

Relationship between Altmetrics and Citations: A Study on the Highly Cited Research Papers

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ABSTRACT

The present study aims to assess highly cited articles using altmetrics and citations and identify the relationship between them. The statistical population consists of all the highly cited articles on surgery indexed on the Web of Science. The number of article citations was measured using the Web of Science and the altmetric score of the articles using the Altmetric Bookmarklet. The analysis of the data was carried out using descriptive statistics and Spearman's correlation coefficient. Of the 1077 highly cited surgery articles, 62.74 per cent had an altmetric score. The highest number of received citations was 1787, and the highest altmetric score was 2019. A positive and significant correlation was observed between the number of citations and the policy-making documents, Wikipedia citations and CiteULike ($P < 0.001$). A positive but non-significant correlation was also observed between the number of citations and the number of Mendeley readers ($r = 0.02$, $P > 0.05$). A poor, negative and significant correlations were observed between the number of citations and the overall altmetric score of the highly cited surgery articles ($r = -0.235$, $P < 0.001$). The findings may be due to the different pattern of using social media by the surgery researchers compared to the researchers of other fields. Altmetrics can only be used to complement citations and not replace them.

Keywords: Altmetrics; Citations; Highly cited articles; Surgery; Social media; Mendeley.

1. INTRODUCTION

Citation-based indices are used to evaluate the impact of scientific researches¹. These metrics have long been used by researchers, publishers, and finance companies to assess the impact and quality of research²⁻³. For many years, citation databases such as Web of Science (WoS) and Scopus have been measuring the impact of research projects with an emphasis on citation analysis. Besides, a new type of web-based metrics was developed in 2010 for measuring the impact of scientific research with an emphasis on social media⁴. The main advantage of these metrics, called altmetrics, is that the impact of the published document can be measured in a few hours or a few days after their publication⁵. The altmetric score can be calculated and is available instantaneously after the publication of an academic article and is suitable for recently published articles as well⁶, and compared to citations, it can provide a wider or at least different perspective on impacts⁷. Altmetrics may also help extend the concept of scientific impact to other impacts (such as societal, educational and cultural), which have been overlooked by most traditional evaluation methods. The purpose of altmetrics is to complement and improve the limitations of the traditional assessment method, i.e. bibliometrics, and web-based assessments, such as download counts⁸. Other features of altmetrics include free accessibility,

determining the total number of the readers of a document, and determining the dissemination of articles since their publication⁹. The altmetric website is used to calculate the overall altmetric score and its various indicators that tracks the attention to articles in the following resources, and may change slightly over time:

- Policy documents
- News (more than 1000 global news outlets)
- Blogs (over 9000 academic and non-academic blogs)
- Social media including Twitter, Facebook, Google+, LinkedIn, Sina Weibo and Pinterest
- Wikipedia
- Online reference managers (Mendeley and CiteULike) readers
- Post-publication peer-review platforms including PubPeer and Publons
- Recommendations of individual research outputs from F1000
- Multimedia and other online platforms including YouTube, Reddit, Q&A (stack overflow)

It should be noted that the altmetric.com has not covered the ResearchGate. Each of the noted resources has a weighted score that is used in calculating the overall altmetric score according to an automatic algorithm. Nonetheless, the number of Mendeley and CiteULike readers are provided separately and have no impact on the overall altmetric score. CiteULike has

currently been deleted from the list of altmetric resources, but during the data collection stage of the present study, examining the number of CiteULike readers was possible. To increase the publicity of published articles, most medical journals nowadays use social media such as Twitter, Facebook, YouTube, weblogs, and reference management tools such as Mendeley and CiteULike, which in turn attract more audience and increase the availability of the research findings to the end-users^{10,11}. Given this change in the mode of information exchange, physicians can access health information through various resources using a wide range of tools and technologies^{7,12}. Altmetrics can therefore be used in conjunction with the number of received citations to assess the quality of articles in these publications.

Surgery is one of the main branches of medicine that has developed extensively in the recent century¹³; it has been the subject of many scientific publications worldwide. According to a WoS report in 2006-2015, surgery has been the 15th most productive field out of 256 subject categories and the seventh most productive medical field¹⁴. Although surgery is one of the main and most productive subfields of medical sciences, and given the importance of social media in establishing scientific communications and disseminating research findings, the altmetric status of articles in this field remains unclear. Along with the advancements and developments in surgery and in scientific publications in this area, the use of social media can help surgeons, researchers and writers to disseminate their novelties and articles and the number of citations received by the surgery publications may be affected by the altmetrics score especially in highly cited articles. Nevertheless, the altmetrics status of highly cited surgery articles and its relation to the citations remains unclear.

2. LITERATURE REVIEW

Previous studies have examined the altmetric score in various medical fields, such as neurosurgery¹⁰, orthodontics¹⁵, emergency medicine⁷, and dentistry¹⁶, and different results have been reported on the relationship between altmetrics and the number of citations. For instance, a positive and significant relationship was found between most altmetric indices and the number of citations in the WoS in the field of medical informatics¹⁷. The altmetric score of orthodontics articles was not related significantly to the citations reported in Scopus¹⁵. A positive but poor correlation was observed between the number of citations and the altmetric scores in emergency medicine articles⁷ and between Twitter posts and citations in biomedicine literature¹⁸. Many studies have pointed out the need for further large-scale studies on the relationship between citations and altmetrics using combined qualitative and quantitative approaches^{1,2,9,19}.

3. OBJECTIVES

The present study intends to assess:

- The status of highly cited surgery articles indexed on the WoS in terms of presence in various social media
- The status of highly cited surgery articles indexed on the WoS in terms of the received citations
- The relationship between citations and the altmetric scores.

4. MATERIALS AND METHODS

The statistical population of this correlational study consisted of all the highly cited articles on surgery indexed on the WoS-Core Collection, which included 1077 documents. Data were collected from December 11 to January 10, 2016. There was no sampling in this study, and the sample size was the same as the population size. Data related to the number of article citations were collected from the WoS and the articles altmetric score using the Altmetric Bookmarklet, which is a Firefox browser extension. Data were analysed using descriptive statistics and Spearman's correlation coefficient in Excel and SPSS 16. Data were collected in four stages in this study.

4.1 Stage One

All the articles on surgery indexed on the WoS were retrieved using the search formula SU= (surgery), and the highly cited papers were then selected by filtering. To access the articles, the following routes were taken:

Web of Science -core collection --> advanced search --> SU= (Surgery)

1,405,986 articles were retrieved in this stage.

4.2 Stage Two

In this stage, the search was confined to the highly cited papers, which led to the retrieval of 1077 documents.

4.3 Stage Three

Articles with a Digital Object Identifier (DOI) were identified, and their required data (article title, publication year, number of citations and DOI) were exported from the WoS into Excel.

4.4 Stage Four

Data related to the altmetric indices (altmetric score, the score of each altmetric indicator and the score of the number of Mendeley and CiteULike readers) were extracted from www.altmetric.com through the Altmetric Bookmarklet and recorded in the checklist, and then entered into Excel and SPSS for further analysis.

5. FINDINGS

Of the 1077 highly cited articles on surgery indexed on the WOS, 1052 (97.7 %) had DOI. 25 articles (2.3 %) were without a DOI which had no altmetric scores. Overall, only 660 titles (61.28 %) from all the highly cited articles on surgery had an altmetric score.

Annals of surgery (14.07 %), American journal of transplantation (6.20 %) and Journal of Neurosurgery (3.89 %) have published the most number of highly cited articles and USA (59.57 %), England (15.76 %), Germany (11.03 %) have published the most number of highly cited surgery articles.

Data related to the highly cited surgery articles indexed on the WOS showed that most articles (n=147) had been published in 2016 and the least (n=78) in 2006. Moreover, the number of citations showed a descending trend over these years, such that the highest mean number of article citations per year pertained to 2006 (32.5) and the lowest mean number pertained to articles

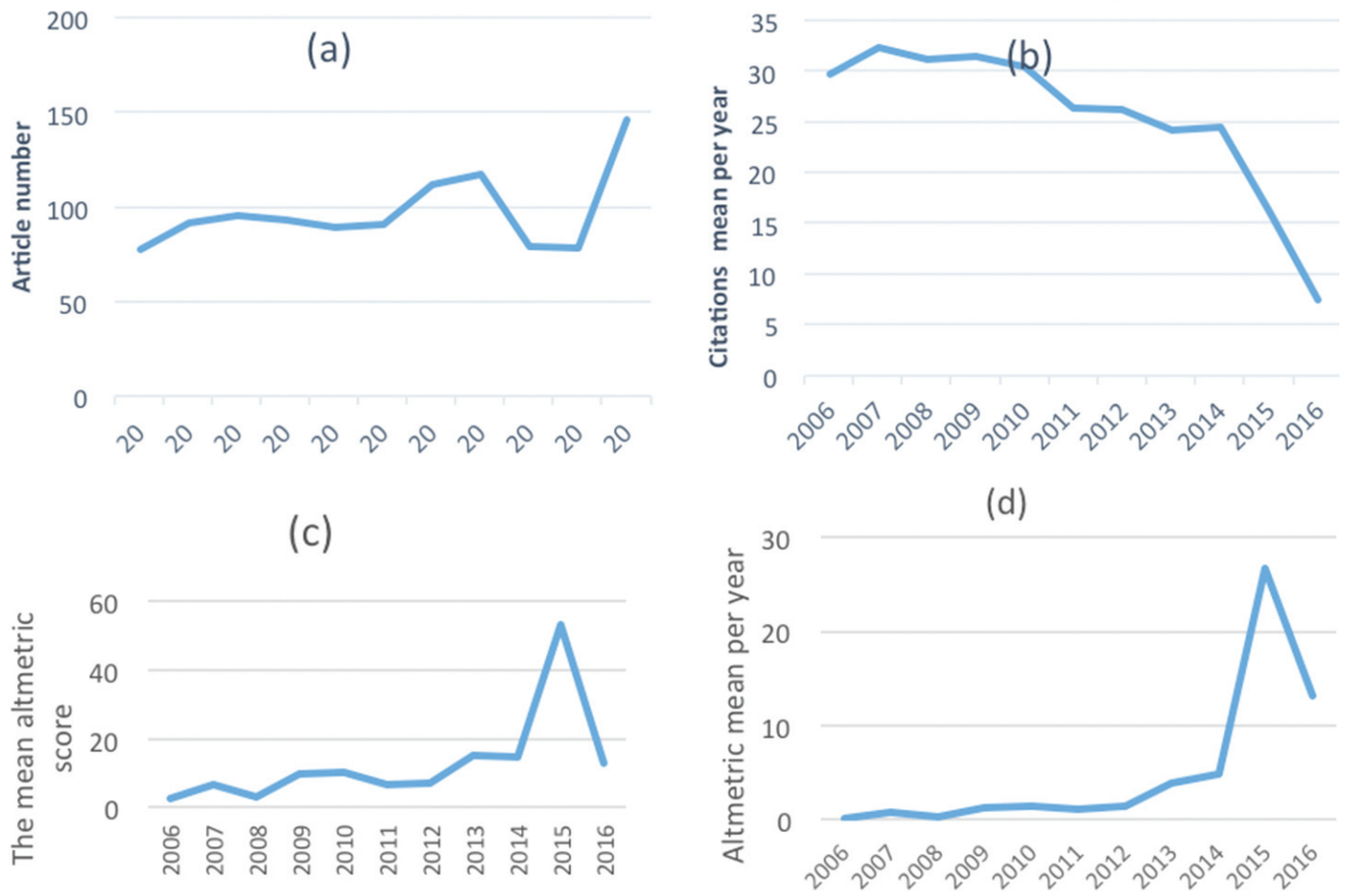


Figure 1. The number of articles, citations, and altmetric score of the highly cited articles on surgery in 2006-2016.

Table 1. The descriptive indices of the citations and the altmetric scores of the highly cited surgery articles

Maximum	Minimum	Standard Deviation	Median	Mean	
1787	4	149.1	140	163	Citations
2019	0	72.3	1	12.6	Altmetric Score

published in 2016 (7.5).

The most number of highly cited surgery articles belongs to the 2016. The mean altmetric score of the highly cited articles on surgery showed an ascending trend, and the articles published in recent years gained higher altmetric scores. The mean altmetric score of the articles was 12.6. The articles published in 2015 had the highest mean altmetric score (53.5) and the highest altmetric mean per year (26.7) [Fig. 1].

Of the 1077 highly cited articles on surgery, 62.74 per cent had an altmetric score. As shown in Table 1, the mean number of citations in the highly cited surgery articles was 163 and the mean altmetric score of these articles was 12.6. The highest number of received citations was 1787, and the highest altmetric score was 2019.

Mendeley and Twitter been used more than other social media to share the highly cited surgery articles (Fig. 2). The

highly cited surgery articles were shared on Twitter (48.38 %), Facebook (20.89 %), news media (13.65 %), and weblogs (11.88 %) as the social media with the highest mean scores in different altmetric indices, in the respective order. In addition, 61.09 per cent of the articles had attracted users in the Mendeley (Table 2).

The analyses showed a negative and significant correlation between the number of citations and the overall altmetric score of the highly cited surgery articles ($r=-0.235$, $P<0.001$) and a positive and significant correlation between citations and some altmetric indicators, including policy-making documents ($r=0.136$), Wikipedia ($r=0.178$) and the number of CiteULike readers ($r=0.147$, $P<0.001$). A positive but non-significant correlation was also observed between the number of citations and the number of Mendeley readers ($r=0.016$, $P>0.05$).

6. DISCUSSIONS

Social media attention and altmetric scores increased for these articles in recent years. This finding is confirmed by the majority of studies conducted on this subject. For example, Maggio *et al.* argued that the number of articles related to professional health education with altmetric scores increased from 2011 to 2015²⁰. Costas *et al.* argued that the presence and coverage of altmetric scores in social media is still very low and not common in scientific journals, but their

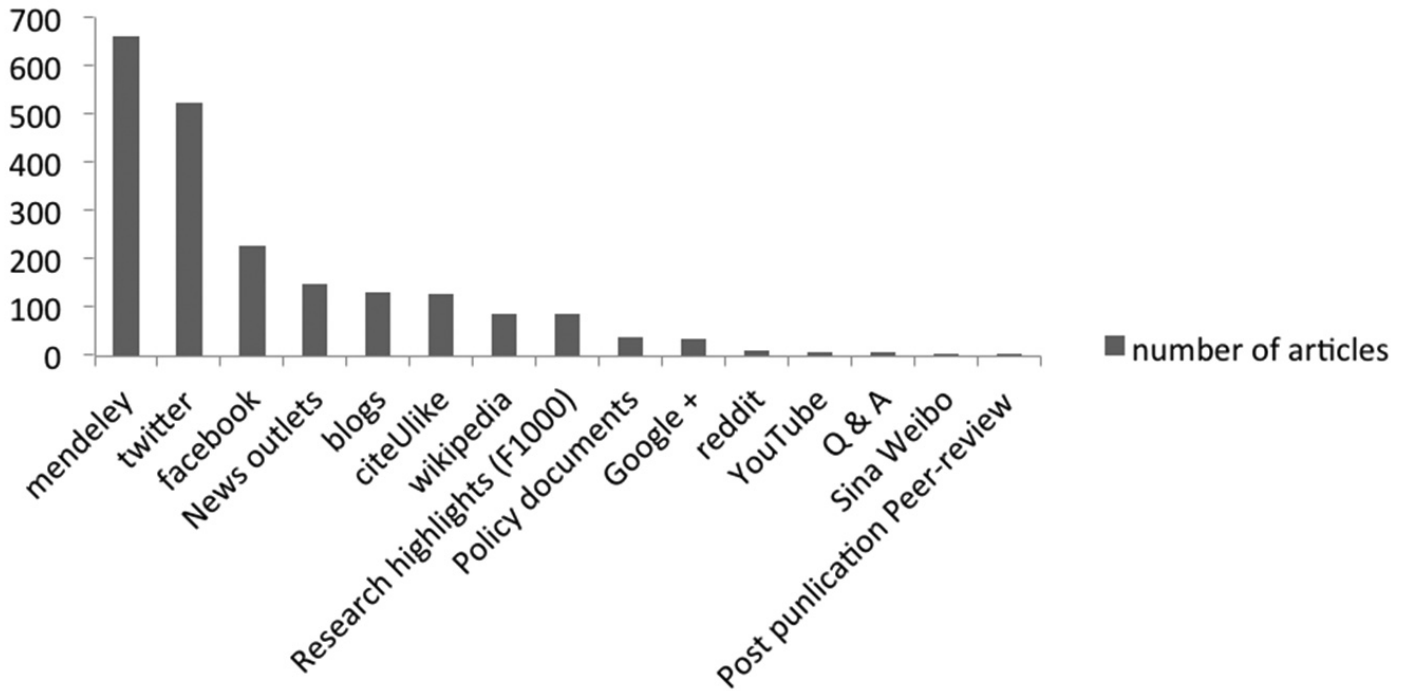


Figure 2. The rate of using social media in highly cited surgery articles.

Table 2. The score of the highly cited surgery articles in different altmetric indicators

Altmetric Indicators	Articles with the Altmetric Score		Mean	Median	Standard Deviation	Maximum Score
	n	Per cent				
Twitter	521	48.38	5.46	0	18.43	377
News outlets	147	13.65	0.63	0	3.68	71
Facebook	225	20.89	0.43	0	1.94	33
Blogs	128	11.88	0.21	0	0.77	8
Wikipedia	86	7.98	0.099	0	0.399	5
Research highlights (F1000)	86	7.98	0.079	0	0.27	1
Policy documents	36	3.34	0.038	0	0.196	2
Google +	33	3.06	0.037	0	0.22	3
Reddit	10	0.93	0.006	0	0.081	1
YouTube	5	0.46	0.004	0	0.102	3
Q & A	4	0.37	0.001	0	0.043	1
Sina Weibo	3	0.28	0.015	0	0.16	2
Post publication Peer-review forums	3	0.28	0.126	0	0.76	1
Mendeley	658	61.09	48.74	19	88.70	1221
CiteUlike	124	11.51	0.17	0	0.69	13

presence has been increasing over time⁸. Given the important role of publication rate and the use of new technologies and methods introduced in scientific papers in the field of medicine, tools such as social media and altmetric sources appear to be effective in spreading information in this field more rapidly and widely. Logge et al. have mentioned that surgeons are using Twitter for sharing their practices and experiences and this is the power to improve the medical care²¹. Findings revealed that Mendeley, Twitter, Facebook, and news media are the key tools for sharing highly cited surgery articles. Other researchers have also stated that Twitter and Mendeley are the most important tools for sharing articles^{16,20,22}. Of all the available social media, Facebook, Twitter and Google Plus, which are altmetric indices, were reported as the most popular in 2018²³. Nonetheless, the censorship of some of these media, such as Facebook and Twitter, in some countries may compromise the free flow of scientific information²⁴.

Post-publication peer reviews, such as PubPeer, Publons and Research Highlights (F1000), are particularly important in the assessment of research outputs. Research Highlights was loaded for 8 per cent of the articles, while Publons and PubPeer for only 3 per cent. It appears that the use of these services is also very low in other fields, such as dentistry¹⁶.

The citation of a medical document in policy-making documents of this field, such as the World Health Organisation, the National Institute

for Care and Health Excellence (UK) and the Association of Scientific Medical Societies (AWMF, Germany), is very important²⁵; however, only 36 articles (3.34 %) from the highly cited surgery articles had been cited in policy-making documents.

There is a poor and negative correlation between the number of citations and the overall altmetric score in the highly cited surgery articles indexed on the WOS. The results obtained by other researchers and in different fields are contradictory; for instance, Livas and Delli found no relationship between the altmetric attention score and the number of citations for discussed orthodontics articles¹⁵. Amath *et al.* argued that there is a poor relationship between the altmetric score and the number of citations for medical education articles¹, and the results obtained by some other researchers showed a positive correlation between the number of citations and the altmetric score⁷⁻⁸.

Regarding Mendeley and CiteULike readers, the present study showed that there is a positive but non-significant correlation between the Mendeley readers of the highly cited surgery articles and the number of citations of these articles, and a positive and significant correlation between the CiteULike readers of the highly cited surgery articles and the number of citations of these articles. These findings agree with the results of other studies²⁶⁻²⁸.

7. CONCLUSIONS

Given that the statistical population of this study consisted of highly cited articles, the altmetric scores obtained appear to be lower than expected, which shows that the highly cited researchers of this field may not use social media extensively. The reason for this finding needs to be investigated; however, their heavy workloads and lack of time for using these media may play a role. A study conducted by Mas-Bleda *et al.*²⁹ argues that highly cited European authors seem to have fallen behind on the use of social media. The social media behaviours of highly cited researchers compared to other researchers can be an interesting topic for future studies.

A negative correlation was observed between the number of citations and the altmetric score of the highly cited surgery articles indexed on the WoS. Nonetheless, the correlation coefficient found in the present study (-0.235) was not sufficiently strong to suggest a totally inverse correlation between these two variables. Given the disparate findings of other studies on this subject and the poor correlation coefficient obtained, no definitive conclusions can be drawn about the correlation between these two variables. As Sotudeh *et al.*²⁸ have pointed out, one of the reasons for the poor or lack of correlation between these variables may be that social media are still not extensively used for scientific purposes. Another reason may be the differences in the environment from which these indices originate, as any author can cite a document several times in his various articles, while he can only mark that document once in his user account. Citations, thus, show the “frequency of use” and altmetrics the “number of users”. It can therefore be argued that altmetrics can only be used to complement citations and not replace them. Universities and ranking institutions are recommended to consider altmetrics

in addition to traditional indicators when assessing scientific outputs.

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