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The 100 Most Mentioned Glaucoma Articles Online with Highest Altmetric Attention Scores

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Precis

Characteristics of the most mentioned glaucoma articles on the internet were analyzed, allowing a better understanding of the dissemination of glaucoma research to the general public.

Abstract

Purpose: To determine the 100 most mentioned articles on the internet in the field of glaucoma and analyze their characteristics.

Materials and Methods: We identified the top 100 glaucoma articles with the highest Altmetric Attention Score (AAS), an automatically calculated metric for monitoring social media. Each article was evaluated for several characteristics including year of publication, title, journal name, journal impact factor (IF), article topic, article type, affiliation, and online mentions (news, blog, policy, Twitter, Facebook, etc). Correlation analysis was conducted for AAS with these characteristics.

Results: The selected 100 articles came from 44 journals with more than half (56%) published in ophthalmology-specific journals. There was no significant correlation between IF and number of articles in a specific journal or AAS ($p>0.1$), but the number of articles in the top 100 was higher for ophthalmology journals with a higher IF ($p<0.05$). Original study was the most common study type (87%), of which clinical observation study was the most common subgroup (40%). Epidemiology/risk factor and basic science were the most common article topics (each 24%), followed by medical treatment (13%). Article topics regarding medical treatment had a significantly greater AAS than other topics ($p<0.05$). Of the top 5 articles, more than half (60%) were related to "Lifestyle choice" topics.

Conclusions: There was no association between journal IF and AAS, consistent with previous studies. 90% of journals that had articles in the top 100 had a Twitter page. "Lifestyle choice" activities and other modifiable risk factors attracted significant online attention regarding glaucoma studies, with two of the top three most mentioned articles related to dietary intake. The present study thus provides a better understanding of online engagement with glaucoma research and the dissemination of this research to the general public.

Keywords: Altmetrics Glaucoma

Introduction

Traditionally, the significance of scientific articles is measured by the number of citations, which affects journal impact factor (IF).[1] A citation is a reference to a published or unpublished source. Citation analysis has been conducted in various fields[2–4] and provides an objective metric for the intellectual impact of individual articles and a relative magnitude of the importance of particular subfields.[2] Within ophthalmology, citation analysis has been conducted in the topics of epidemiology, dry eyes, cataract surgery, glaucoma, and global ophthalmology.[5–9] Traditional citation analyses have limitations such as considerable lag time for citation accumulation after publication and generally only assessing relevance to researchers within the field. These limitations are becoming increasingly important as the advancement of the internet and rapid growth of social media have enabled a more diverse audience and wide spread acquisition of scientific knowledge.[10,11]

Altmetrics, a Web-based metric, was developed in 2010 to evaluate and monitor the early influence of scientific articles.[12] This metric measures the scientific and social influences of published scientific articles based on the number of "mentions" across various sources of online social media platforms such as Twitter and Facebook and assigns an Altmetric Attention Score (AAS), which is a weighted approximation of the online attention received by the article.[10,12] The AAS is calculated based on 3 main factors: the number of times the article is mentioned, the sources that mention the article (including news outlets and various social media sites), and the authors of each mention.[21] Altmetrics may provide a more broad assessment of research impact, diversity of underlying factors, and timeliness.[13] Recently, there have been several published studies that have used Altmetrics to identify the most mentioned articles in the fields of neurosurgery, neuroimaging, neurointervention, stroke, emergency medicine, dentistry, and critical care.[14–20] Findings from these studies indicate that factors driving AAS and IF may not completely overlap. Given these previous findings, it is thought that traditional metrics such as citation count and IF may predominantly represent what is important to scientists, while online attention scores represent what is important to the general population. To the best of our knowledge, no study to date has investigated the most mentioned articles in ophthalmology as a whole or in any ophthalmology subspecialty. Herein, we identify the top 100 glaucoma articles with the highest AASs and investigate the characteristics of these articles. We hypothesized that AAS of glaucoma articles would not correlate with journal IF. We did not have any hypotheses on the characteristics of the most mentioned articles in glaucoma.

Materials and Methods

This study did not include human subjects. Therefore, the study did not require institutional review board approval as per the standing policy of The George Washington School of Medicine and Health Sciences.

Altmetric Database Extraction

Altmetric Explorer (Altmetric, London, UK) is a commercially available Web-based application offering a nontraditional metric to monitor a publication's online mentions, social media discussion, and general online interaction. We accessed the Altmetric database[21] to extract article data. The database contains up-to-date information regarding online activity of millions of articles. The various online activity measures are given weighted scores from which an Altmetric Attention Score (AAS) is calculated.[22] In particular, the three categories from which the AAS is calculated are number of mentions, sources of the mentions, and the authors of each mention. Within these categories, the sources are weighted to reflect the relative reach of each type of source.[22] The weightings reflect the relative reach of each source per Altmetric and are as follows, with each source's relative weight in parentheses: news (8), blog (5), policy document (3), patent (3), Wikipedia (3), Peer review on Publons or Pubpeer (1), Weibo (1), Google+ (1), F1000 (1), syllabi on Open Syllabus (1), LinkedIn (0.5), Twitter tweets and retweets (0.25), Facebook public pages (0.25), Reddit (0.25), Pinterest (0.25), Stack Overflow Q&A (0.25), Youtube (0.25). Further modifiers are applied to the score from news outlets depending on reach, and Twitter scores are also modified based on reach (followers), how often the user tweets about research, and potential bias. In addition to the summary AAS, the database also provides the underlying mention counts in individual categories.

The following search term was used in the database: *"*(glaucoma) OR glaucoma[MeSH Terms]" (Data extracted: May, 24th, 2019). We made no restriction on dates. The following information was extracted with each article: AAS, year published, title, journal, affiliation, news mentions, blog mentions, policy mentions, Twitter mentions, Facebook mentions, Wikipedia mentions, Google+ mentions, LinkedIn mentions, Reddit mentions, Pinterest mentions, F1000 mentions, Q&A mentions, Video mentions, Syllabi mentions, number of Mendeley readers, and number of dimensions citations. The data was extracted in Excel (Microsoft Office, Version 16.24).

Selection of Articles

The searches returned 11,955 unique articles, which were ordered by AAS. Starting from the highest ranked article by AAS, two independent reviewers (J.L.C and J.S) assessed sequentially identifying 100 articles with the primary focus determined to be glaucoma. Articles with the primary focus determined to be glaucoma were included and articles with glaucoma as secondary focus were excluded. Examples of excluded articles include those

focused on general methodology, ocular disease in general, and chronic diseases without a focus in glaucoma. Article titles and abstracts were reviewed. When necessary, the full manuscript was reviewed for clarification. There was agreement regarding inclusion for all articles. All articles that were excluded and those that had an AAS below the top 100 were removed from further analysis. A total of 191 articles were reviewed to identify the top 100 glaucoma focused articles.

Extraction of Journal Impact Factor and Twitter Presence

For the top 100 mentioned glaucoma articles included in the study, we identified the journals that these articles were published in. For each journal, the Web of Science 2017 impact factor (IF) was identified.[23] Articles that were from journals that did not have IF available were not included in the subsequent analysis of IF correlation with number of articles in journal or AAS. IF, as extracted from Web of Science, is calculated as the number of citations received in a particular year for publications published in that journal divided by the number of publications in the journal in the two preceding years. We also calculated Average IF to take into account year each article was published. We used the website https://www.bioxbio.com/ to identify an IF for each article based on the journal and year published. We then averaged these numbers for each journal to determine the average IF.

In addition, presence of Twitter page for each journal was identified and if present, the year in which the Twitter page was created was identified for each journal. We used search terms “Twitter” + “journal name” in Google search to identify each journal twitter page.

When comparing IF and AAS directly the actual IF was used as there was a correlation. When IF was used to identify the number of articles the IF was rounded so that number of articles from journals with a similar IF could be binned.

Extraction of Article Specific Factors

Both reviewers (J.L.C and J.S) reviewed all included articles to determine topic and type of article. The details of these categories are provided here. Article topic included: 1) epidemiology/risk factors, 2) diagnostics, 3) medical treatment, 4) surgical treatment, 5) genetics, 6) basic science, and 7) Other (cost, patient satisfaction, and quality of life). In the case where both medical and surgical treatment were being compared we chose the treatment method that was being investigated (not standard of care control).

Article type included: 1) original study, 2) review/meta-analysis, 3) case report/case series, and 4) editorial. Original study further subdivided to 1a) clinical observation, 1b) comparative clinical trial, 1c) experimental study,

and 1d) genome-wide association study (GWAS). These categories were similar to those used in other Altmetric analyses.[19]

A subset of articles was categorized as "lifestyle choice". "Lifestyle choice" was defined as activities that can be modified by the patient (ex: tobacco use, diet and nutrient intake, exercise, physical activity, cardiorespiratory fitness, oral health). Two reviewers (J.L.C and J.S) assessed the articles and determined which articles would fall under this classification.

For each article, the continent of origin for the corresponding author was identified. An article with more than one country contributing was also identified and labeled as an international collaboration.

Statistical Analysis

Wilcoxon rank-sum test was used to compare non-normally distributed data such as the AAS. When multiple pairwise comparisons were done we applied Benjamini-Hochberg correction for multiple comparisons with a false discovery rate of 5%. Kruskal-Wallis was used to compare distribution of AAS across multiple groups. When correlation between various data and AAS was assessed, Spearman Rank correlation was applied. To determine if data was uniformly distributed, we applied a Pearson chi-square test. For comparing the number of articles in the top 100 with impact factor we applied the Jonckheere-Terpstra Test which is a non-parametric test similar to Kruskal-Wallis but allows a priori ordering of groups. In this case groups were ordered by impact factor. When this test is applied the score test, z score and one-tailed p value is included. All statistical tests were carried out in MATLAB (Mathworks, R2018B). Calculated *p*-values are included in the text.

Results

The full list of the top 100 glaucoma articles with the highest AAS along with published year and individual AAS is included in Supplementary Table 1, Supplemental Digital Content 1, http://links.lww.com/IJG/A581. The AAS ranged from 42 to 1009 (mean 171.04±186.02; median 95). Article publication year ranged from 2012 to 2019. There was no significant trend for correlation between year published and AAS ($p>0.5$). The most frequent year was 2016 (31%). For most articles, the corresponding author was from North America (71%) and international collaboration represented almost a third of the articles (36%). The median AAS was not significantly different between articles from any specific continent or between those with and without an international collaboration ($p>0.1$). Of the top 100 articles, 14% listed industry as a funding source; the median AAS for this subset was not significantly different than the rest ($p>0.1$). The most frequently mentioned article was

"Frequency of a diagnosis of glaucoma in individuals who consume coffee, tea and/or soft drinks",[24] a retrospective cross-sectional study. The article had 128 news mentions, 8 blog mentions, 129 Twitter mentions, 18 Facebook mentions, 1 Reddit mention, and 1 F1000 mention. Of the top 10 articles, Twitter mentions (10/10) was the most important vehicle for dissemination followed by news mentions (10/10).

The selected articles came from 44 journals. Journal name, journal Twitter presence, ophthalmology specific versus non-ophthalmology focus of each journal, article count per journal, and IF are reported in Table 1. *JAMA Ophthalmology* (formerly *Archives of Ophthalmology*) had the highest number of articles (17%), followed by *Ophthalmology* (13%). This was followed by *Investigative Ophthalmology & Visual Science* (6%), *American Journal of Ophthalmology* (4%), and then *Clinical Ophthalmology* (3%), *Journal of Glaucoma* (3%), and *The Lancet* (3%). The remaining journals had less than 3 articles, with most journals having 1 article. There was no significant correlation between journal IF and number of articles contributed by the journal ($p>0.1$). There was also no significant correlation between journal IF and article AAS ($p>0.2$; Supp Fig 1, Supplemental Digital Content 2, http://links.lww.com/IJG/A582). Ophthalmology specific journals accounted for 13 of the 44 (29.5%) journals represented and accounted for 56% of the top 100 articles. No significant difference in the AAS of articles was found between ophthalmology specific versus non-ophthalmology specific journals ($p>0.5$). When looking only at those journals that were ophthalmology specific the IF was still not correlated with AAS, however the number of articles in the top 100 (Table 2) was higher for journals with a higher IF ($p<0.05$, Jonckheere-Terpstrsa test). Using the average IF for each journal also revealed a significant correlation with number of articles in the top 100 ($p<0.01$, Jonckheere-Terpstrsa). Only 10% of articles came from journals without an identified Twitter page; however, the AAS was not significantly different between the articles from journals with Twitter presence versus those without Twitter presence ($p>0.5$), though the fact that most of the journals had a twitter presence may limit our ability to assess this. We also did not find a significant relationship between number of years having a twitter with AAS or number of articles in the top 100.

The most frequent article type was original study, which comprised 87% of the articles (Table 3). This was subdivided into clinical observation study (40%), followed by experimental study (25%) and comparative clinical (11%) and GWAS (11%). Systemic reviews/meta-analyses comprised 6%, editorials comprised 4%, and case reports/case series were least common at 3%. The highest median AAS was for comparative clinical trial (AAS 216), but did not reach significance compared to that of the other groups ($p>0.05$).

The two most frequent categories were epidemiology/risk factor and basic science type, each at 24% (Table 4). The next most common were treatment (22%), topics related to medical treatments (13%), and surgical treatments (9%). This was followed by genetics (10%), diagnostics (10%), and "other" (10%). The median AAS of topics related to medical treatments was significantly higher than genetics, basic science, and other categories ($p<0.05$; Figure 1). The difference between medical treatments and both diagnostics and surgical treatment was not significantly different ($p>0.05$).

We identified a subgroup of articles associated with "lifestyle choice". "Lifestyle choice" was defined as activities that can be modified by the patient (ex: tobacco use, diet and nutrient intake, exercise, physical activity, cardiorespiratory fitness, oral health). We categorized 15% of articles as falling within this subgroup, 3 articles of which were in the top 5.

Discussion

In this study we identified the top 100 published articles in the field of glaucoma with the highest online attention on social media. These articles were analyzed for the journal they were published in, the journal's IF, the general topic of study, and the type of study. More than half (56%) were published in ophthalmology specific journals, with the majority in *JAMA Ophthalmology* (17%) and *Ophthalmology (*13%). A similar analysis of most mentioned neurointervention articles found multidisciplinary journals to have more frequent mentions than specialty journals.[19] They attributed this to the fact that neurointervention is a newer field and the specialty specific journals have less penetrance among the public. This could also be related to the interdisciplinary nature of neurointervention compared to glaucoma. Compared to classic citation counts in ophthalmology, Altmetric analysis identified more journals (44) than previous bibliometric studies.[5–8] Other Altmetric analyses in different fields also report a similar number of journals among the top 100 mentioned articles.[16] The articles were primarily original studies with most being clinical observation studies. The majority of articles focused on the following topics: epidemiology/risk factor, basic science, and treatments. The medical treatment subcategory had a significantly higher AAS. The range of AAS in this study (42 to 1009) and publication dates is comparable to those seen in Altmetric analysis in neurosurgery, oral cancer, and critical care.[14,16,18,19] Most articles were published in 2016 (31%).

As we had hypothesized, our study demonstrated a lack of association between journal IF and AAS, which is consistent with studies in other fields.[15,16,18] Even when there has been a correlation demonstrated between IF and AAS in a previous study on Altmetrics in emergency medicine, the correlation was only modest.[17] In the fields of

neurology and neurosurgery, Kim et al suggested that traditional metrics and AAS measure different perspectives,[19] which also appears to apply to glaucoma research. AAS has been hypothesized to be higher when articles relate to "popular topics" or are otherwise able to garner public attention, which can be good or bad, while traditional metrics pertain to impact on the scientific community. It is important to note though IF and AAS are not correlated, ophthalmology specific journals with a higher IF have more articles in the top 100 (Table 2). The discrepancy between ophthalmology specific and general journals can be explained by the fact that some recent important publications have been published in high-impact general journals, which rarely publish glaucoma related work. Altogether, these results suggest IF is an important measure, but there are other factors which drive some articles to generate higher amounts of attention. Therefore, when assessing the intellectual and societal impact of an article, a combination of traditional metrics and attention scores may be best.

Our study demonstrated that "lifestyle choice" activities and/or modifiable risk factors attracted online attention regarding glaucoma studies. Though the median AAS was not significantly higher, two of the top 3 most mentioned articles in our study were related to dietary intake. The article with the highest social media presence was "Frequency of a diagnosis of glaucoma in individuals who consume coffee, tea, and/or soft drinks."[24] When looking across all medical and health science articles, diet and exercise represented about 31% and 11% of articles with top Altmetric scores.[25] Altmetric analysis of stroke papers showed modifiable risk factors such as diet and exercise to make up half of the top articles.[15] The results from our study and other Altmetrics studies suggests that the medical interest of the "general public" gravitates towards modifiable "lifestyle choice" activities. It is likely that patients find these articles to be directly relatable and will mention them in their social media platforms such as Twitter or Facebook. Interestingly, these results also match classic bibliometric analysis, as a study of articles related to ophthalmic epidemiology found that the most cited article was a study of outdoor activities and prevalence of myopia among schoolchildren.[5]

The distribution of article types, with most being original studies, is also similar to that of other studies of AAS.[15,18,19] Here we find most of these original studies to be clinical observation and experimental, rather than comparative clinical trials as shown in neurointervention.[19] In terms of article topic, we found topics to be unevenly distributed but without a clear leading topic. This is in contrast with other Altmetric analyses that found lower prevalence of basic science.[18,19,26] This may be due to the highly specialized nature of ophthalmology compared to other medical fields, and we speculate many online media mentions of glaucoma articles may be from scientist or

physicians in ophthalmology. The medical treatment subcategory had a significantly greater mean AAS compared to that of genetics, basic science, and other subcategories, and we hypothesize that medical treatment topics may draw more online interest as these articles may be more understandable and applicable for the general public. It is possible that this is specific to glaucoma as topical medications are essential to glaucoma management. For instance, Altmetric studies in neurosurgery showed types of articles related to operative procedures were the most frequent in the top 100.[14] Future research should thus compare these findings in glaucoma to other specialties within ophthalmology. Additionally, future studies with analysis based on the demographics of users mentioning these glaucoma articles on social media are warranted. Classic bibliometric analyses have shown higher citation counts for clinical research.[7] This may represent a factor more specific to glaucoma. Supporting this, a bibliographic analysis of glaucoma papers showed that though clinical and epidemiology papers were more prevalent among highly cited papers, there was an increasing amount of basic science studies more recently.[9]

There are limitations to our study. We only identified Altmetric data from the Altmetric database. Other studies have shown not all articles in a journal are included in the database.[27] However, this database is widespread and more easily accessible for investigators to work with, and is the sole source of most studies in the field. Secondly, we excluded all articles that did not have glaucoma as the primary focus. For instance, articles with primary focus on cataract surgery (glaucoma secondary) were excluded. Further exploration may consider including all articles related to glaucoma. Moreover, we only assessed the top 100 mentioned articles, as has previously been done in published literature. The search terms need to be broad enough to include all articles related to glaucoma, but as shown in our results many of the papers from the search results were not related to glaucoma (see methods). Additionally, since information is in real-time the scores can change in a short amount of time. This was minimized by collecting all the data in one setting and limiting to top 100 articles which are unlikely to represent new articles which will show higher shifts. Older studies that were published in a "non-online media era" will likely not have an AAS score, resulting in the limitation of using AAS to compare articles from different eras. However, because we did the analysis until May 2019 with no limit, there is a chance that older articles have had more opportunities to be read and cited. Additionally, IF varies per year, though usually without significant changes. As above, we attempted to minimize this by collecting the data on one day, and we believe that performing the analysis with no historical limit will be more representative of the true “most mentioned” articles in glaucoma. Additionally, Altmetric score tracking only is available starting from October 2011, and numerous previous Altmetrics studies have also had no

historical limit or a limit close to or even preceding October 2011. Future research may consider stratifying AAS analyses by year. Another limitation for comparing number of articles is the difference in amount of the article type in the literature; for example, there are a higher number of original studies than review papers or editorials, which would impact the number in the top 100. Finally, other limitations of Altmetric database studies ones previously mentioned[27] of personal biases (individual tastes or perfunctory citations), automation bias (bots generating retweets to increase Altmetric impact), and Matthew effect of accumulated advantage bias (the "wealthy" influencers or content creators are rewarded with additional wealth). These may have increased the significant disparity between IF and AAS score; however, it is not possible to determine exactly the reasons for this discrepancy. Relatedly, it was not possible to determine how all of the articles reached social media, whether through self-citation, publication by the journal's official Twitter account, or dissemination by societies such as the American Glaucoma Society or organizations such as the American Academy of Ophthalmology. It is also not possible to determine with accuracy what populations – the general public, scientists, or medical professions – are reading the articles and most driving the higher AAS scores. However, given the lack of correlation with IF and the much larger size of the general population relative to medical professionals, it is likely that the AAS score may be more related to general interest.

In conclusion, we herein present the first Altmetric analysis in the field of ophthalmology to help quantify public engagement with glaucoma research. This study identifies factors not captured by classic citation analysis and includes a more diverse set of journals than typically seen in bibliometric studies. However, it is important to be cautious when interpreting these results as articles can be sensationalized and receive wide interest even when not properly interpreted. Almetrics reflect crowd attention, which is not necessarily related to the quality or originality of the article. However, it does have its place in scientific research as it captures valuable information beyond traditional IF. This information can help scientists and clinicians understand where the general population may be currently focused and areas of their field which need to draw more attention. Altmetric and bibliometric analyses should function as complementary approaches when assessing journal article impact.[2]

Figure Legend

Figure 1. Altmetric Attention Score (AAS) is compared across article topics. The median AAS (red line) and interquartile range (black box) are shown for each topic. Asterisks indicate that the specified topic is significantly different from Treatment - Medical ($p<0.05$).

Supp Figure 1. Scatter plot of Altmetric Attention Score (AAS) vs Impact Factor (IF) demonstrating a lack of correlation between the 2 scores.

Table Legends

Table 1. The table displays the name of journals with the top 100 mentioned glaucoma articles. The number of articles, Twitter presence, ophthalmology-specific nature, and impact factor are provided.

Table 2. The table displays the impact factor and name of ophthalmology specific journals falling under different impact factors. The number of articles in journals with indicated impact factor is provided. The statistical data regarding the trend analysis between number of articles and impact factor is provided in the table.

Table 3. The table displays the seven article types present across the top 100 mentioned glaucoma articles. The number of articles along with mean, standard deviation, median, and range are provided.

Table 4. The table displays the seven topics present across the top 100 mentioned glaucoma articles. The number of articles along with mean, standard deviation, median, and range are provided.

Supplementary Table 1. The table displays the top 100 mentioned glaucoma articles ordered by their Altmetric Attention Score (AAS). The title, year published, AAS, continent, and industry funding are included.

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Table 1. Journals in which the top 100 mentioned glaucoma articles were published, with journal-specific factors and number of articles in the top 100 contributed by each.					
Journal Name	Journal Twitter Presence	Ophthalmology Specific Journal	Number of Articles Contributed by the Journal (n)	Impact Factor *	Average Impact Factor **
ACS Chemical Biology	Yes	No	1	4.592	5.356
Advances in Therapy	Yes	No	2	3.085	2.709
American Journal of Ophthalmology	Yes	Yes	4	4.795	4.6925
Annals of Internal Medicine	Yes	No	2	19.384	16.957
Biomaterials	Yes	No	1	8.806	8.557
Brain: A Journal of Neurology	Yes	No	1	10.848	10.84
British Journal of Ophthalmology	Yes	Yes	2	3.384	3.18
British Medical Journal	Yes	No	1	23.562	23.259
Cell Cycle	Yes	No	1	3.304	3.53
Cell Death & Disease	No	No	1	5.638	5.378
Clinical & Experimental Ophthalmology	Yes	Yes	1	3.217	3.217
Clinical Ophthalmology	No	Yes	3	NA	NA
European Journal of Epidemiology	No	No	1	7.023	5.118
Heliyon	Yes	No	1	NA	NA
Human Molecular Genetics	Yes	No	1	4.902	4.544
Investigative Ophthalmology & Visual Science	Yes	Yes	6	3.388	3.428
JAMA Ophthalmology	Yes	Yes	17	6.669	5.813
JAMA: Journal of the American Medical Association	Yes	No	1	47.661	35.289
JCI Insight	Yes	No	1	NA	NA
Journal of Clinical Investigation	Yes	No	2	13.251	13.0
Journal of Glaucoma	Yes	Yes	3	1.742	2.062
Journal of Medical Economics	Yes	No	1	2.264	2.264
Journal of Molecular Biology	Yes	No	1	4.894	4.333
Journal of Neuroscience	Yes	No	1	5.971	5.924
Journal of Ocular Pharmacology & Therapeutics	No	Yes	2	1.921	1.575
Medicine	Yes	No	1	2.028	2.028
Medicine and Science in Sports & Exercise	Yes	No	1	4.291	4.478
Molecular Cell	Yes	No	1	14.248	13.958
Molecular Neurobiology	No	No	1	5.076	4.586
Nature Communications	Yes	No	1	12.353	11.878
Nature Genetics	Yes	No	7	27.125	27.380

Nature Medicine	Yes	No	1	32.621	27.363
Ophthalmic & Physiological Optics	Yes	Yes	1	2.262	2.302
Ophthalmology	Yes	Yes	13	7.479	7.550
Ophthalmology and Therapy	Yes	Yes	1	NA	NA
Optometry and Vision Science	Yes	Yes	2	1.499	1.471
PLoS Genetics	Yes	No	1	5.54	5.224
PLoS ONE	Yes	No	1	2.766	3.057
Proceedings of the National Academy of Sciences	Yes	No	2	9.504	9.583
Science	Yes	No	1	41.058	41.058
Scientific Reports	Yes	No	2	4.122	4.122
Stem Cells	Yes	No	1	5.587	5.599
The Lancet	Yes	No	3	53.254	50.741
Translational Vision Science & Technology	Yes	Yes	1	2.193	4
∗Impact factor scores were retrieved from Web of Science 2017 (https://jcr.clarivate.com) **See methods NA indicates impact factor score was not available					

Table 2. Ophthalmology-specific journals per rounded impact factor and number of the top 100 most mentioned glaucoma articles per each impact factor, showing a greater number of articles coming from the journals with highest impact factor.

*****Journals	Rounded IF	******Number of Articles (n)
Optometry Vis Sci	1	2
J Glaucoma, J Ocul Pharmacol Th,	2	7
Ophthal Physl Opt, TVST	3	9
BJO, Clin Exp Ophtho, IOVS,	5	4
AJO	7	30
JAMA Ophtho, Ophthalmology		

IF: Impact factor
*Excluded journals with no IF: Clin Ophthalmol, Ophthalmol Ther
**Jonckheere-Terpstrsa test for nonparametric trend analysis, Test score = 510, z = 1.7078, One-tailed $p = 0.04$

Table 3. Breakdown of article types of the top 100 mentioned glaucoma articles and mean AAS per article type, showing that most studies were clinical observational studies but the highest AAS were seen in comparative clinical trials.

Types of Article	*Number of Articles (n)	Mean AAS, Mean±SD (median, range)
Original article		
Clinical observational study	40	169.1±206.6 (94.5, 43-1009)
Comparative clinical trial	11	269.0±193.8 (216.0, 63-579)
Experimental study	25	178±205.6 (100.0, 46-853)
Genome-wide association study	11	114.3±100.4 (76.0, 42-379)
Systematic review/meta-analysis	6	146.7±131.2 (109.0, 55-397)
Case report/case series	3	132.33±64.9 (101.0, 89-207)
Editorial	4	99.0±40.6 (103.0, 53-137)

AAS: Altmetric Attention Score; SD: standard deviation.
*The articles are not evenly distributed across all seven topics, Pearson chi-square ($p<0.01$).

Table 4. Topics of the top 100 most mentioned glaucoma articles, showing that the greatest number of articles were about epidemiology/risk factors but that the mean AAS was highest for medical treatment articles.

Topic of article	*Number of Articles (n)	**Mean AAS, Mean±SD (median, range)
Epidemiology and Risk Factors	24	214.9±242.0 (112.0, 46-1009)
Diagnostics	10	104.8±50.3 (101.5, 43-199)
Treatment – medical	13	**318.5±244.0 (397.0, 55-853)**
Treatment – surgical	9	101.9±50.5 (100.0, 51-216)
Genetics	10	116.2±105.6 (73.0, 42-379)+
Basic science	24	145.5±154.1 (93.5, 46-743)+
Other (cost, patient satisfaction, and quality of life)	10	118.60±143.4 (62.0, 46-516)+

AAS: Altmetric Attention Score; SD: standard deviation.

* The articles are not evenly distributed across all seven topics, Pearson chi-square ($p<0.01$).

**AAS for "Treatment – medical" group (bold) was significantly greater than the identified topics (+), $p<0.05$ (Wilcoxon rank-sum with correction for multiple comparison (see methods).

Supplementary Table. Top 100 Mentioned Glaucoma Articles as determined by Altmetric Attention Score					
Rank	Article name	Year published	Altmetric Attention Score	*Country	Industry Funding
1	Frequency of a diagnosis of glaucoma in individuals who consume coffee, tea and/or soft drinks	2017	1009	1	0
2	Latanoprost-Eluting Contact Lenses in Glaucomatous Monkeys	2016	853	1	0
3	Association of Dietary Nitrate Intake With Primary Open-Angle Glaucoma	2016	788	1	0
4	Intraocular Pressure Rise in Subjects with and without Glaucoma during Four Common Yoga Positions	2015	743	1	0
5	Six-Month Intraocular Pressure Reduction with a Topical Bimatoprost Ocular Insert	2016	579	1	1
6	Patterns of Glaucoma Medication Adherence over Four Years of Follow-Up	2015	516	1	0
7	Comparison of Latanoprostene Bunod 0.024% and Timolol Maleate 0.5% in Open-Angle Glaucoma or Ocular Hypertension: The LUNAR Study	2016	445	1	1
8	A randomised, controlled comparison of latanoprostene bunod and latanoprost 0.005% in the treatment of ocular hypertension and open angle glaucoma: the VOYAGER study	2014	432	1	1
9	Efficacy of Latanoprostene Bunod 0.024% Compared With Timolol 0.5% in Lowering Intraocular Pressure Over 24 Hours	2016	428	1	1
10	Latanoprostene Bunod 0.024% versus Timolol Maleate 0.5% in Subjects with Open-Angle Glaucoma or Ocular Hypertension	2016	426	1	1
11	Preservative toxicity in glaucoma medication: clinical evaluation of benzalkonium chloride-free 0.5% timolol eye drops	2013	397	1	0
12	Real-time imaging of single neuronal cell apoptosis in patients with glaucoma	2017	386	2	0
13	Nutrient intake and risk of open-angle glaucoma: the Rotterdam Study	2012	385	2	0
14	Prospective Study of Oral Health and Risk of Primary Open-Angle Glaucoma in Men	2016	380	1	0
15	Smoking and incidence of glaucoma	2017	379	2	0
16	Glaucoma Risk Alleles in the Ocular Hypertension Treatment Study	2016	379	1	0
17	Relationships Between Anthropometric Measurements and Intraocular Pressure: The Korea National Health and Nutrition Examination Survey	2017	379	3	0
18	Commensal microflora-induced T cell responses mediate progressive neurodegeneration in glaucoma	2018	359	1	0

19	Selective laser trabeculoplasty versus eye drops for first-line treatment of ocular hypertension and glaucoma (LiGHT): a multicentre randomised controlled trial	2019	216	2	0
20	Physical Activity, Cardiorespiratory Fitness, and Incident Glaucoma	2018	215	1	0
21	Genome-wide analyses identify 68 new loci associated with intraocular pressure and improve risk prediction for primary open-angle glaucoma	2018	210	2	0
22	Glaucoma and Congenital Zika Syndrome	2017	207	6	0
23	Visual Field Change and 24-Hour IOP-Related Profile with a Contact Lens Sensor in Treated Glaucoma Patients	2016	199	1	1
24	Stepwise Differentiation of Retinal Ganglion Cells from Human Pluripotent Stem Cells Enables Analysis of Glaucomatous Neurodegeneration	2016	195	1	0
25	Transplantation of iPSC-derived TM cells rescues glaucoma phenotypes in vivo	2016	185	1	0
26	Association of Daily Dosage and Type of Statin Agent With Risk of Open-Angle Glaucoma	2017	166	1	0
27	An implantable microfluidic device for self-monitoring of intraocular pressure	2014	165	1	0
28	Global Prevalence of Glaucoma and Projections of Glaucoma Burden through 2040	2014	154	3	0
29	The Pathophysiology and Treatment of Glaucoma	2014	153	1	0
30	In vivo performance of a drug-eluting contact lens to treat glaucoma for a month	2014	152	1	0
31	Differentially expressed microRNAs in the aqueous humor of patients with exfoliation glaucoma or primary open-angle glaucoma	2018	147	1	0
32	Shaping Patients' Perspective of Medical Marijuana for Glaucoma Treatment	2015	137	1	0
33	Association of Statin Use and High Serum Cholesterol Levels With Risk of Primary Open-Angle Glaucoma	2019	137	1	0
34	Genome-wide association analysis identifies TXNRD2, ATXN2 and FOXC1 as susceptibility loci for primary open-angle glaucoma	2016	134	1	0
35	Newly Diagnosed Primary Open-Angle Glaucoma Randomized to 2 Trabecular Bypass Stents or Prostaglandin: Outcomes Through 36 Months	2016	133	1	1
36	Screening for Glaucoma: U.S. Preventive Services Task Force Recommendation Statement	2013	129	1	0
37	Δ9-Tetrahydrocannabinol and Cannabidiol Differentially Regulate Intraocular Pressure	2018	122	1	0
38	Angiopoietin receptor TEK mutations underlie primary congenital glaucoma with variable expressivity	2016	121	1	0
39	Measurement of Intraocular Pressure by Patients With Glaucoma	2017	118	2	0
40	The Relationship between Caffeine and Coffee Consumption and Exfoliation Glaucoma or Glaucoma Suspect: A Prospective Study in Two Cohorts	2012	116	1	0

41	P16INK4a Upregulation Mediated by SIX6 Defines Retinal Ganglion Cell Pathogenesis in Glaucoma	2015	115	3	0
42	Cost-comparison of two trabecular micro-bypass stents versus selective laser trabeculoplasty or medications only for intraocular pressure control for patients with open-angle glaucoma	2017	110	1	1
43	Glaucoma and intraocular pressure in EPIC-Norfolk Eye Study: cross sectional study	2017	108	2	0
44	Three-Year Follow-up of a Novel Aqueous Humor MicroShunt	2016	108	1	1
45	Marijuana Use Among Patients With Glaucoma in a City With Legalized Medical Marijuana Use.	2015	108	1	0
46	A lymphatic defect causes ocular hypertension and glaucoma in mice	2014	103	1	0
47	Evaluation of a Trabecular Micro-Bypass Stent in Pseudophakic Patients With Open-Angle Glaucoma.	2016	101	1	0
48	Outcomes Following Implantation of Two Second-Generation Trabecular Micro-Bypass Stents in Patients with Open-Angle Glaucoma on One Medication: 18-Month Follow-Up	2016	100	1	1
49	GDF15 is elevated in mice following retinal ganglion cell death and in glaucoma patients	2017	100	1	0
50	Association of Dietary Fatty Acid Intake With Glaucoma in the United States	2018	95	1	0
51	Genomic locus modulating corneal thickness in the mouse identifies POU6F2 as a potential risk of developing glaucoma	2018	95	1	0
52	Equating spatial summation in visual field testing reveals greater loss in optic nerve disease	2016	95	5	0
53	Genome-wide analysis of multi-ancestry cohorts identifies new loci influencing intraocular pressure and susceptibility to glaucoma	2014	95	2	0
54	Long-Term Trends in Glaucoma-Related Blindness in Olmsted County, Minnesota	2014	94	1	0
55	Association of Repeated Intravitreous Bevacizumab Injections With Risk for Glaucoma Surgery	2017	92	1	0
56	CRISPR-Cas9ñbased treatment of myocilin-associated glaucoma	2017	92	1	0
57	Clinical evaluation of a trabecular microbypass stent with phacoemulsification in patients with open-angle glaucoma and cataract	2016	89	1	0
58	A Dose-Escalation Study to Evaluate the Safety, Tolerability, Pharmacokinetics, and Efficacy of 2 and 4 Weeks of Twice-Daily Ocular Trabodenoson in Adults with Ocular Hypertension or Primary Open-Angle Glaucoma	2016	85	1	0
59	Pro-fibrotic pathway activation in trabecular meshwork and lamina cribrosa is the main driving force of glaucoma	2016	84	1	0
60	Neuroprotective Effect of Curcumin Against Oxidative Damage in BV-2 Microglia and High Intraocular Pressure Animal Model	2014	83	3	0
61	Latanoprost for open-angle glaucoma (UKGTS): a randomised, multicentre, placebo-controlled trial	2015	80	2	1
6	Association of Macular Visual Field Measurements With Glaucoma Staging Systems	2019	77	1	0

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63	The Role of Statins and Cholesterol in the Primary Prevention of Primary Open-Angle Glaucoma	2019	77	1	0
64	Genome-wide association study identifies five new susceptibility loci for primary angle closure glaucoma	2016	76	3	0
65	Heterozygous Meg2 Ablation Causes Intraocular Pressure Elevation and Progressive Glaucomatous Neurodegeneration	2018	73	2	0
66	Long-term Safety and Efficacy of Latanoprostene Bunod 0.024% in Japanese Subjects with Open-Angle Glaucoma or Ocular Hypertension: The JUPITER Study	2016	72	1	1
67	Ligands for glaucoma-associated myocilin discovered by a generic binding assay.	2013	70	1	0
68	Genome-wide association study of intraocular pressure uncovers new pathways to glaucoma	2018	70	5	0
69	Association of an Electronic Health RecordñLinked Glaucoma Medical Reminder With Patient Satisfaction	2019	70	1	0
70	Detecting Glaucoma With a Portable Brain-Computer Interface for Objective Assessment of Visual Function Loss	2017	68	3	0
71	The Glaucoma-Associated Olfactomedin Domain of Myocilin Forms Polymorphic Fibrils That Are Constrained by Partial Unfolding and Peptide Sequence	2014	67	1	0
72	Targeted Delivery of Antiglaucoma Drugs to the Supraciliary Space Using Microneedles	2014	66	1	0
73	DRP1 inhibition rescues retinal ganglion cells and their axons by preserving mitochondrial integrity in a mouse model of glaucoma	2015	65	1	0
74	Vitamin B3 protects mice from glaucoma	2017	65	1	0
75	Effectiveness of early lens extraction for the treatment of primary angle-closure glaucoma (EAGLE): a randomised controlled trial	2016	63	2	0
76	Impact of the Introduction of Generic Latanoprost on Glaucoma Medication Adherence	2015	63	1	0
77	Mindfulness Meditation Reduces Intraocular Pressure, Lowers Stress Biomarkers and Modulates Gene Expression in Glaucoma	2018	61	3	0
78	Association of Geroprotective Effects of Metformin and Risk of Open-Angle Glaucoma in Persons With Diabetes Mellitus	2015	61	1	0
79	Neuroprotective effects of VCP modulators in mouse models of glaucoma	2016	61	3	0
80	Association of Long-term Ambient Black Carbon Exposure and Oxidative Stress Allelic Variants With Intraocular Pressure in Older Men	2019	60	1	0
81	Large Disparities in Receipt of Glaucoma Care between Enrollees in Medicaid and Those with Commercial Health Insurance	2017	60	1	0
82	Continuous Intraocular Pressure Monitoring During Nocturnal Sleep in Patients With Obstructive Sleep Apnea Syndrome	2016	59	3	0
83	African Ancestry Is Associated with Higher Intraocular Pressure in Latinos	2016	57	1	0
8	Minimally invasive glaucoma surgery: current status and future prospects	2016	56	1	0

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85	Network Meta-analysis for Clinical Practice Guidelines: A Case Study on First-Line Medical Therapies for Primary Open-Angle Glaucoma	2016	55	1	0
86	Common variants near ABCA1, AFAP1 and GMDS confer risk of primary open-angle glaucoma	2014	55	5	0
87	A Common Variant in MIR182 Is Associated With Primary Open-Angle Glaucoma in the NEIGHBORHOOD Consortium	2016	55	1	0
88	Patient-Physician Communication on Medication Cost during Glaucoma Visits	2017	54	1	0
89	Preliminary Steps to Address Glaucoma Medication Adherence	2019	53	1	0
90	Implantation of two second-generation trabecular micro-bypass stents and topical travoprost in open-angle glaucoma not controlled on two preoperative medications: 18-month follow-up	2017	51	1	1
91	Glaucoma is associated with plasmin proteolytic activation mediated through oxidative inactivation of neuroserpin	2017	49	5	0
92	Relationship Between Preferred Sleeping Position and Asymmetric Visual Field Loss in Open-Angle Glaucoma Patients	2014	47	3	0
93	Oral Glucosamine Supplements as a Possible Ocular Hypertensive Agent	2013	47	1	0
94	Association Between Body Levels of Trace Metals and Glaucoma Prevalence	2015	46	1	0
95	Characteristic Patterns of Dendritic Remodeling in Early-Stage Glaucoma: Evidence from Genetically Identified Retinal Ganglion Cell Types	2015	46	1	0
96	Refined Frequency Doubling Perimetry Analysis Reaffirms Central Nervous System Control of Chronic Glaucomatous Neurodegeneration	2015	46	1	0
97	Genetic association study of exfoliation syndrome identifies a protective rare variant at LOXL1 and five new susceptibility loci	2017	46	7	0
98	Driving with Glaucoma	2015	46	2	1
99	Optical Coherence Tomography Angiography Analysis of Perfused Peripapillary Capillaries in Primary Open-Angle Glaucoma and Normal-Tension Glaucoma	2016	43	1	0
100	Whole-Exome Sequencing of Congenital Glaucoma Patients Reveals Hypermorphic Variants in GPATCH3, a New Gene Involved in Ocular and Craniofacial Development	2017	42	2	0

*Country of corresponding author. 1=North America, 2=Europe, 3=Asia, 4=Africa, 5=Oceania, 6=South America, 7 indicates >1 country