Online Visibility and Scientific Relevance of Strabismus Research: Bibliometric Analysis

Aleksander Dominik Stupnicki, Basil Suresh, Saurabh Jain

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Abstract

Background: Quality and accuracy of online scientific data are crucial given the internet and social media serve nowadays as primary sources of medical knowledge.

Objective: Our study aims to assess the relationship between online visibility and the scientific relevance of strabismus research.

Methods: We used the Altmetric Attention Score (AAS) as a proxy for online visibility whereas citations and the journal's impact factor served as a metric for scientific robustness. We identified articles including the keyword "strabismus" and evaluated the correlation between the aforementioned variables within the 100 articles with the highest AAS and 100 articles with the highest number of citations.

Results: We demonstrated a significant, but weak correlation between online visibility and citations ($P = .04$, $r = .22$). We found no correlation between the Altmetric Score and the journal's impact factor ($P = .15$) or time ($P = .37$). For the 100 articles with the highest number of citations we found no correlation between the citations and the Altmetric Attention Score ($P = .73$) or the impact factor of the journal ($P = .15$).

Conclusions: Highly cited research related to strabismus is not always the most shared on social media. Therefore, researchers should make a greater effort to share high-impact articles related to strabismus on social media platforms to improve accessibility and quality of evidence-based knowledge for patients.

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Online Visibility and Scientific Relevance of Strabismus Research: Bibliometric Analysis

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Background: Quality and accuracy of online scientific data are crucial given the internet and social

media serve nowadays as primary sources of medical knowledge.

Objectives: Our study aims to analyse the relationship between scientific relevance and online visibility of strabismus research to establish: 1) Are the most popular strabismus articles scientifically relevant? 2) Are the most high-impact strabismus studies shared online enough?

Methods: The Altmetric Attention Score (AAS) was used as a proxy for online visibility whereas citations and the journal's impact factor (IF) served as a metric for scientific relevance. Using „strabismus" as a keyword, 100 articles with the highest AAS and 100 articles with the highest number of citations were identified. Statistical analyses, including Spearman's rank test, linear regression and factor analysis were performed to assess the relationship between AAS, citations, journal's impact factor and mentions across 18 individual web 2.0 platforms.

Results: Weak positive, statistically significant correlation was observed between normalised AAS and normalised citations ($P < .001$, r = .27) for articles with high visibility. Only Twitter mentions and Mendeley readers correlate significantly with normalized citations ($P = .02$, $P < .001$ respectively) and impact factor ($P = .04$, $P < .01$ respectively), with Twitter being the strongest, significant predictor of citation numbers (r = .53). For high-impact articles, no correlation was found between normalised citations and normalised AAS ($P = .12$) or the IF of the journal ($P = .55$).

Conclusion: Whilst clinical relevance influences online attention, most high-impact research related to strabismus is not sufficiently shared online. Therefore, researchers should make a greater effort to share high-impact articles related to strabismus on online media platforms to improve accessibility and quality of evidence-based knowledge for patients.

Introduction:

Patients, healthcare professionals and researchers increasingly use social media and online platforms as a source of knowledge, healthcare news and scientific research [1]. Despite the worldwide

prevalence of strabismus remaining stable at around 2% [2], the public's online interest in the topic has been rising; a trend reflected by the increasing popularity of queries related to the disease over the past two decades according to Google Trends. Due to this increasing reliance on online platforms, it is essential to ensure the quality and relevance of scientific data that is commonly accessed online, especially for lay members of the public who may lack the skills or time to assess that themselves.

To quantify the relevance of research within the field of medical science, the number of citations and impact factor of the journal are used most frequently [3]. The dissemination of the same academic information through platforms used by the general public, on the other hand, can be most reliably quantified by the Altmetric Attention Score; a real-time weighted measure of mentions across all Web 2.0 social media platforms [4, 5].

Bibliometric analyses using Altmetrics and other scientometrics have been conducted previously in the field of ophthalmic research to evaluate publication trends [6], disruptiveness of articles [7] or research productivity [8]. To date, however, there have been no such analyses within the subspeciality of strabismus, despite the pervasiveness of the disease.

Therefore, we decided to analyse the relationship between the scientific relevance of strabismus research and its contributions to the online sphere, in order to answer the following questions: 1) Are the most popular strabismus articles scientifically relevant? 2) Are the most high-impact strabismus studies shared online enough?

Methods:

In line with the best practice of literature searching [9], a Thesaurus synonym search was performed to identify appropriate keywords for database search. As of January 2023, Thesaurus does not identify synonyms for "strabismus" and the Cambridge Dictionary confirms it is the only medical

term to describe the condition [10]. No morphological variation of the term has been identified, eliminating the need for the use of truncation in keyword searches.

Therefore, a list of research articles including the keyword "strabismus" was generated on the 27th of January 2023 with Altmetric Explorer with no other restrictions (search period: January 2011 - January 2023). The keyword search engine in Altmetric Explorer yields comprehensive results including outputs that match the keyword across publication title, author name or journal title [11]. Hence, the pooled list was then filtered by a consultant ophthalmologist according to relevance to include 100 articles with the highest Altmetric Attention Score (a total of 255 titles and abstracts were analysed to compile 100 relevant publications). Additional preliminary searches using lay synonyms of strabismus, including "squint" and "cross-eye" were performed, but yielded no relevant or sufficiently high AAS results for inclusion, proving the keyword "strabismus" captures the bona fide core of publications in the field.

On the same day (27.01.2023), for each of the articles, Web of Science (WoS) was used to add information on the number of citations, time since publication and impact factor of the journal at the time of publication; other metrics traditionally used to assess the quality and relevance of scientific research [12]. Additional data on the source of AAS (including mentions across 1) news 2) blogs 3) Twitter 4) peer-review 5) Facebook 6) Wikipedia 7) LinkedIn 8) Weibo 9) Google+ 10) Reddit 11) Pinterest 12) F100 13) Q&A 14) Policy 15) Patent 16) Video 17) Syllabi 18) Mendeley) was pooled from Altmetric.com and evaluated to characterise the field.

For systematic comparison, the same approach to searching was implemented to yield a list of articles with the highest number of citations: On 27.01.2023 Web of Science was used to generate a list of 100 papers including the keyword "strabismus" with the highest number of citations, excluding papers published before 2011, the year Altmetric Explorer was founded and started tracking the Attention Score (search period: January 2011 - January 2023). No other filters were

applied to the search. On the same day, the Altmetric Attention Score for each of the articles was manually pooled from Altmetric.com. Data on time since publication and the journal's impact factor at the time of publication was extracted from WoS.

To account for temporal differences [13], the values for AAS and citations for both groups have been then normalised per year since publication.

Kolmogorov-Smirnov test was used to verify the distribution of the data does not follow a normal distribution and Spearman's rank correlation coefficient was used to test for correlation between all variables. Following correlational calculations, a linear regression model and factor analysis were performed to explain patterns among correlated variables; both of which are statistical techniques commonly employed in altimetric research [14, 15]. SPSS was employed for all statistical calculations. Statistical significance was defined as $P <.05$.

Results:

<u>Correlation analysis</u>

The normalised Altmetric Attention Scores of the 100 articles with the highest online visibility (median AAS = 11, IQR =10.75) correlate significantly with normalised citations (P = <.001) but demonstrate a weak strength of the relationship (rs = .27), for articles with Altmetric Score <150. To achieve this result, we have excluded three outlier articles with significantly higher AAS (AAS = 922, 413, 169 respectively, compared to median 11; z-score > 3), which would otherwise skew the statistical analysis. Spearman's rank test demonstrated no correlation between the normalised Altmetric Attention Score and the impact factor of the journal (P = .15) or time (P = .37) (see Table 1).

For the 100 articles with the highest number of citations (median = 30, IQR = 15), no statistically significant correlation was found between normalised citations and the normalised Altmetric Attention Score (P = .12) or impact factor of the journal (P = .55) but as expected they correlated significantly with time (P = .01) (see Table 1).

100 articles with the highest Altmetric Attention Scores (AAS)		
	normalised AAS and normalised citations	AAS and impact factor	AAS and time since publication
p-value	*<.001*	.15	.37
100 articles with the highest number of citations		
	normalised citations and normalised AAS	citations and impact factor	citations and time
p-value	.12	.55	*.01*

Table 1. Calculated p-values between the measured variables. Values in italics highlight a statistically significant correlation between variables for $P < .05$.

Upon analysis of AAS sources, we found a weak positive, statistically significant correlation between normalised citations and Twitter mentions ($P = .02$, rs = .27), normalised citations and Mendeley Readers ($P < .001$, rs = .40), as well as normalised citations and Policy mentions ($P = .02$, rs = .24) for the 100 articles with highest AAS. The same variables showed a weak positive, statistically significant correlation with the impact factor of the journal at the time of publication: Twitter and IF ($P = .04$, rs = .25), Mendeley Readers and IF ($P < .01$, rs = .32), Policy mentions and IF ($P < .05$, rs = .26).

Correlations between the number of mentions in the news, on blogs, in peer-reviews, on Facebook, Wikipedia, LinkedIn, Reddit, Google+, Weibo, Pinterest, Syllabi or Video and normalised citations or impact factor were not significant for $P < .05$ (see Appendix 1).

Multivariate analysis

To better understand variance among the correlated variables a linear regression model was run with normalized citations as the dependent variable and Twitter mentions, Mendeley readers and policy mentions as covariates. ANOVA test showed significant variance within the sample, confirming the suitability of the test ($P < .001$). We obtained an R^2 value of .31, indicating that 31% of the variance within citations can be explained cumulatively by the three AAS sources. Only Twitter and policy mentions, however, were significant predictors ($P < .01$), with Twitter mentions being the most important predictor as indicated by the highest standardized coefficient (r = .53).

Factor analysis

Factor analysis was performed on metrics with adequate data for the articles with the top 100 AAS - normalised citations, normalised AAS, impact factor, time since publication (months), Twitter mentions, Mendeley readers and policy documents. Bartlett's test of sphericity indicated an approximate Chi-square value of 124.42 ($P < 0.001$) and a Kaiser-Meyer-Olkin adequacy value of 0.607, together indicating the suitability of the dataset for factor analysis. Three factors were identified across these variables - F1 between Twitter, Mendeley, AAS and citations; F2 between Mendeley, Policy and citations; F3 between impact factor (IF) and time.

Discussion:

The significant, yet weak correlation of AAS with citations for articles with the highest online visibility, shows that the clinical relevance of strabismus-related publications (as measured by citations) can contribute to increased online popularity, but is not the sole determining factor. Furthermore, the lack of correlation between AAS and impact factor demonstrates that the relative importance of a journal in the field (and consequently the paper) does not determine its online popularity, which raises questions about the quality of strabismus research receiving the most online

attention.

Through correlational and multivariate analysis of mentions across individual Web 2.0 platforms, we have demonstrated Twitter mentions to be a significant and strongest predictor of citations for the most popular strabismus articles. Although prior studies demonstrated a more significant, causative impact of tweets on citation numbers [16] that relationship can differ between fields [17] and seems to be statistically significant for strabismus research, albeit moderate compared with other research domains. Overall, our findings imply that dissemination of strabismus research through Twitter can have an impact on scholarly visibility and subsequently citation rates.

Furthermore, we demonstrated a lack of statistically significant correlations between traditional scientometrics (citations and impact factor) and mentions across other social or media platforms, which has been also observed in other fields of research [17]. This reveals existing gaps that require more references to research papers on strabismus, including social media platforms like Facebook or LinkedIn, as well as critical, knowledge-oriented pages such as Wikipedia.

Furthermore, in terms of factor analysis, F1 linking AAS, citations, Mendeley and Twitter likely suggests that for strabismus research, there is a degree of overlap regarding the user bases/networks between Mendeley and Twitter despite the former being considered a platform largely used by academic professionals as opposed to the more widely public microblogging service [18]. It may also indicate that highly cited papers are receiving engagement and being discussed in both academic and general public networks indicating that such papers may have a wider social impact. F2 linking Mendeley, policy documents and citations may suggest that for highly cited papers, there is increased interest and readership on Mendeley - a proportion of which may be faculty and departmental figures. This in turn may lead to policy mentions for impactful research articles. Therefore, this suggests that papers with high citation counts and academic impact may be influencing policies and organisational standards [19]. F3 linking IF and time could be due to the overall increase and growth

of the cited strabismus literature over time however this is less relevant to our research question.

For the 100 articles with the highest number of citations, the lack of correlation between citations or impact factor and the AAS suggests that clinical relevance or perceived prestige related to the publishing journal does not affect the online visibility of strabismus articles. Researchers publishing in the strabismus realm should, therefore, make a greater effort to share their high-impact articles on social media. In turn, this could increase the visibility and accessibility of their research, especially for the lay public which rarely browses journals for medical knowledge, enhance collaboration and further the overall impact of their research.

Altmetric Attention Score (AAS) itself is a useful tool for authors to get quick, up-to-date insight into the performance of their articles online. It is crucial, however, to bear in mind the inherent limitations of AAS; the fact that it is ultimately only a metric of "mentions" or "posts" and is not an indicator of research quality or legitimacy [20]. In isolation, it may be deemed unreliable, as "viral" articles which do not exhibit robust research methodology or present sensible conclusions may still acquire a high AAS. Similarly, the AAS does not account for following or website traffic. As a result, a frequently mentioned article can effectively have low visibility and reception, despite a high AAS. Although Twitter mentions and Mendeley readership seem to have some impact on citation numbers of the most popular strabismus articles, they only account for a small proportion of the variance within citation data (31%). Thus, using alternative metrics, like Tweets, as predictors of scientific contribution and success is far from comprehensive and precise, as demonstrated before across several other fields [16, 17].

Furthermore, citations take a longer time to accumulate, whereas AAS is updated almost in real-time, so even when a new article is published that can have high publicity in social media and among the scientific community, the citation numbers will lag months or sometimes years behind. Due to this phenomenon, there may be weaker or no association between citations and AAS for the latest

research articles, which could skew the results of our 12-year view. Further statistical testing would be necessary to confirm that.

Additionally, in the case of strabismus research, both the AAS and citation numbers are characteristically low, which raises questions about the reliability of the dataset, as it is analogical to having a small sample size. Various scientifically irrelevant factors can cause a high AAS, such as the topic of the article, sensationalism, how easy it is understood by the general public or the number of intersections of the topic with other branches of medicine. A good example of the effect of those confounding factors is a publication included in our dataset entitled "Evidence That Leonardo da Vinci Had Strabismus", which had the highest AAS of 922 (over 83 times the median score), but only 6 citations. This demonstrates that especially for articles with high AAS scores, the virality of the topic can have a higher impact on the AAS than its scientific significance.

Conclusion:

We have demonstrated that the clinical relevance of strabismus research contributes to the amount of online attention it receives. However, the most high-impact strabismus research is not sufficiently shared across online platforms. Therefore, we recommend that researchers make a greater effort to share high-impact studies on social media platforms to improve the quality of evidence-based information about strabismus and improve the accessibility of this knowledge. To maximise the societal impact of research, it is important to interact with both academic and general audiences, as shown by the overlap between Mendeley and Twitter engagement of strabismus publications.

Furthermore, we revealed Twitter mentions to be the strongest predictor of citation numbers for strabismus articles, highlighting the potential impact of social media on scholarly visibility. Our findings also highlight the need for engagement of strabismus researchers across a broader range of platforms, including Facebook, LinkedIn or Wikipedia. However, due to its inherent biases and

limitations, the Altmetric Attention Score itself or mentions across specific platforms should only complement traditional metrics, such as impact factor and citations, to provide a broader picture of the publicity of the paper, but should not act as a stand-alone metrics for assessing the quality and relevance of strabismus articles.

Conflicts of Interests:

We declare no conflicts of interest.

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Supplementary Files

Multimedia Appendixes

Summary table of Spearman's rank test for normalised citations, impact factor and all 18 web 2.0 platforms analysed. * indicates significance level of P < .05 (two-tailed). ** indicates significance level of P < .01 (two-tailed).
URL: http://asset.jmir.pub/assets/9f1a01358e27db7a3423c79489b67311.xlsx