terms and articles[18,47,68–71]). It was not found that such research was conducted in visual displays to verify their hypotheses so that research could focus on a specific area rather than providing many tables and graphs (e.g., the one[27] with 15 tables and 27 figures in an article) to explore the knowledge of interest and noninterest to readers.

Third, combining the Y-index and CJAL scores on a radar plot is an innovative, modern method for comparing IRAs between countries, regions, institutes, departments, authors, publication years, journals, WoS categories, and research areas that have not yet been demonstrated in the literature and deserve to be incorporated into future bibliometric analyses.

Fourth, 4 visual representations are included in the study, including a choropleth map based on CJAL scores, a 4-quadrant radar plot to identify IRA comparisons among entities, a network diagram illustrating the results of coword analysis, and a dot plot to display all articles of interest in a single plot, rather than listing them individually.

Moreover, it would be beneficial if journals (or WoS) provided the practical application of articles worthy of reading on their website in place of the traditional highlighted articles with the highest number of downloads or reads for readers. Several previous studies[15,47,58] have demonstrated how to calculate hotspots, growth types, and inflection points based on sequential time-series data in recent years. In addition to providing highly cited articles, journals (or WoS) can also test and implement algorithms (MSExcel module at the link,[45] which include the code produced in R for drawing the TBG) that assist readers in selecting high-impact articles worth reading, rather than simply providing highly cited articles published many years ago.

4.4. Limitations and suggestions

There are a number of issues that need to be addressed in detail in further research. As a first concern, only articles pertaining to the research area of ophthalmology in CHT are included. It is recommended that future studies include a wider range of articles based on co-first authors in ophthalmology using the CJAL score.

The second point is that although the Y-index[12,13] and the CJAL score[15] have been considered to be fair measures of IRA contributions, it is assumed that the co-first authors contribute equally to the articles. If authorship does not follow the rule as designed using the author-weighted scheme,[6,7,10] the results regarding the authors who contributed the most to articles will be biased.

Third, it takes some time to calculate the CJAL score. The advancement in hardware has made this task trivial, similar to computing other bibliometric metrics (e.g., h-/x-index[5,11]) with a dedicated software program, equally easy and quick.

Fourth, it was proposed in this study to use the CJAL score, including article citations, as is standard in bibliometrics; however, the IRA is determined by many other factors (e.g., when multiplying items in the CJAL[15]), which need to be taken into account other possible factors (e.g., grant funding) in the future.

Fifth, according to Figure 2, only regions with higher CJAL scores are compared. Readers may also be interested in the list of regions with the Y-index[12,13] shown on the radar plot. Using the radar plot to display the productive regions should be involved in a future study (see how to draw the radar plot at the link[45]).

Sixth, it is possible that there are some biases because there are some different authors with the same name or abbreviation who are affiliated with different institutions. Authors are limited to a region in order to prevent identical names across regions, but the results of IRA comparison would be influenced by authors with the same name or abbreviation in the same region.

Finally, although the enhanced TBG is considered useful and applicable, some basic R expertise is required to draw them effectively in R.

5. Conclusion

We compared IRAs in article entities using a radar plot, the Y-index, and the CJAL score. The results of this study confirm the hypothesis that AI is emerging in ophthalmology, and the trend of keywords and the articles that are worth reading in ophthalmology can be displayed on the TBG. This study employed 4 novel visualization techniques. For future bibliographical studies, enhanced TBG and CJAL scores are recommended.

Acknowledgment

We are grateful for the grant provided by An Nan Hospital, China Medical University, Tainan, Taiwan (ANHRF105-07) that enabled us to complete this study.

Author contributions

S-YH and Y-TY developed the study concept and design. TWC, Y-TY and S-CK analyzed and interpreted the data. S-CK monitored the process of this study and helped in responding to the reviewers' advice and comments. T-WC drafted the manuscript, and all authors provided critical revisions for important intellectual content. The study was supervised by SC.
Investigation: Shu-Chun Kuo.
Methodology: Tsair-Wei Chien.

References

[1] Mimouni M, Zayit-Soudry S, Segal O, et al. Trends in authorship of articles in major ophthalmology journals by gender, 2002-2014. Ophthalmology. 2016;123:1824–8.
[2] Pekel E, Pekel G. Publication trends in corneal transplantation: a bibliometric analysis. BMC Ophthalmol. 2016;16:194.
[3] Zhao F, Shi B, Liu R, et al. Theme trends and knowledge structure on choroidal neovascularization: a quantitative and coword analysis. BMC Ophthalmol. 2018;18:86.
[4] Nowak JK, Lubarski K, Kowalik LM, et al. H-index in medicine is driven by original research. Croat Med J. 2018;59:25–32.
[5] Hirsch JE. An index to quantify an individual's scientific research output. Proc Natl Acad Sci USA. 2005;102:16569–72.
[6] Vavryčuk V. Fair ranking of researchers and research teams. PLoS One. 2018;13:e0195509.
[7] Sekercioglu CH. Quantifying coauthor contributions. Science. 2008;322:371371.–371.
[8] Chien TW, Wang HY, Lai FJ. Applying an author-weighted scheme to identify the most influential countries in research achievements on skin cancer: observational study. JMIR Dermatology. 2019;2:e11015.
[9] Huang MH, Chi PS. A comparative analysis of the application of h-index, g-index, and a-index in institutional-level research evaluation. J Lib Inf Stud. 2010;8:1–10.
[10] Kan WC, Chou W, Chien TW, et al. The most-cited authors who published papers in JMIR mHealth and uHealth using the authorship-weighted scheme: bibliometric analysis. JMIR Mhealth Uhealth. 2020;8:e11567.
[11] Fenner T, Harris M, Levene M, et al. A novel bibliometric index with a simple geometric interpretation. PLoS One. 2018;13:e0200098.
[12] Ho YS. Top-cited articles in chemical engineering in science citation index expanded: a bibliometric analysis. Chin J Chem Eng. 2012;20:478–88.
[13] Ho YS. A bibliometric analysis of highly cited articles in materials science. Current Sci. 2014;107:1565–72.
[14] Castagna C, Consorti G, Turinetto M, et al. Osteopathic models integration radar plot: a proposed framework for osteopathic diagnostic clinical reasoning. J Chiropr Humanit. 2021;28:49–59.

[15] Shao Y, Chien TW, Jang FL. The use of radar plots with the Yk-index to identify which authors contributed the most to the journal of Medicine in 2020 and 2021: a bibliometric analysis. Medicine (Baltim). 2022;101:e31033.
[16] Yeh JT, Shulruf B, Lee HC, et al. Faculty appointment and promotion in Taiwan's medical schools, a systematic analysis. BMC Med Educ. 2022;22:356.
[17] Belikov AV, Belikov VV. A citation-based, author- and age-normalized, logarithmic index for evaluation of individual researchers independently of publication counts. F1000Res. 2015;4:884.
[18] Wu JW, Yan YH, Chien TW, et al. Trend and prediction of citations on the topic of neuromuscular junctions in 100 top-cited articles since 2001 using a temporal bar graph: a bibliometric analysis. Medicine (Baltim). 2022;101:e30674.
[19] Block JH, Fisch C. Eight tips and questions for your bibliographic study in business and management research. Manag Rev Q. 2020;70:307–12.
[20] Shen L, Xiong B, Li W, et al. Visualizing collaboration characteristics and topic burst on international mobile health research: bibliometric analysis. JMIR Mhealth Uhealth. 2018;6:e135.
[21] Kleinberg J. Bursty and hierarchical structure in streams. Data Mining Knowl Disc. 2003;7:373–97.
[22] Chow JC, Chien TW, Chou W. Suggestions to the article: demonstrating the ascendancy of COVID-19 research using acronyms. Scientometrics. 2022;127:2897–9.
[23] Huang Z, Zhang H, Luo Y, et al. The 100 top-cited articles in diabetic kidney disease: a bibliometric analysis. Ren Fail. 2021;43:781–95.
[24] Vishwanathan K, Kambhampati SBS, Vaishya R. Top 100 cited articles on diabetes mellitus and Covid-19: a bibliometric analysis. Diabetes Metab Syndr. 2021;15:102160.
[25] Frater JL. The top 100 cited papers in the field of iron deficiency in humans: a bibliometric study. Biomed Res Int. 2021;2021:5573790.
[26] García-Fernández FJ, GarcíGarca-Fernáía-Fernández AE, Ikuta I, et al. A bibliometric evaluation of the top 100 cited dimethyl fumarate articles. Molecules. 2021;26:1085.
[27] Radu AF, Bungau SG, Negru PA, et al. In-depth bibliometric analysis and current scientific mapping research in the context of rheumatoid arthritis pharmacotherapy. Biomed Pharmacother. 2022;154:113614.
[28] Aliyev F, Urkmez T, Wagner R. A comprehensive look at luxury brand marketing research from 2000 to 2016: a bibliometric study and content analysis. Manag Rev Q. 2019;69:233–64.
[29] Block J, Fisch C, Rehan F. Religion and entrepreneurship: a map of the field and a bibliometric analysis. Manag Rev Q. 2020;70:591–627.
[30] Kumar S, Sureka R, Colombage S. Capital structure of SMEs: a systematic literature review and bibliometric analysis. Manag Rev Q. 2020;70:535–65.
[31] Yang TY, Chen CH, Chien TW, et al. Predicting the number of article citations on the topic of pemphigus vulgaris with the 100 top-cited articles since 2011: a protocol for systematic review and meta-analysis. Medicine (Baltim). 2021;100:e26806.
[32] Lin CH, Chien TW, Yan YH. Predicting the number of article citations in the field of attention-deficit/hyperactivity disorder (ADHD) with the 100 top-cited articles since 2014: a bibliometric analysis. Ann Gen Psychiatr. 2021;20:6.
[33] Kuo YC, Chien TW, Kuo SC, et al. Predicting article citations using data of 100 top-cited publications in the journal Medicine since 2011: a bibliometric analysis. Medicine (Baltim). 2020;99:e22885.
[34] Dehghanbanadaki H, Aazami H, Keshavarz Azizi Raftar S, et al. Global scientific output trend for Akkermansia muciniphila research: a bibliometric and scientometric analysis. BMC Med Inform Decis Mak. 2020;20:291.
[35] Science of Science (Sci2) Tool. Indiana University and SciTech Strategies. Available at: https://sci2.cns.iu.edu. [access date October 15, 2022].
[36] Chen C, Hu Z, Liu S, et al. Emerging trends in regenerative medicine: a scientometric analysis in Citespace. Expert Opin Biol Ther. 2012;12:593–608.
[37] Chen DK, Modi Y, Al-Aswad LA. Promoting transparency and standardization in ophthalmologic artificial intelligence: a call for artificial intelligence model card. Asia Pac J Ophthalmol. 2022;11:215–8.
[38] Scheetz J, He M, van Wijngaarden P. Ophthalmology and the emergence of artificial intelligence. Med J Aust. 2021;214:155–157.e1.
[39] Zhou H. Design of intelligent diagnosis and treatment system for ophthalmic diseases based on deep neural network model. Contrast Media Mol Imaging. 2022;2022:4934190.
[40] Ran A, Cheung CY. Deep learning-based optical coherence tomography and optical coherence tomography angiography image analysis: an updated summary. Asia Pac J Ophthalmol. 2021;10:253–60.
[41] Lee EB, Wang SY, Chang RT. Interpreting deep learning studies in glaucoma: unresolved challenges. Asia Pac J Ophthalmol. 2021;10:261–7.
[42] Boudry C, Al Hajj H, Arnould L, et al. Analysis of international publication trends in artificial intelligence in ophthalmology. Graefes Arch Clin Exp Ophthalmol. 2022;260:1779–88.
[43] Zheng B, Wu MN, Zhu SJ, et al. Attitudes of medical workers in China toward artificial intelligence in ophthalmology: a comparative survey. BMC Health Serv Res. 2021;21:1067.
[44] Over 40 articles regarding topical comparison in mainland China, Hong Kong, and Taiwan were published. Available at: https://pubmed.ncbi.nlm.nih.gov/?term=+%28%28China%5BTitle%5D%29+AND+%28Hong+Kong%5BTitle%5D%29%29+AND+%28Taiwan%5BTitle%5D%29. [access date August 2, 2022].
[45] Chien TW. Dataset, module, tutorial materials and video of how to conduct this study. Available at: http://www.healthup.org.tw/article/course_mb2.asp?repno=37. [access date November 24, 2022].
[46] Wu L, Wu H, Ou T, et al. Mapping theme trends and recognizing hot spots in viral pneumonia: a bibliometric analysis of global research. Am J Transl Res. 2022;14:2972–87.
[47] Yang DH, Chien TW, Yeh YT, et al. Using the absolute advantage coefficient (AAC) to measure the strength of damage hit by COVID-19 in India on a growth-share matrix. Eur J Med Res. 2021;26:61.
[48] Chien TW, Wang HY, Hsu CF, et al. Choropleth map legend design for visualizing the most influential areas in article citation disparities: a bibliometric study. Medicine (Baltim). 2019;98:e17527.
[49] Wright JK. Problems in population mapping in notes on statistical mapping, with special reference to the mapping of population phenomena. American Geographical Society; Washington, Population Association of America, NY, 1938. 2019/4/4. Available at: https://www.worldcat.org/title/notes-on-statistical-mapping-with-special-reference-to-the-mapping-of-population-phenomena/oclc/5160537/.
[50] Newman ME, Gastner MT. Diffusion-based method for producing density-equalizing maps. Proc Natl Acad Sci USA. 2004;101:7499–504.
[51] Chen WJ. Dengue outbreaks and the geographic distribution of dengue vectors in Taiwan: A 20-year epidemiological analysis. Biomed J. 2018;41:283–9.
[52] Lai WT, Chen CH, Hung H, et al. Recognizing spatial and temporal clustering patterns of dengue outbreaks in Taiwan. BMC Infect Dis. 2018;18:256.
[53] Soetens L, Hahné S, Wallinga J. Dot map cartograms for detection of infectious disease outbreaks: an application to Q fever, the Netherlands and pertussis, Germany. Euro Surveill. 2017;22:30562.
[54] Schizophrenia fact sheet. 2018/2/23 archived from the original reviewed April 2018. Available at: https://www.who.int/news-room/fact-sheets/detail/schizophrenia.
[55] Yie KY, Chien TW, Yeh YT, et al. Using social network analysis to identify spatiotemporal spread patterns of COVID-19 around the world: online dashboard development. Int J Environ Res Public Health. 2021;18:2461.
[56] Chien TW, Chang Y, Wang HY. Understanding the productive author who published papers in medicine using National Health Insurance Database: a systematic review and meta-analysis. Medicine (Baltim). 2018;97:e9967.
[57] Liu SY, Chien TW, Yang TY, et al. A bibliometric analysis on dengue outbreaks in tropical and sub-tropical climates worldwide since 1950. Int J Environ Res Public Health. 2021;18:3197.
[58] de Nooy W, Mrvar A, Batagelj V. Exploratory Social Network Analysis With Pajek: Revised and Expanded, 2nd edn. New York, NY: Cambridge University Press, 2011.
[59] Kan WC, Kuo SC, Chien TW, et al. Therapeutic duplication in Taiwan hospitals for patients with high blood pressure, sugar, and lipids: evaluation with a mobile health mapping tool. JMIR Med Inform. 2020;8:e11627.
[60] Author impact beam plots in web of science author records. Available at: https://www.youtube.com/watch?v=dcXgx5wxUp4. [access date October 11, 2022].
[61] Spaide RF, Jaffe GJ, Sarraf D, et al. Consensus nomenclature for reporting neovascular age-related macular degeneration data: consensus on neovascular age-related macular degeneration nomenclature study group [published correction appears in Ophthalmology. 2020 Oct;127(10):1434-1435]. Ophthalmology. 2020;127:616–36.
[62] Wang J, Li Y, Musch DC, et al. Progression of myopia in school-aged children after COVID-19 home confinement. JAMA Ophthalmol. 2021;139:293–300.
[63] Teo ZL, Tham YC, Yu M, et al. Global prevalence of diabetic retinopathy and projection of burden through 2045: systematic review and meta-analysis. Ophthalmology. 2021;128:1580–91.

[64] Chien TW. Figure 2 in this study. Available at: http://www.healthup.org.tw/gps/Ophal2208china.htm. [access date October 2, 2022].
[65] Chien TW. Figure 3 in this study. Available at: http://www.healthup.org.tw/gps/opha22radar.htm. [access date October 2, 2022].
[66] Chien TW. Figure 4 in this study. Available at: http://www.healthup.org.tw/gps/opha22mesh.htm. [access date October 2, 2022].
[67] Chien TW. Figure 4 in this study. Available at: http://www.healthup.org.tw/gps/opha22radar.htm. [access date October 2, 2022].
[68] Kung SC, Chien TW, Yeh YT, et al. Using the bootstrapping method to verify whether hospital physicians have different h-indices regarding individual research achievement: a bibliometric analysis. Medicine (Baltim). 2020;99:e21552.
[69] Yie KY, Chien TW, Chen CH, et al. Suitability of h- and x-indices for evaluating authors' individual research achievements in a given short period of years: a bibliometric analysis. Medicine (Baltim). 2021;100:e25016.
[70] Chou PH, Yeh YT, Kan WC, et al. Using Kano diagrams to display the most cited article types, affiliated countries, authors and MeSH terms on spinal surgery in the past 12 years. Eur J Med Res. 2021;26:22.
[71] Yeh YT, Chien TW, Kan WC, et al. The use of the hx-index to compare research achievements for ophthalmology authors in mainland China, Hong Kong, and Taiwan since 2010. Medicine (Baltim). 2021;100:e24868.